

Rikhoff, Jeffrey

From: Rikhoff, Jeffrey
Sent: Wednesday, August 11, 2010 3:53 PM
To: Eccleston, Charles
Cc: Imboden, Andy; Pham, Bo
Subject: RE: Salem and Hope Creek Chapter 2 - Technical review of Land Use and Socioeconomics Sections
Attachments: Chapter 2 - V 2 1 (GB DB) - JJR edits 081010.docx

Charles,

Attached is my redline/strikeout markup, corrections, and comments on Salem HCGS SEIS Chapter 2. I revised and corrected the land use and socioeconomics sections. I also made a few corrections to references to account for new and updated information. Markups of Chapters 4 and 8 to follow.

Let me know if you have any questions.

Thanks,

jeff

Jeffrey Rikhoff

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From: Eccleston, Charles
Sent: Monday, August 09, 2010 11:04 AM
To: Rikhoff, Jeffrey
Subject: Chapter 2, 4, & 8

Jeff,

Here is chapter 2, 4, and 8. If you can simply add any changes to these files, I can send then send the files back to AECOM. They will do a "compare" between your version and their baseline version, and incorporate your changes into the baseline version.

Charles H. Eccleston

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Draft

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2.0 AFFECTED ENVIRONMENT

Salem Nuclear Generating Station (Salem) and Hope Creek Generating Station (HCGS) are located at the southern end of Artificial Island in Lower Alloways Creek Township, Salem County, New Jersey. The facilities are located at River Mile 50 and River Mile 51, respectively, approximately 17 miles south of the Delaware Memorial Bridge. Philadelphia is about 40 miles northeast and the city of Salem, New Jersey, is 8 miles northeast of the site (U.S. Atomic Energy Commission [AEC] 1973). Figure 2-1 shows the location of Salem and HCGS within a six-mile radius and Figure 2-2 is an aerial photograph of the site.

Because existing conditions are partially the result of past construction and operation at the plants, the impacts of these past and ongoing actions and how they have shaped the environment are presented in this chapter. Section 2.1 of this report describes Salem and HCGS as a combined site (site), the individual facilities, and their operations; Section 2.2 discusses the affected environment; and Section 2.3 describes related Federal and State activities near the site.

2.1 Facility and Site Description and Proposed Plant Operation during the Renewal Term

Artificial Island is a 1500 acre island that was created by the U.S. Army Corps of Engineers (USACE) beginning in the early twentieth century. The island began as buildup of hydraulic dredge spoils within a progressively enlarged diked area established around a natural sandbar that projected into the river. The low and flat tidal marsh and grassland has an average elevation of about 9 feet (ft) above mean sea level (MSL) and a maximum elevation of about 18 ft above MSL. (AEC 1973)

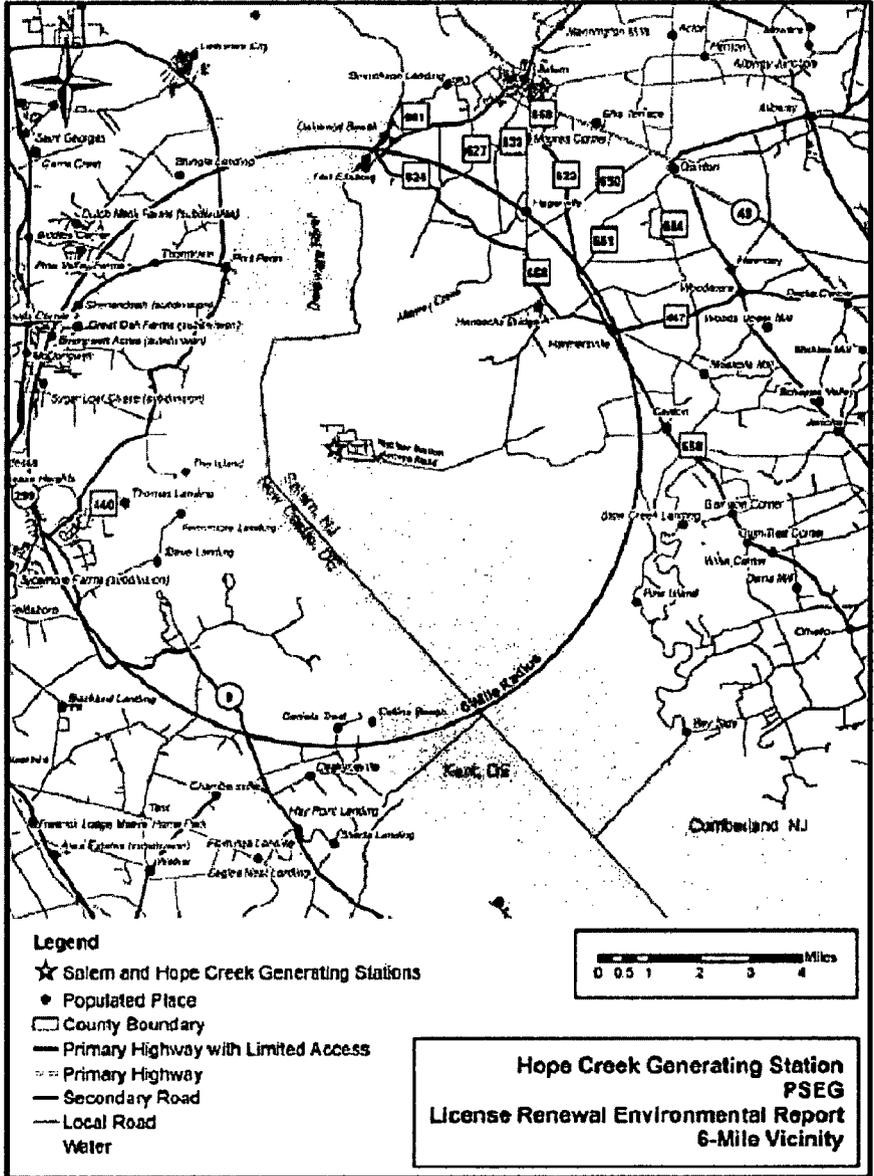
PSEG Nuclear, LLC (PSEG) owns approximately 740 acres on the southern end of Artificial Island. The Salem and HCGS facilities occupy 373 acres (220 acres for Salem and 153 acres for HCGS) in the southwestern corner of the island. The remainder of Artificial Island is undeveloped.

Adjacent land owners include the U.S. Government and the State of New Jersey. The northern portion of Artificial Island, a very small portion of which is within the State of Delaware boundary, and a 1-mile wide inland strip of land abutting the island are owned by the U.S. Government (AEC 1973). The State of New Jersey owns the remainder of Artificial Island as well as much nearby inland property. Distance to the PSEG property boundary from the two Salem reactor buildings is approximately 4200 ft. Distance to the PSEG property boundary from the HCGS reactor building is 2960 ft.

There are no major highways or railroads within about 7 miles of the site. Land access is provided via Alloway Creek Neck Road to Bottomwood Avenue. The site is located at the end of Bottomwood Avenue and there is no traffic that bypasses the site. Barge traffic has access to the site by way of the Intracoastal Waterway channel maintained in the Delaware River. (AEC 1973)

Figures 2-3 and 2-4 show the property boundaries and facility layouts for the Salem and HCGS facilities.

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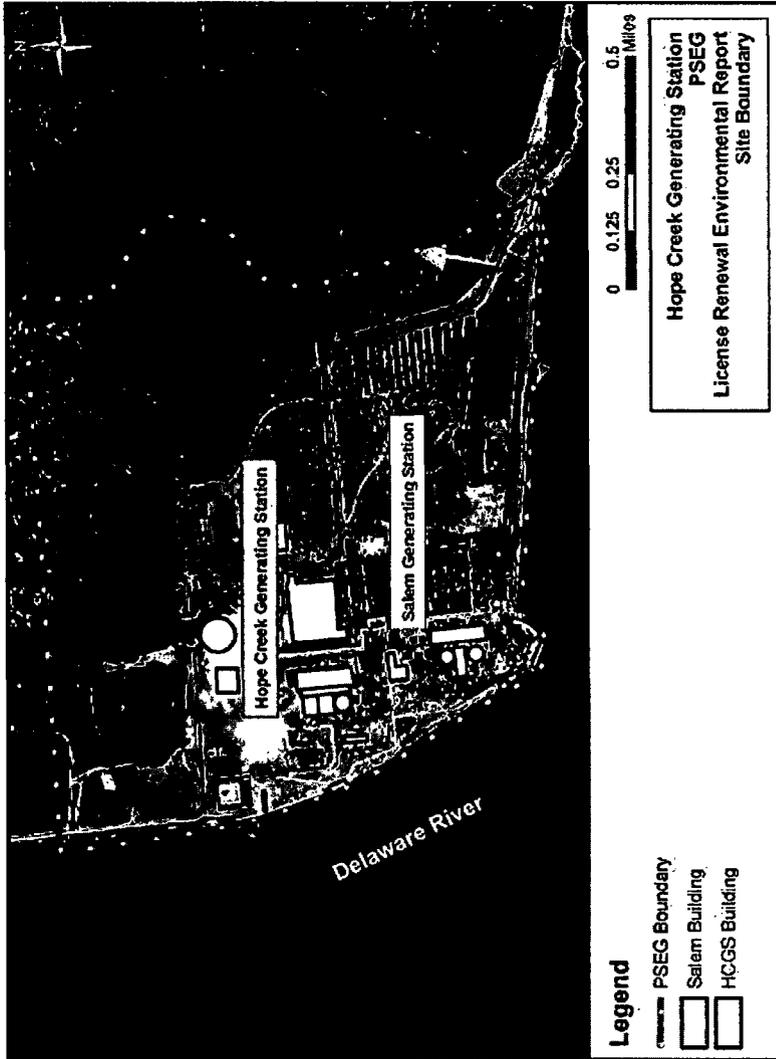


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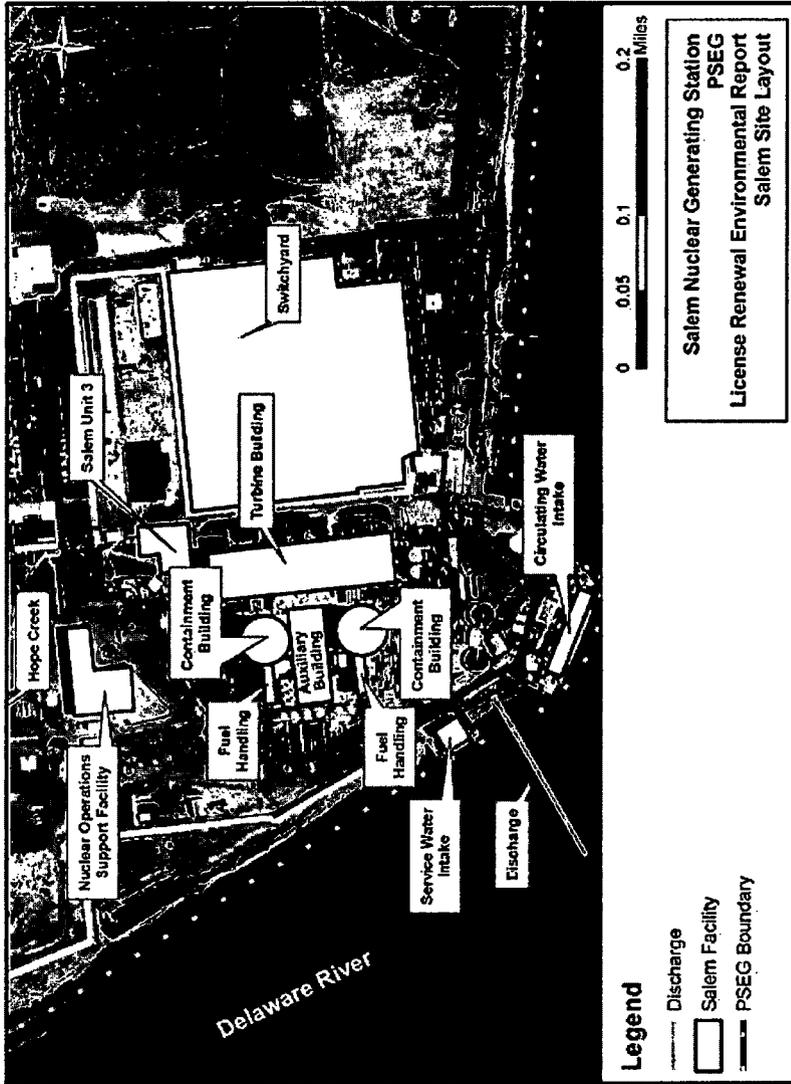
Figure 2-1. Location of Salem and HCGS Site, within a 6-Mile Radius
(Source: PSEG 2009a; PSEG 2009b)

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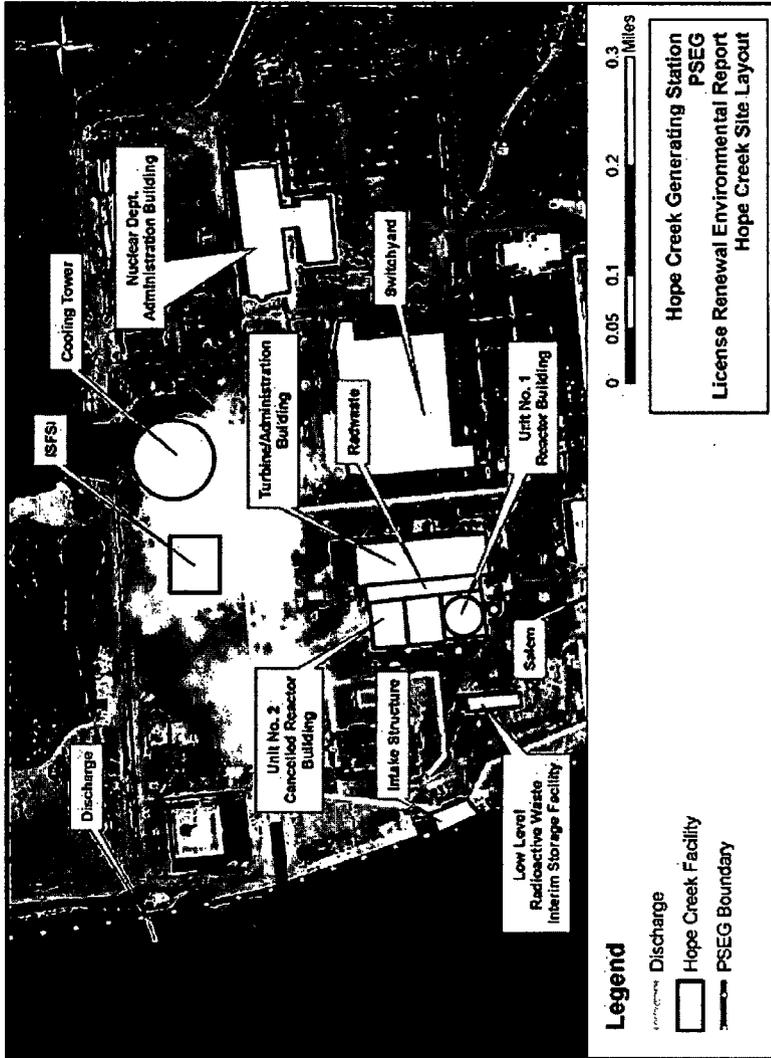
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Figure 2-2. Aerial Photo (Source: PSEG 2009a, PSEG 2009b)



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Figure 2-3. Salem Facility Layout (Source: PSEG 2009a)



Affected Environment

- 1 **Figure 2-4. HCGS Facility Layout (Source: PSEG 2009b)**
- 2

Affected Environment

1 Three metropolitan areas lie within 50 miles of the PSEG site: Wilmington, Delaware, the
2 closest city, approximately 15 miles to the northwest; Philadelphia, Pennsylvania, approximately
3 35 miles to the northeast; and Baltimore, Maryland, approximately 45 miles to the east-
4 southw~~est~~east (Figure 2-5 shows a map of the site within a 50-mile radius).

5 Industrial activities within 10 miles of the site are confined principally to the west bank of the
6 Delaware River north of Artificial Island (Delaware City, New Castle, and Wilmington). There is
7 no significant industrial activity near the site. With little industry in the region, construction and
8 retail trade account for nearly 40 percent of the revenues generated in the Salem County
9 economy (U.S. Census Bureau [USCB] 2006). Smaller communities in the vicinity of the site
10 (Haddock's Bridge, New Jersey; Salem, New Jersey; Quinton, New Jersey; and Shenandoah,
11 Delaware) consist of primarily of small retail businesses.

12 Located about two miles west of the site on the western shore of the Delaware River is the
13 Augustine State Wildlife Management Area, a 2667-acre wildlife management area managed by
14 the Delaware Division of Fish and Wildlife (Delaware Division of Fish and Wildlife 2010a).
15 Southwest of the site, also on the Delaware side of the Delaware River, is the Appoquinimink
16 Wildlife Area. Located less than a mile northeast of the site is the upper section of the Mad
17 Horse Creek Fish and Wildlife Management Area. This is a non-contiguous 9500-acre wildlife
18 area managed by the New Jersey Division of Fish and Wildlife with sections northeast, east,
19 and southeast of the site (NJDFW 2009a). Recreational activities at these wildlife areas within
20 10 miles of the site consist of boating, fishing, hunting, camping, hiking, picnicking, and
21 swimming.

22 ~~Salem currently employs a workforce of approximately 665 regular, full-time employees and~~
23 ~~HCGS currently employs a workforce of approximately 513 regular, full-time employees. The~~
24 ~~facilities share up to an additional 270 PSEG corporate and 86 matrixed employees for a total of~~
25 ~~about 1500 site employees (PSEG 2009a, PSEG 2009b).~~

Comment [JR1]: Different employment numbers than the employment numbers discussed in Section 2.2.8.

26 2.1.1 Reactor and Containment Systems

27 2.1.1.1 Salem

28 Salem is a two-unit plant utilizing pressurized water reactors (PWR) designed by Westinghouse
29 Electric. Each unit has a current licensed thermal power at 100 percent power of 3459
30 megawatt-thermal (MWt; PSEG 2009a). Salem Units 1 and 2 entered commercial service June
31 1977 and October 1981, respectively (~~Nuclear News 2009~~) (NRC Information Digest, NUREG-
32 1350). At 100 percent reactor power, the currently anticipated net electrical output is
33 approximately 1169 megawatt-electric (MWe) for Unit 1 and 1181 for Unit 2 (Nuclear News
34 2009). The Salem units have once-through circulating water systems for condenser cooling that
35 withdraws brackish water from the Delaware Estuary through one intake structure located at the
36 shoreline on the south end of the site. An air-cooled combustion turbine peaking unit rated at
37 approximately 40 MWe (referred to as "Salem Unit 3") is also present. (PSEG 2009a, PSEG
38 2009b)

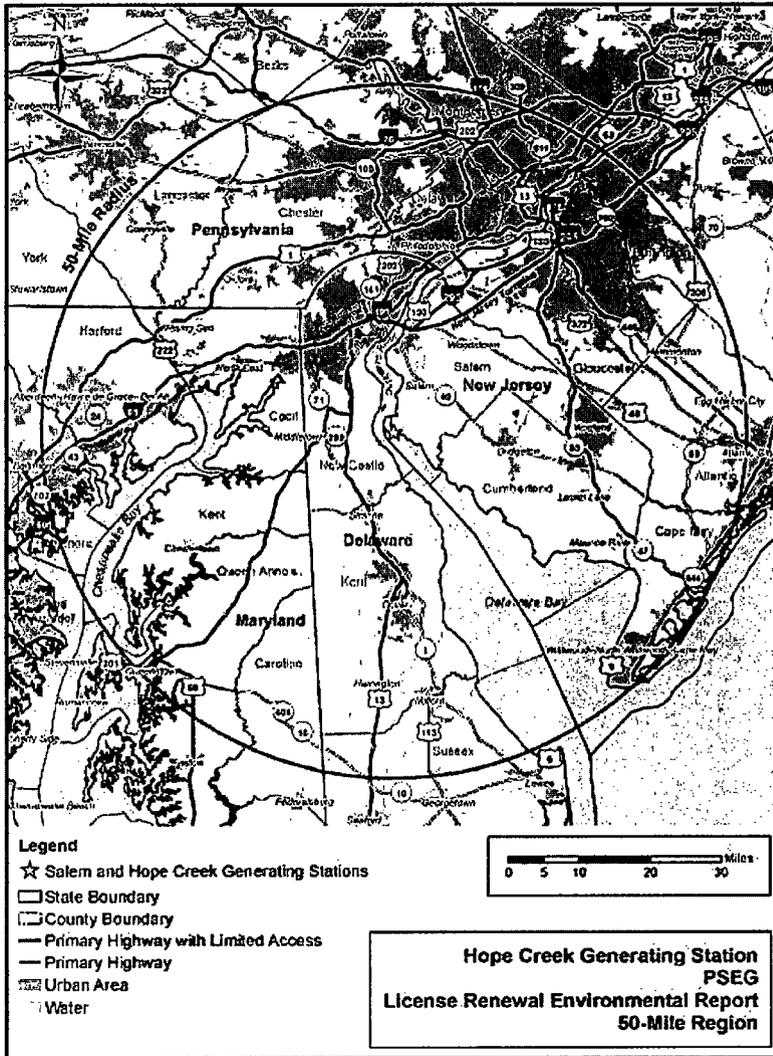
Comment [C2]: We should use an NRC source for this information.

39 In the PWR power generation system (Figure 2.6), reactor heat is transferred from the primary
40 coolant to a lower pressure secondary coolant loop, allowing steam to be generated in the
41 steam supply system. The primary coolant loops each contain one steam generator, two
42 centrifugal coolant pumps, and the interconnected piping. Within the reactor coolant system
43 (RCS), the reactor coolant is pumped from the reactor through the steam generators and back

Affected Environment

1 to the reactor inlet by two centrifugal coolant pumps located at the outlet of each steam
2 generator. Each steam generator is a vertical straight tube-and-shell heat exchanger that

3



4 **Figure 2-5. Location of of Salem and HCGS Site, within a 50-Mile Radius**
5 **(Source: PSEG 2009a, PSEG 2009b)**
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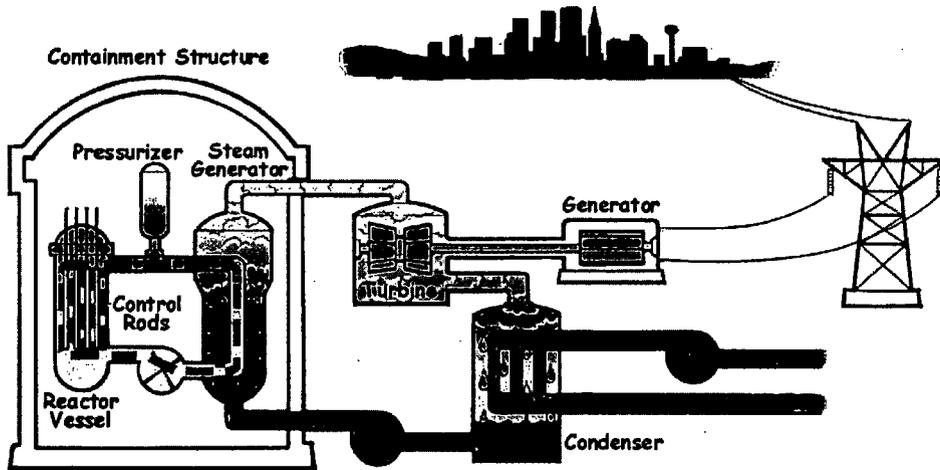


Figure 2-6. Simplified Design of a Pressurized Water Reactor (U.S. Nuclear Regulatory Commission [NRC] 2010a)

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produces superheated steam at a constant pressure over the reactor operating power range. The steam is directed to a turbine, causing it to spin. The spinning turbine is connected to a generator, which generates electricity. The steam is directed to a condenser where it cools and converts back to liquid water. This cool water is then cycled back to the steam generator, completing the loop. (NRC 2010a)

The secondary containment for radioactive material that might be released from the core following a loss-of-coolant accident are the units' independent Containment and Fuel Handling Buildings and their associated isolation systems. The structures serve as both a biological shield and a pressure container for the entire reactor cooling system. The reactor containment structures are vertical cylinders with 16 ft (4.88 meters [m]) thick flat foundation mats and 2 to 5 ft (0.61 to 1.52 m) thick reinforced concrete slab floors topped with hemispherical dome roofs. The side walls of each building are 142 ft (43.28 m) high and the inside diameter is 140 ft (42.67 m). The concrete walls are 4.5 ft (1.37 m) thick and the containment building dome roofs are 3.5 ft (1.07 m) thick. The inside surface of the reactor building is lined with a carbon steel liner with a varying thickness of 0.25 inch (0.635 centimeter [cm]) to 0.5 inch (1.27 cm) (PSEG 2007).

The cores of the Salem reactors are moderated and cooled by light water ($^1\text{H}_2\text{O}$ as compared to heavy water, $^2\text{H}_2\text{O}$) at a pressure of 2250 pounds per square inch absolute (psia). Boron is present in the light water coolant as a neutron absorber. A moderator, or neutron absorber, is a substance that slows the speed of neutrons increasing the likelihood of fission of a uranium-235 atom in the fuel. The cooling water is circulated by the reactor coolant pumps. These pumps are vertical single stage centrifugal pumps equipped with controlled-leakage shaft seals (PSEG 2007a).

Both Salem units utilize slightly enriched uranium dioxide (UO_2) ceramic fuel pellets in zircaloy cladding (PSEG 2007a). Fuel pellets form fuel rods and fuel rods are joined together in fuel

Comment [C3]: Using "secondary" containment is confusing. There was no discussion of the "primary" containment (i.e., fuel pellet and rod). Primary and secondary containment can be confused with BWR physical structures. I recommend that "secondary" be deleted.

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1 assemblies. The fuel assemblies consist of 264 fuel rods arranged in a square array. Salem
2 uses fuel that is nominal enriched to 5.0 percent (percent uranium-235 by weight). The
3 combined fuel characteristics and power loading result in a fuel burn-up of about 60,000
4 megawatt-days per metric ton uranium (PSEG 2009a).

5 The original Salem steam generators have been replaced. In 1997, the Unit 1 steam generators
6 were replaced and in 2008 the Unit 2 steam generators were replaced (PSEG 2009a).

7 **2.1.1.2 Hope Creek**

8 HCGS is a one-unit station utilizing a boiling water reactor (BWR) designed by General Electric.
9 The power plant has a current licensed thermal power at 100 percent power of 3840 MWt with
10 an electrical output estimated to be approximately 1083 MWe (73 FR 13032, Nuclear News
11 2009). HCGS has a closed cycle circulating water system for condenser cooling that consists of
12 a natural draft cooling tower and associated withdrawal, circulation, and discharge facilities.
13 HCGS withdraws brackish water with the Service Water System (SWS) from the Delaware
14 Estuary (PSEG 2009b).

Comment [C4]: See above comment (S1) to use an NRC reference, NUREG-1350

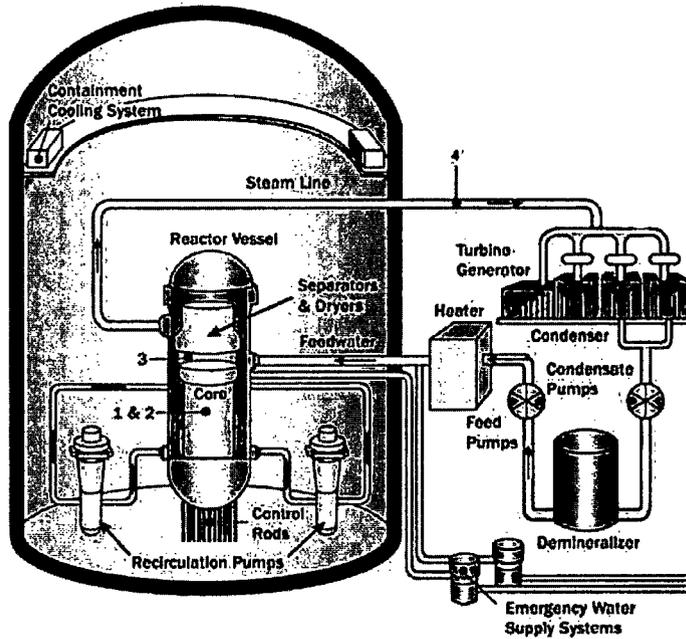


Figure 2-7. Simplified Design of a Boiling Water Reactor (NRC 2010b)

Affected Environment

1 In the BWR power generation system (Figure 2.7), heat from the reactor causes the cooling
2 water which passes vertically through the reactor core to boil, producing steam. The steam is
3 directed to a turbine, causing it to spin. The spinning turbine is connected to a generator, which
4 generates electricity. The steam is directed to a condenser where it cools and converts back to
5 liquid water. This cool water is then cycled back to the reactor core, completing the loop (NRC
6 2010b).

7 The ~~secondary~~ containment for radioactive material that might be released from the core
8 following a loss-of-coolant accident is the Reactor Building. The structure serves as both a
9 biological shield and a pressure container for the entire reactor cooling system. The reactor
10 building structure is a vertical cylinder with 14-ft (4.28-m) thick flat foundation mats and 2 to 5 ft
11 (0.61 to 1.52 m) thick reinforced concrete slab floor. The side walls of the cylinder are
12 approximately 250 ft (72.2 m) high, topped with torispherical dome roof, and surrounded by a
13 rectangular structure that is up to 132 ft (40.2 m) tall. (PSEG 2006).

Comment [C5]: Similar to comment S2.
Delete "secondary"

14 The HCGS reactor utilizes slightly enriched UO₂ ceramic fuel pellets in zircaloy cladding (PSEG
15 2007). Fuel pellets form fuel rods and fuel rods are joined together in fuel assemblies. HCGS
16 uses fuel that is nominal enriched to 5.0 percent (percent uranium-235 by weight) and the
17 combined fuel characteristics and power loading result in a fuel burn-up of about 60,000
18 megawatt-days per metric ton uranium (73 FR 13032).

19 2.1.2 Radioactive Waste Management

20 Radioactive wastes resulting from plant operations are classified as liquid, gaseous, or solid.
21 Liquid radioactive wastes are generated from liquids received directly from portions of the
22 reactor coolant system or were contaminated by contact with liquids from the reactor coolant
23 system (RCS). Gaseous radioactive wastes are generated from gases or airborne particulates
24 vented from reactor and turbine equipment containing radioactive material. Solid radioactive
25 wastes are solids from the reactor coolant system, solids that came into contact with reactor
26 coolant system liquids or gases, or solids used in the reactor coolant system or steam and
27 power conversion system operation or maintenance.

28 The Salem and HCGS facilities include radioactive waste systems, which collect, treat, and
29 provide for disposal of radioactive and potentially radioactive wastes that are byproducts of plant
30 operations. Radioactive wastes include are activation products resulting from the irradiation of
31 reactor water and impurities therein (principally metallic corrosion products) and fission products
32 resulting from defective fuel cladding or uranium contamination within the reactor coolant
33 system. Radioactive waste system operating procedures ensure that radioactive wastes are
34 safely processed and discharged from the plant within the limits set forth in Title 10 of the Code
35 of Federal Regulations (CFR) Part 20, "Standards for Protection against Radiation," and 10 CFR
36 Part 50, "Domestic Licensing of Production and Utilization Facilities."

37 When reactor fuel has been exhausted, a certain percentage of its fissile uranium content is
38 referred to as spent fuel. Spent fuel assemblies are removed from the reactor core and
39 replaced with fresh fuel assemblies during routine refueling outages, typically every 18
40 months. Spent fuel assemblies are stored in the spent fuel pool. Salem's spent fuel pool
41 storage capacity for each unit is 1632 fuel assemblies that will allow sufficient storage up to the
42 year 2011 for Unit 1 and 2015 for Unit 2 (PSEG 2009a). The HCGS spent fuel pool facility is
43 designed to store up to 3976 fuel assemblies (PSEG 2009b).

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1 In 2005, the NRC issued a general license to PSEG authorizing that spent nuclear fuel could be
2 stored at an Independent Spent Fuel Storage Installation (ISFSI) at the PSEG site. The general
3 license allows PSEG, as a reactor licensee under 10 CFR 50, to store spent fuel from both
4 HCGS and Salem at the ISFSI, provided that such storage occurs in pre-approved casks in
5 accordance with the requirements of 10 CFR 72, subpart K (General License for Storage of
6 Spent Fuel at Power Reactor Sites) (NRC 2005). At this time, only HCGS spent fuel is stored at
7 the ISFSI. However, transfers of spent fuel from the Salem spent fuel pool to the ISFSI are
8 expected to begin approximately one year before the remaining capacity of the pool is less than
9 the capacity needed for a complete offload to spent fuel (PSEG 2009b).

10 2.1.2.1 Radioactive Liquid Waste

11 Both the Salem and HCGS facilities operate systems to provide controlled handling and
12 disposal of small quantities of low-activity liquid radioactive wastes generated during station
13 operation. However, because the Salem units are cooled by a once-through RCS and the
14 HCGS unit is cooled by a closed cycle RCS, the management of potentially radioactive liquids is
15 different. Potentially radioactive liquid waste streams at the Salem facility are managed by the
16 Radioactive Liquid Waste System (RLWS) and the Chemical and Volume Control System
17 (CVCS). At HCGS, potentially radioactive liquid waste streams are managed under the Liquid
18 Waste Management System (LWMS).

19 The bulk of the radioactive liquids discharged from the Salem RCS are processed and retained
20 inside the plant by the CVCS recycle train. This minimizes liquid input to the RLWS. Liquid
21 radioactive waste entering the RLWS is released in accordance with Federal and State
22 regulation. Prior to release, liquids are collected in tanks, sampled, and analyzed. Based on
23 the results of the analysis, the waste is processed to remove radioactivity prior to releasing it to
24 the Delaware Estuary via the circulating water system and a permitted outfall. Discharge
25 streams are appropriately monitored, and safety features are incorporated to preclude releases
26 in excess of the limits of 10 CFR 20, *Standards for Protection Against Radiation* (PSEG 2009a).

27 In 2003, PSEG identified tritium in groundwater from onsite sampling wells near the Salem Unit
28 1 Fuel Handling Building (FHB). The source of tritium was identified as the Salem Unit 1 Spent
29 Fuel Pool. In November 2004, the New Jersey Department of Environmental Protection
30 (NJDEP), Bureau of Nuclear Engineering (BNE) approved a groundwater remediation strategy
31 and by September 2005 a full-scale ground-water recovery system (GRS) had been installed
32 (PSEG 2009a). The groundwater recovery system pulls groundwater toward the recovery
33 system and away from the site boundary.

34 Since 2005, tritium-contaminated groundwater from the groundwater recovery system is
35 transferred to the LWMS where it mixes with other liquid plant effluent before being discharged
36 into the Salem once-through, condenser cooling water system discharge line. The recovered
37 groundwater is sampled prior to entering the discharge line to demonstrate compliance with off-
38 site dose requirements. The water is subsequently released to the Delaware Estuary via a
39 permitted outfall in accordance with plant procedures and NRC requirements for the effluent
40 release of radioactive liquids. Surface water sampling as part of the Radiological Environmental
41 Monitoring Program (REMP) does not show an increase in measurable tritium levels since the
42 groundwater recovery system was initiated.

43 Potentially radioactive liquid wastes entering the HCGS LWMS are collected in tanks in the
44 Auxiliary Building. Radioactive contaminants are removed from the wastewater either by
45 demineralization or filtration. This ensures that the water quality is restored prior to being

1 returned to the condensate storage tank (CST) or discharged via the cooling tower blowdown
 2 line to the Delaware Estuary via a permitted outfall. If the liquid is recycled to the plant, it meets
 3 the purity requirements for CST makeup. Liquid discharges to the Delaware Estuary are
 4 maintained in compliance with 10 CFR 20, *Standards for Protection Against Radiation* (PSEG
 5 2009b).

6 Both Salem and HCGS release liquid effluents into the environment. Rereleases are controlled
 7 and monitored. Doses from these releases represent a fraction of the regulatory allowable 100
 8 millirem per year (mrem/yr) doses specified in the facility operating license and NRC
 9 regulations. Radiological monitoring began in 1968. Monitoring results are presented in the
 10 Radiological Environmental Monitoring Program reports. The NRC staff reviewed the Salem/
 11 HCGS radioactive effluent release reports for 2004 through 2009 for liquid effluents were
 12 reviewed by the NRC Staff (PSEG 2005a, PSEG 2006a, PSEG 2007a, PSEG 2008a, PSEG
 13 2009c, PSEG 2010a). No unusual trends were identified in the total activity of the liquid waste
 14 effluent (measured in curies). However, while the effluent activity remained rather constant in
 15 the trend graphs presented in the 2009 report (PSEG 2010a), the calculated dose to the
 16 hypothetical maximum exposed individual showed a dramatic decrease from 2007 to 2008 and
 17 the dose stayed near the 2008 level in 2009. The decrease in dose demonstrated on the trend
 18 graph is about three orders on magnitude, or 1000 times. No explanation is provided in the
 19 2008 or 2009 reports for the dramatic decrease in calculated dose.

20 ~~Both Salem and HCGS release liquid effluents into the environment. Rereleases are controlled~~
 21 ~~and monitored. Doses from these releases represent a fraction of the regulatory allowable 100~~
 22 ~~millirem per year (mrem/yr) doses specified in the facility operating license and NRC~~
 23 ~~regulations. Radiological monitoring began in 1968. Monitoring results are presented in the~~
 24 ~~Radiological Environmental Monitoring Program reports. The NRC staff reviewed the Salem/~~
 25 ~~HCGS radioactive effluent release reports for 2004 through 2009 for liquid effluents were~~
 26 ~~reviewed by the NRC Staff (Staff) (PSEG 2005a, PSEG 2006a, PSEG 2007a, PSEG 2008a,~~
 27 ~~PSEG 2009c, PSEG 2010a).~~

28 Radioactivity removed from the liquid wastes is concentrated in the filter media and ion
 29 exchange resins, which are managed as solid radioactive wastes.

30 **2.1.2.2 Radioactive Gaseous Waste**

31 The Salem and HCGS radioactive gaseous waste disposal systems process and dispose of
 32 routine radioactive gasses removed from the gaseous effluent and released to the atmosphere.
 33 Gaseous wastes are processed to reduce radioactive materials in gaseous effluents before
 34 discharge to meet the dose limits in 10 CFR Part 20 and the dose design objectives in Appendix
 35 I to 10 CFR Part 50.

36 At both facilities, radioactive gases are collected so that the short-lived gaseous isotopes
 37 (principally air with traces of krypton and xenon) are allowed to decay. At Salem, these gasses
 38 are collected in tanks in the Auxiliary Building and released intermittently in a controlled manner.
 39 At HCGS, gasses are held up in holdup pipes prior to entering a treatment section where
 40 adsorption of gases on charcoal provides additional time for decay. At HCGS, gases are then
 41 filtered using high efficiency particulate air (HEPA) filters prior to being released to the
 42 atmosphere from the north plant vent.

43 Radioactive effluent release reports for 2004 through 2009 for gaseous effluents were reviewed
 44 by the Staff (PSEG 2005a, PSEG 2006a, PSEG 2007a, PSEG 2008a, PSEG 2009c, PSEG

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1 2010a). While variations in total effluents and effluent concentrations can vary from year to year
2 due to outages and plant performance, based on the gaseous waste processing system's
3 performance from 2004 through 2008, the gaseous discharges for 2009 are consistent with prior
4 year effluents. The NRC identified no unusual trends.

5 2.1.2.3 Radioactive Solid Waste

6 Solid radioactive waste generated at the Salem and HCGS facilities' are managed by a single
7 Solid Radioactive Waste System. This System manages radioactive solid waste, including
8 packaging and storage, until the waste is shipped offsite. Offsite wastes are processed by
9 volume reduction and/or shipped for disposal at a licensed disposal facility. PSEG provides a
10 quarterly waste storage report to the township of Haddock's Bridge.

11 The State of South Carolina's licensed low-level radioactive waste (LLW) disposal facility,
12 located in Barnwell, has limited the access from radioactive waste generators located in states
13 that are not part of the Atlantic Low-Level Waste Compact. New Jersey is a member of the
14 Atlantic Low-Level Interstate Compact and has access to the Barnwell Low Level Radioactive
15 Waste facility (Barnwell). Shipments to Barnwell include spent resins from the demineralizers
16 and filter cartridges (wet processing waste). To control releases to the environment, these
17 wastes are packaged in the Salem and HCGS Auxiliary Buildings.

18 The PSEG Low-Level Radwaste Storage Facility (LLRSF) supports normal Dry Active Waste
19 (DAW) handling activities for HCGS and Salem. DAW consists of compactable trash such as
20 contaminated or potentially contaminated rags, clothing, and paper. This waste is generally
21 bagged, placed in Sea-van containers, and stored prior to being shipped for volume reduction
22 by a licensed off-site vendor. The volume-reduced DAW is repackaged at the vendor and
23 shipped for disposal at a licensed low-level waste disposal facility (PSEG 2009a, PSEG 2009b).
24 DAW and other non-compactable contaminated wastes are typically shipped to the Energy
25 Solutions' Class A disposal facility in Clive, Utah.

26 The LLRSF also maintains a NRC-approved Process Control Program. The Process Control
27 Program helps to ensure that waste is properly characterized, profiled, labeled, and shipped in
28 accordance with the waste disposal facility's waste acceptance criteria and U.S. Department of
29 Transportation (DOT) and NRC requirements. The LLRSF is a large facility that was designed
30 to store and manage large volumes of waste. However, the facility is operated well below its
31 designed capacity. The facility is also designed to ensure that worker radiation exposures are
32 controlled in accordance with facility and regulatory criteria.

33 Solid waste and irradiated fuel shipment reports from 2005 through 2009 were reviewed by the
34 NRC staff (Annual Radiological Release Reports for 2005-2009). The solid waste volumes and
35 radioactivity amounts generated in 2009 are typical of previous years. Typically all waste
36 consisted for Class A LLW.; however, in 2009, Class B and Class C wastes (resins, filters,
37 and/or evaporator bottoms) were shipped from Salem. Class B waste had not been shipped
38 from Salem since 2006 and no Class C waste was shipped in any of the previous 5 years.
39 Variations in the types and amount of solid waste generated and shipped from year to year are
40 expected based on the overall performance of the plants and the number and scope of outages
41 and maintenance activities. The most recent outages were April 2010 for Salem Unit 1, October
42 2009 for Salem unit 2, and April 2009 for Hope Creek. Schedule outages occur at each plant
43 every 18 months. The volumes and activity of solid waste LLW reported are reasonable and no
44 unusual trends were noted.

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2 ~~LLRSF LLW reports for _____ through 2000 were reviewed by the Staff (*Document available~~
3 ~~May 30 _____). The solid waste volumes and radioactivity amounts generated in 2000 are~~
4 ~~typical of previous annual waste shipments. Variations in the amount of solid radioactive waste~~
5 ~~generated and shipped from year to year are expected based on the overall performance of the~~
6 ~~plant and the number and scope of outages and maintenance activities. The volume and~~
7 ~~activity of solid radioactive wastes reported are reasonable and no unusual trends were noted.~~

8 No plant refurbishment activities were identified by the applicant as necessary for the continued
9 operation of either Salem or HPGS through the license renewal terms. Routine plant
10 operational and maintenance activities currently performed will continue during the license
11 renewal term. Based on past performance of the radioactive waste system, and the lack of any
12 planned refurbishment activities, similar amounts of radioactive solid waste are expected to be
13 generated during the license renewal term.

14 **2.1.2.4 Mixed Waste**

15 The term "mixed waste" refers to waste that contain both radioactive and hazardous
16 constituents. Neither Salem nor HCGS have processes that generate mixed wastes and there
17 are no mixed wastes stored at either facility.

18

1 **2.1.3 Nonradioactive Waste Management**

2 The Resources Conservation and Recovery Act (RCRA) governs the disposal of solid and
3 hazardous waste. RCRA regulations are contained in Title 40, "Protection of the Environment,"
4 Parts 239 through 299 (40 CFR 239, et seq.). Parts 239 through 259 of these regulations cover
5 solid (nonhazardous) waste, and Parts 260 through 279 regulate hazardous waste. RCRA
6 Subtitle C establishes a system for controlling hazardous waste from "cradle to grave," and
7 RCRA Subtitle D encourages States to develop comprehensive plans to manage nonhazardous
8 solid waste and mandates minimum technological standards for municipal solid waste landfills.

9 RCRA regulations are administered by NJDEP and address the identification, generation,
10 minimization, transportation, and final treatment, storage, or disposal of hazardous and
11 nonhazardous wastes. Salem and HCGS generate nonradiological waste including oils,
12 hazardous and nonhazardous solvents and degreasers, laboratory wastes, expired shelf-life
13 chemicals and reagents, asbestos wastes, paints and paint thinners, antifreeze, project-specific
14 wastes, point-source discharges regulated under the National Pollutant Discharge Elimination
15 System (NPDES), sanitary waste (including sewage), and routine, daily refuse (PSEG 2009a,
16 PSEG 2009b).

17 **2.1.3.1 Hazardous Waste**

18 The U.S. Environmental Protection Agency (EPA) classifies certain nonradioactive wastes as
19 "hazardous" based on characteristics including ignitability, corrosivity, reactivity, or toxicity
20 (identification and listing of hazardous waste is available in 40 CFR 261). State-level regulators
21 may add wastes to the EPA's list of hazardous wastes. RCRA provides standards for the
22 treatment, storage, and disposal of hazardous waste for hazardous waste generators (40 CFR
23 262). The Salem and HCGS facilities generate small amounts of hazardous wastes including
24 spent and expired chemicals, laboratory chemical wastes, and occasional project-specific
25 wastes.

26 PSEG currently is a small-quantity hazardous waste generator (PSEG 2010b), generating less
27 than 220 pounds/month (lb/month; 100 kilograms/month[kg/month]). Hazardous waste storage
28 (180-day) areas include the Hazardous Waste Storage Facility (Locations Numbers [Nos.] SH3
29 and SH30), the Combo Shop (Location No. SH5), and two laydown areas (Location Nos. SH6
30 and SH7) east of the Combo Shop.

31 Hazardous waste generated at the facility include: F003, F005 (spent non-halogenated
32 solvents), F001, F002 (spent halogenated solvents), D001 (ignitable waste), D002 (corrosive
33 wastes), D003 (reactive wastes), and D004-D011 (toxic [heavy metal] waste) (PSEG 2008b).

34 The EPA authorized the State of New Jersey to regulate and oversee most of the solid waste
35 disposal programs, as recognized by Subtitle D of the RCRA. Compliance is assured through
36 State-issued permits. The EPA's Enforcement and Compliance History Online (ECHO)
37 database showed no violations for PSEG (EPA 2010).

38 Proper facility identification numbers for hazardous waste operations include:

- 39
- DOT Hazardous Materials Registration No. 061908002018QS
- 40
- EPA Hazardous Waste Identification No. NJD 077070811

- 1 • NJDEP Hazardous Waste Program ID No. NJD 077070811

2 Under the Emergency Planning and Community Right-to-Know Act (EPCRA), applicable
 3 facilities are required to provide information on hazardous and toxic chemicals to local
 4 emergency planning authorities and the EPA (Title 42, Section 11001, of the United States
 5 Code [U.S.C.] [42 U.S.C. 11001]). On October 17, 2008, the EPA finalized several changes to
 6 the Emergency Planning (Section 302), Emergency Release Notification (Section 304), and
 7 Hazardous Chemical Reporting (Sections 311 and 312) regulations that were proposed on
 8 June 8, 1998 (63 Federal Register [FR] 31268). PSEG is subject to Federal EPCRA reporting
 9 requirements, and thus submits an annual Section 312 (TIER II) report on hazardous
 10 substances to local emergency agencies.

11 **2.1.3.2 Solid Waste**

12 A solid waste is defined by New Jersey Administrative Code (N.J.A.C.) 7:26-1.6. as "any
 13 garbage, refuse, sludge, or any other waste material except it shall not include the following: 1.
 14 Source separated food waste collected by livestock producers, approved by the State
 15 Department of Agriculture, who collect, prepare and feed such wastes to livestock on their own
 16 farms; 2. Recyclable materials that are exempted from regulation pursuant to N.J.A.C. 7:26A;
 17 [and] 3. Materials approved for beneficial use or categorically approved for beneficial use
 18 pursuant to N.J.A.C. 7:26-1.7(g)." The definition of solid waste in N.J.A.C. 7:26-1.6. applies only
 19 to wastes that are not also defined as hazardous in accordance with N.J.A.C. 7:26G.

20 During the site audit, the NRC observed an active solid waste recycling program. Solid waste
 21 ("trash") is segregated and about 55 percent is transferred to recycling vendors (PSEG 2009a).
 22 The remaining volume of solid waste is disposed at a local landfill.

23 A common sewage treatment system treats domestic wastewater from both facilities. Following
 24 treatment, solids (i.e., sludge) are either returned to the system's oxidation ditch or removed to a
 25 sludge-holding tank, based upon process requirements. Sludge directed to the sludge-holding
 26 tank is aerated and dewatered before being trucked offsite for disposal. During the site audit,
 27 the NRC viewed the PSEG sewage sludge waste volumes from 2005 through 2009. The
 28 average annual volume for these years was about 50,000 lbs. Site officials stated that the
 29 disposal volume is generally driven by the facilities' budgets.

30 **2.1.3.3 Universal Waste**

31 In accordance with N.J.A.C. 7:26G-4.2, "Universal waste" means any of the following hazardous
 32 wastes that are managed under the universal waste requirements of N.J.A.C. 7:26A-7, whether
 33 incorporated prospectively by reference from 40 CFR Part 273, "Standards for Universal Waste
 34 Management," or listed additionally by the NJDEP: paint waste, batteries, pesticides,
 35 thermostats, fluorescent lamps, mercury-containing devices, oil-based finishes, and consumer
 36 electronics.

37 PSEG is a small quantity handler of universal waste (meaning the facility cannot accumulate
 38 more than 11,000 lbs [approximately 5000 kg] of universal waste at any one time), generating
 39 common operational wastes such as lighting ballasts containing polychlorinated biphenyls
 40 (PCBs), lamps, and batteries. Universal waste is segregated and disposed of through a licensed
 41 broker. Routine building space renovations and computer equipment upgrades can lead to
 42 substantial short-term increases in universal waste volumes.

1 **2.1.3.4 Permitted Discharges**

2 Salem facility maintains a New Jersey Pollutant Discharge Elimination System (NJPDES)
3 permit, NJ 0005622, which authorizes the discharge of wastewater to the Delaware Estuary and
4 stipulates the conditions of the permit. HCGS maintains a separate NJPDES permit, NJ
5 0025411 for discharges to the Delaware Estuary. All monitoring shall be conducted in
6 accordance with the NJDEP's "Field Sampling Procedures Manual" applicable at the time of
7 sampling (N.J.A.C. 7: 14A-6.5(b)4), and/or 2) the method approved by the NJ DEP in Part IV of
8 the site permits (NJDEP 2002a).

9 As discussed previously, a common sewage treatment system treats domestic wastewater from
10 both HCGS and Salem. The sewage treatment system liquid effluent discharges through the
11 Hope Creek cooling tower blowdown outfall to the Delaware Estuary. Residual cooling tower
12 blowdown dechlorination chemical, ammonium bisulfite, de-chlorinates the sewage treatment
13 effluent (PSEG 2009a, PSEG 2009b).

14 Salem and HCGS share the Non-Radioactive Liquid Waste Disposal System (NRLWDS)
15 chemical waste treatment system. The NRLWDS is located at Salem facility and operated by
16 Salem staff. The NRLWDS collects and processes non-radioactive secondary plant wastewater
17 prior to discharge into the Delaware Estuary. The waste water originates in plant process such
18 as demineralizer regenerations; steam generator blowdown, chemical handling operations, and
19 reverse osmosis reject waste. The outfall is monitored in accordance with the current Hope
20 Creek NJPDES Permit (No. NJ0025411) (PSEG 2009a, PSEG 2009b).

21 Oily waste waters are treated at HCGS using an oil water separator. Treated effluent is then
22 discharged through the internal monitoring point which is combined with cooling tower
23 blowdown before discharge to the Delaware Estuary. The outfall is monitored in accordance
24 with the current Hope Creek NJPDES Permit (No. NJ0025411).

25 Section 2.1.7 of this report provides more information on the site's NPDES permits and effluent
26 limitations.

27 **2.1.3.5 Pollution Prevention and Waste Minimization**

28 As described in Section 2.1.3.2, PSEG operates an active solid waste recycling program that
29 results in about 55 percent of its "trash" being recycled. PSEG also maintains a Discharge
30 Prevention and Response Program. This program incorporates the requirements of the NJDEP,
31 EPA Facility Response Plan, and National Oceanic and Atmospheric Administration (NOAA)
32 Natural Resource Damage Assessment Protocol. Specific documents making up the program
33 include:

- 34 • Spill/Discharge Prevention Plan
- 35 o Hazardous Waste Contingency Plan
- 36 • Spill/Discharge Response Plan
- 37 • Environmentally Sensitive Areas protection Plan

38 PSEG also maintains the following plans to support pollution prevention and waste
39 minimization:

- 1 • Discharge Prevention, Containment, and Countermeasure Plan
- 2 • Discharge Cleanup and Removal Plan
- 3 • Facility Response Plan
- 4 • Spill Prevention, Control, and Countermeasure Plan
- 5 • Stormwater Pollution Prevention Plan
- 6 • Pollution Minimization Plan for PCBs

7 **2.1.3.6 Release of Plant-Related Radionuclides**

8 To provide a history of spills for Salem and Hope Creek site, an expanded 10 CFR 50.75(g)
 9 report was provided to the NRC at the site audit. For completeness, it included some legacy
 10 items that are not required to be retained under 10 CFR 50.75(g). The only 50.75(g) events
 11 named in the report (i.e., instances where significant contamination remains after cleanup) are
 12 the April 1995 Hope Creek incident and the Salem condensate polisher event from May 2007
 13 described below.

- 14 • Hope Creek: April 5, 1995: Approximately 88 millicuries (mCi): Steam from the
 15 decontamination Solution Evaporator release from Hope Creek's south plant vent due to
 16 inadequate rigor during the design review process.
- 17 • Salem: May 24, 2007: 2.8 mCi of Cs-137 released in front of the Salem Unit 2
 18 condensate polisher as a result of burst site glass during operation and resin was blown
 19 through the wall into the switchyard.

20 In 2002, low-level tritium contamination was detected on the shoes of several Salem
 21 technicians. In September of the same year, a remedial investigation identified that the source
 22 of the contamination was water leaking from the Salem spent fuel pool (SFP) (Arcadis 2006).
 23 Remediation activities that were conducted between 2002 and 2006 help to further define the
 24 pathway of the contamination to the shallow groundwater where tritium concentrations
 25 exceeded the NJDEP Groundwater Quality Criteria (GWQC). The source of the contamination
 26 was identified as SFP water leaking into the seismic gap between the SFP Building and the
 27 Salem Unit 1 Containment Building (Arcadis 2006).

28 In 2006, PSEG performed a Preliminary Assessment and Site Investigation (PA/SI) describing
 29 the environmental status of a release of tritium, strontium, and plant-related gamma emitting
 30 radionuclides (GER). Groundwater samples indicated that tritium had not migrated beyond the
 31 shallow groundwater in area south of the Salem Auxiliary Building and that GERs had not
 32 migrated beyond the seismic gap. Monitoring of the GERs in the seismic gap also indicates that
 33 releases from the SFP have stopped (Arcadis 2006). However, given that there is no transport
 34 mechanism to remove the GERs from the area of the seismic gap, the GERs with long half-lives
 35 are expected to remain until plant decommissioning.

36 **2.1.4 Facility Operation and Maintenance**

37 Various types of maintenance activities are performed at the Salem and HCGS facilities,
 38 including inspection, testing, and surveillance to maintain the current licensing basis of the

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1 facility and to ensure compliance with environmental and safety requirements. Various
2 programs and activities currently exist at Salem and HCGS to maintain, inspect, test, and
3 monitor the performance of facility equipment. These maintenance activities include inspection
4 requirements for reactor vessel materials, boiler and pressure vessel in-service inspection and
5 testing, a maintenance structures monitoring program, and maintenance of water chemistry.

6 Additional programs include those implemented in response to NRC generic communications,
7 those implemented to meet technical specification surveillance requirements, and various
8 periodic maintenance, testing, and inspection procedures. Certain program activities are
9 performed during the operation of the unit, while others are performed during scheduled
10 refueling outages. Nuclear power plants must periodically discontinue the production of
11 electricity for refueling, periodic in-service inspection, and scheduled maintenance. Salem and
12 HCGS are on an 18-month refueling cycle (PSEG 2009a, PSEG 2009b).

13 Aging effects at Salem and HCGS are managed by integrated plant assessments required by
14 10 CFR 54.21. These programs are described in Section 2 of the facilities' Nuclear Generating
15 Station License Renewal Applications - Scoping and Screening Methodology for Identifying
16 Structures and Components Subject to Aging Management Review, and Implementation
17 Results (PSEG 2009a, PSEG 2009b).

18 **2.1.5 Power Transmission System**

19 Three right-of-way (ROW) corridors and five 500-kilovolt (kV) transmission lines connect Salem
20 and HCGS to the regional electric grid, all of which are owned and maintained by Public Service
21 Electric and Gas Company (PSE&G) and Pepco Holdings Inc. (PHI). Each corridor is 350 ft
22 (107 m) wide, with the exception of two-thirds of both the HCGS-Red Lion and Red Lion-Keeney
23 lines, which narrow to 200 ft. Unless otherwise noted, the discussion of the power transmission
24 system is adapted from the Applicant's Environmental Reports (ER) (PSEG 2009a, PSEG
25 2009b) or information gathered at NRC's environmental site audit.

26 For the operation of Salem, three transmission lines were initially built for the delivery of
27 electricity: two lines connecting to the New Freedom substation near Williamston, NJ (Salem-
28 New Freedom North and Salem-New Freedom South), and one line extending north across the
29 Delaware River terminating at the Keeney substation in Delaware (Salem-Keeney). After
30 construction of HCGS, several changes were made to the existing Salem transmission system,
31 including the disconnection of the Salem-Keeney line from Salem and its reconnection to
32 HCGS, as well as the construction of a new substation (known as Red Lion) along the Salem-
33 Keeney transmission line. The addition of this new substation divided the Salem-Keeney
34 transmission line into two segments: one connecting HCGS to Red Lion and the other
35 connecting Red Lion to Keeney. Consequently, these two segments are now referred to
36 separately as Salem-Red Lion and Red Lion-Keeney. The portion of the Salem-Keeney line
37 located entirely within Delaware, Red Lion-Keeney, is owned and maintained by Pepco (a
38 regulated electric utility that is a subsidiary of PHI).

39 The construction of HCGS also resulted in the re-routing of the Salem-New Freedom North line
40 and the construction of a new transmission line, HCGS-New Freedom. The Salem-New
41 Freedom North line was disconnected from Salem and re-routed to HCGS, leaving Salem
42 without a northern connection to the New Freedom transmission system. Therefore, a new
43 transmission line was required to connect Salem and the New Freedom substation; this line is
44 known as the HCGS-New Freedom line and it shares a corridor with the Salem-New Freedom
45 North line. Prior to and following the construction of HCGS, the Salem-New Freedom South line
46 provides a southern-route connection between Salem and the New Freedom substation.

1 The only new transmission lines constructed as a result of HCGS were the HCGS-New
 2 Freedom line, the tie line, and short reconnections for Salem-New Freedom North and Salem-
 3 Keeney. The HCGS-Salem tie line and the short reconnections do not pass beyond the site
 4 boundary.

5 Transmission lines considered in-scope for license renewal are those constructed specifically to
 6 connect the facility to the transmission system (10 CFR 51.53(c)(3)(ii)(H)); therefore, the Salem-
 7 New Freedom North, Salem-Red Lion, Red Lion-Keeney, Salem-New Freedom South, HCGS-
 8 New Freedom, and HCGS-Salem lines are considered in-scope for this Supplemental
 9 Environmental Impact Statement (SEIS) and are discussed in detail below.

10 Figure 2.8 illustrates the Salem and HCGS transmission system. The five transmission lines are
 11 described below within the designated ROW corridor (see Table 2-1):

12 **2.1.5.1 New Freedom North ROW**

- 13 • *Salem-New Freedom North* – This 500-kV line, which is operated by PSE&G, runs
 14 northeast from HCGS for 39 miles (mi; 63 kilometers [km]) within a 350-ft (107-m) wide
 15 corridor to the New Freedom switching station north of Williamstown, New Jersey. This
 16 line shares the corridor with the 500-kV HCGS-New Freedom line.
 17
- 18 • *HCGS-New Freedom* – This 500-kV line, which is operated by PSE&G, extends
 19 northeast from Salem for 43 mi (69 km) within a 350-ft (107-m) wide corridor to the New
 20 Freedom switching station north of Williamstown, New Jersey. This line shares the
 21 corridor with the 500-kV Salem-New Freedom North line. During 2008, a new substation
 22 (Orchard) was installed along this line, dividing it into two segments.

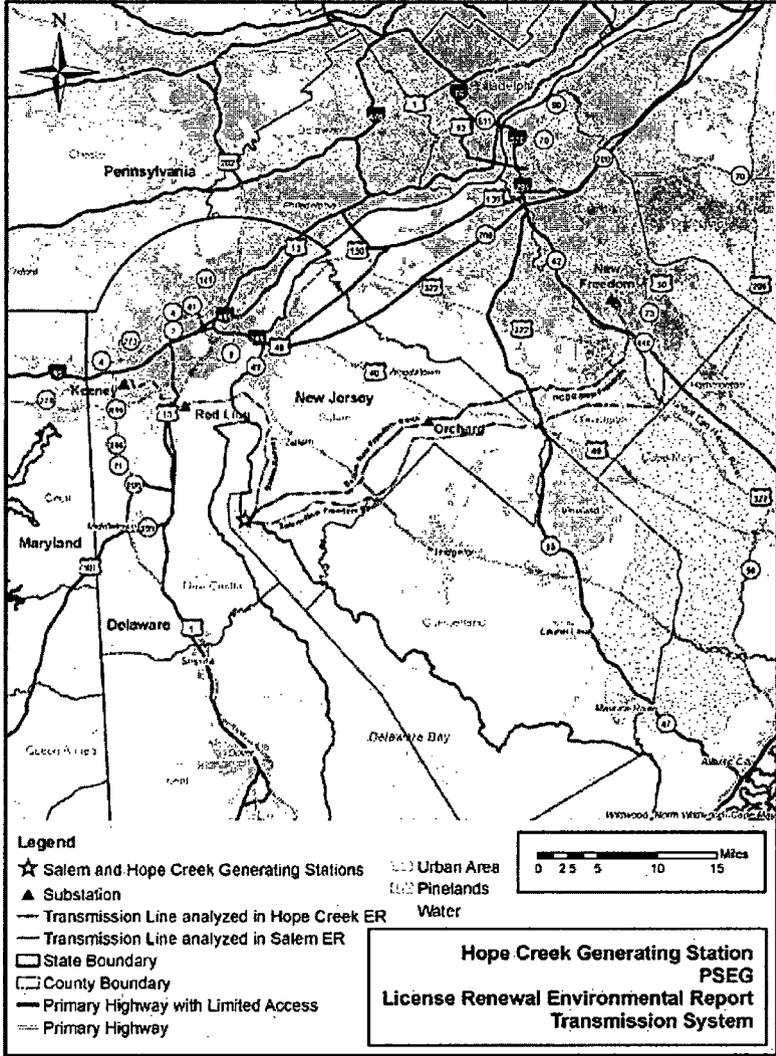
23 **2.1.5.2 New Freedom South ROW**

- 24 • *Salem-New Freedom South* - This 500-kV line operated by PSE&G extends northeast
 25 from Salem for 42 mi (68 km) within a 350-ft (107-m) wide corridor from Salem to the
 26 New Freedom substation north of Williamstown, New Jersey.

27 **2.1.5.3 Keeney ROW**

- 28 • *Salem-Red Lion* – This 500-kV line extends north from HCGS for 13 mi (21 km) and then
 29 crosses over the New Jersey-Delaware state line. It continues west over the Delaware
 30 River about 4 mi (6 km) to the Red Lion substation. In New Jersey, the line is operated
 31 by PSE&G, and in Delaware it is operated by PHI. Two thirds of the 17-mi (27-km)
 32 corridor is 200 ft (61 m) wide, and the remainder is 350-ft (107-m) wide.
 33
- 34 • *Red Lion-Keeney* – This 500-kV line, which is operated by PHI, extends from the Red
 35 Lion substation 8 mi (13 km) northwest to the Keeney switch station. Two thirds of the
 36 corridor is 200 ft (70 m) wide, and the remainder is 350-ft (107-m) wide.

1



2

Figure 2-8. Salem and HCGS Transmission Line System (Source: PSEG 2009b)

3

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- 1 The ROW corridors comprise approximately 149 mi (240 km) and 4,376 acres (ac; 1771
 2 hectares [ha]); the lines cross within Camden, Gloucester, and Salem counties in New Jersey
 3 and New Castle County in Delaware. All of the ROW corridors traverse the marshes and
 4 wetlands adjacent to the Salem and HCGS sites, including agricultural and forested lands.
- 5 All transmission lines were designed and built in accordance with industry standards in place at
 6 the time of construction. All transmission lines will remain a permanent part of the transmission
 7 system and will be maintained by PSE&G and PHI regardless of Salem and HCGS continued
 8 operation (PSEG 2009a, PSEG 2009b). The HCGS-Salem line, which connects the two
 9 substations, would be de-activated if the Salem and HCGS switchyards were no longer in use
 10 and would need to be reconnected to the grid if they were to remain in service beyond the
 11 operation of Salem and HCGS.
- 12 Five 500-kV transmission lines connect electricity from Salem and HCGS to the regional electric
 13 transmission system via three ROWs outside of the property boundary. The HCGS-Salem tie-
 14 line is approximately 2000 ft (610 m); this line does not pass beyond the site boundary and is
 15 not discussed as an offsite ROW.

Table 2-1. Salem and HCGS Transmission System Components

Line	Owner	Approximate Length		ROW width	Approximate ROW area	
		kV	mi (km)	ft (m)	ac (ha)	
New Freedom North ROW						
Salem–New Freedom North	PSE&G	500	39 (63)	350 (107)	—	1824
HCGS–New Freedom	PSE&G	500	43 (69)			
New Freedom South ROW						
Salem–New Freedom South	PSE&G	500	42 (68)	350 (107)		1782
Red Lion ROW						
Salem–Red Lion	PSE&G	500	17 (27)	*200/350 (107)		521
Red-Lion Keeney	PHI	500	8 (13)	*200/350 (107)		249
Total acreage within ROW						4,376

* two-thirds of the corridor is 200 ft (70 m) wide.

Source: PSEG 2009a, PSEG 2009b.

16

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1 **2.1.6 Cooling and Auxiliary Water Systems**

2 Salem and HCGS use different types of cooling water systems (CWS) for condenser cooling but
3 both withdraw from and discharge water to the Delaware Estuary. Salem Units 1 and 2 use
4 once-through circulating water systems. HCGS uses a closed-cycle system that employs a
5 single natural draft cooling tower. Unless otherwise noted, the discussions below were adapted
6 from the Salem and HCGS ERs (PSEG 2009a, PSEG 2009b), or information gathered at the
7 site audit.

8 Both sites use groundwater as the source for fresh potable water, fire protection water, industrial
9 process make-up water, and for other sanitary water supplies. Under authorization from the
10 NJDEP (NJDEP 2004a) and Delaware River Basin Commission (DRBC) (DRBC 2000), PSEG
11 can services both facilities with up to 43.2 million gallons (163 million liters) of groundwater per
12 month.

13 Discussions on surface water and groundwater use and quality are provided in Section 2.1.7.

14 **2.1.6.1 Salem**

15 The Salem facility includes two intake structures, each equipped with equipment used to
16 remove debris and biota from the intake water stream (i.e., removable ice barriers, trash racks,
17 traveling screens, and a fish return system). The CWS withdraws brackish water from the
18 Delaware Estuary using 12 circulating water pumps through a 12-bay intake structure located
19 on the shoreline at the south end of the site and discharges water north on the CWS intake
20 structure via a discharge pipe that extends 500 ft (152 m) from the shore line. Heavy duty trash
21 racks protect the circulating water pumps and traveling screens from damage by large debris.
22 The trash racks are constructed of 0.5-inch (1.27-cm) wide steel bars with slot opening that are
23 3 inch (7.6 cm) wide. No biocides are required in the CWS.

24 The CWS provides approximately 1,050,000 gallons per minute (gpm) (3,974,670 liters per
25 minute [lpm]) to each of Salem's two reactor units. The total design flow is 1,110,000 gpm
26 (4,201,794 lpm) through each unit. The intake velocity is approximately 1 per second (fps) (0.3
27 meters per second [mps]) (at mean low tide, a rate that is compatible with the protection of
28 aquatic wildlife (EPA 2001). The CWS provides water to the main condenser to condense steam
29 from the turbine and the heated water is returned back to estuary (flow path shown in the lower
30 right of Figure 2-3).

31 Approximately 400 ft (122 m) north of the CWS intake structure, a separate intake structure
32 withdraws water for the SWS which supplies cooling water to the reactor safeguard and
33 auxiliary systems. The structure contains four bays, each containing three pumps. The 12
34 service-water pumps have a total design rating of 130,500 gpm (493,922 lpm). The average
35 velocity throughout the SWS intake is less than 1 fps (0.3 mps) at the design flow rate. Like the
36 CWS intake structure, the SWS intake structure is equipped with trash racks, traveling screens,
37 and filters to remove debris and biota from the intake water stream. Debris collected from the
38 system is removed and transported to a landfill for disposal. Backwash water is returned to the
39 estuary.

40 To prevent organic buildup and biofouling in the heat exchangers and piping of the SWS,
41 sodium hypochlorite is injected into the system. SWS water is discharged via the discharge pipe
42 shared with the CWS. Residual chlorine levels are maintained in accordance with the site's
43 NJPDES Permit.

1 2.1.6.2 Hope Creek

2 HCGS uses a single intake structure to supply water from the Delaware Estuary to the SWS.
3 The intake structure consists of four active bays that are equipped with pumps and associated
4 equipment (trash racks, traveling screens, and a fish-return system) and four empty bays that
5 were originally intended to service a second reactor which was never built. Water is drawn into
6 the SWS at a rate of 0.3 fps (0.09 mps) passing through trash racks and traveling screens.
7 After passing through the traveling screens, the estuary water enters the service water pumps.
8 Depending on the temperature of the Delaware Estuary water, two or three pumps are normally
9 needed to supply service water. Each pump is rated at 16,500 gpm (62,459 lpm). To prevent
10 organic buildup and biofouling in the heat exchangers and piping of the SWS, sodium
11 hypochlorite is continuously injected into the system.

12 Water is then pumped into the stilling basin in the pump house. The stilling basin supplies water
13 to the general SWS and the fire protection system. The stilling basin also supplies water for
14 back-up residual heat removal service water and for emergency service water.

15 The SWS also provides makeup water for the CWS by supplying water to the cooling tower
16 basin. The cooling tower basin contains approximately 9 million gallons (34 million liters) of
17 water and provides approximately 612,000 gpm (2.317 million lpm) of water to the CWS via four
18 pumps. The CWS provides water to the main condenser to condense steam from the turbine
19 and the heated water is returned back to Estuary (flow path shown in the lower right of Figure 2-
20 4).

21 The HCGS cooling tower is a 512-foot (156-meter) high single counterflow, hyperbolic, natural
22 draft cooling tower (PSEG 2008). While the CWS is a closed-cycle system, water is lost due to
23 evaporation. Monthly losses average from 9600 gpm (36,340 lpm) in January to 13,000 gpm
24 (49,210 lpm) in July. Makeup water is provided by the SWS.

25 2.1.7 Facility Water Use and Quality

26 The Salem and HCGS facilities rely on the Delaware River as their source of makeup water for
27 its cooling system, and they discharge various waste flows to the river. An onsite well system
28 provides groundwater for other site needs. A description of groundwater resources at the facility
29 location is provided in Section 2.2.8, and a description of the surface water resources is
30 presented in Section 2.2.9. The following sections describe the water use from these
31 resources.

32 2.1.7.1 Groundwater Use

33 The Salem and HCGS facilities access groundwater through production wells to supply fresh
34 water for potable, industrial process make-up, fire protection, and sanitary purposes (PSEG
35 2009a, PSEG 2009b). Facility groundwater withdrawal is authorized by the NJDEP and the
36 DRBC. The total authorized withdrawal volume is 43.2 million gallons (163 million liters) per
37 month for both the Salem and HCGS sites combined (NJDEP 2004a, DRBC 2000). Although
38 each facility has its own wells and individual pumping limits, the systems are interconnected so
39 that water can be transferred between the facilities, if necessary (PSEG 2009a, PSEG 2009b).
40 The NJDEP permit is a single permit which establishes a combined permitted limit for both
41 facilities combined of 43.2 million gallons (163 million liters) per month (NJDEP 2004a).

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1 The groundwater for Salem is produced primarily from two wells, PW-5 and PW-6. PW-5 is
2 installed at a depth of 840 ft (256 m) below ground surface (bgs) in the Upper Raritan
3 Formation, and PW-6 is installed at a depth of 1,140 ft (347 m) in the Middle Raritan Formation.
4 Well PW-5 has a capacity of 800 gpm (3016 lpm), and PW-6 has a capacity of 600 gpm (2262
5 lpm) (DRBC 2000). The average water withdrawal from these two wells between 2002 and
6 2008 was 114 million gallons (430 million liters) per year (TetraTech 2009). These wells are
7 used to maintain water volume within two 350,000 gallon (1.3 million liter) storage tanks, of
8 which 600,000 gallons (2.26 million liters) is reserved for fire protection (PSEG 2009a). In
9 addition to these two primary wells, two additional wells, PW-2 and PW-3, exist at Salem.
10 These wells are installed within the Mount Laurel-Wenonah aquifer at depths of about 290 ft (88
11 m) bgs (DRBC 2000). These wells are classified as stand-by wells by NJDEP (NJDEP 2004a),
12 and had only minor usage in the period from 2002 to 2008 (TetraTech 2009).

13 The groundwater for HCGS is produced from two production wells, HC-1 and HC-2, which are
14 installed at depths of 816 ft (249 m) bgs in the Upper Potomac-Raritan-Magothy aquifer (DRBC
15 2000). Each well has a pumping capacity of 750 gpm (2,827 liters per minute), and the average
16 water withdrawal from the two wells between 2002 and 2008 was 96 million gallons (362 million
17 liters) per year (TetraTech 2009). The wells are used to maintain water supply within two
18 350,000 gallon (1.3 million liter) storage tanks. The bulk of the water in the storage tanks
19 (656,000 gallons [2.47 million liters]) is reserved for fire protection, and the remainder is used for
20 potable, sanitary, and industrial uses (PSEG 2009b).

21 Overall, the combined water usage for the two facilities has averaged 210 million gallons (792
22 million liters) per year, or 17.5 million gallons (66 million liters) per month (TetraTech 2009).
23 This usage is approximately 41 percent of the withdrawal permitted under the DRBC
24 authorization and NJDEP permit (DRBC 2000, NJDEP 2004a).

25 2.1.7.2 Surface Water Use

26 Salem and HCGS are located on the eastern shore of the Delaware River, approximately 18 mi
27 (29 km) south of the Delaware Memorial Bridge. The Delaware River at the facility location is
28 an estuary approximately 2.5 mi (4 km) wide. The Delaware River is the source of condenser
29 cooling water and service water for both the Salem and HCGS facilities (PSEG 2009a, PSEG
30 2009b).

31 The Salem units are both once-through circulating water systems that withdraw brackish water
32 from the Delaware River through a single CWS intake located at the shoreline on the southern
33 end of Artificial Island. The CWS intake structure consists of 12 bays, each outfitted with
34 removable ice barriers, trash racks, traveling screens, circulating water pumps, and a fish return
35 system. The pump capacity of the Salem CWS is 1,110,000 gpm (4,201,794 liters per minute)
36 for each unit, or a total of 2,220,000 gpm (8,403,588 liters per minute) for both units combined.
37 Although the initial design included use of sodium hypochlorite biocides, these were eliminated
38 once enough operational experience was gained to indicate that they were not needed.
39 Therefore, the CWS water is used without treatment (PSEG 2009a).

40 In addition to the CWS intake, the Salem units withdraw water from the Delaware River for the
41 SWS, to provide cooling for auxiliary and reactor safeguard systems. The Salem SWS is
42 supplied through a single intake structure located approximately 400 ft (122 m) north of the
43 CWS intake. The Salem SWS intake is also fitted with trash racks, traveling screens, and fish-
44 return troughs. The pump capacity of the Salem SWS is 65,250 gpm (246,996 liters per minute)
45 for each unit, or a total of 130,500 gpm (493,992 liters per minute) for both units combined. The

1 Salem SWS water is treated with sodium hypochlorite biocides to prevent biofouling (PSEG
2 2009a).

3 The withdrawal of Delaware River water for the Salem CWS and SWS systems is regulated
4 under the terms of the Salem NJPDES permit, Number NJ005622, and is also authorized by the
5 DRBC. The NJPDES permit limits the total withdrawal of Delaware River water to 3,024 million
6 gallons per day (11,447 million liters per day), for a monthly maximum of 90,720 million gallons
7 (342,014 million liters) (NJDEP 2001). The DRBC authorization allows withdrawals not to
8 exceed 97,000 million gallons (365,690 million liters) in a single 30-day period (DRBC 1977,
9 DRBC 2001). The withdrawal volumes are reported to NJDEP through monthly Discharge
10 Monitoring Reports (DMRs), and copies of the DMRs are submitted to DRBC.

11 Both the CWS and SWS at Salem discharge water back to the Delaware River through a single
12 return that serves both systems. The discharge location is situated between the CWS and
13 Salem SWS intakes, and consists of six separate discharge pipes, each extending 500 ft (152
14 m) into the river, and discharging water at a depth of 35 ft (11 m) below mean tide. The pipes
15 rest on the river bottom with a concrete apron at the end to control erosion, and discharge water
16 at a velocity of 10.5 fps (3.2 mps) (PSEG 2006c). The discharge from Salem is regulated
17 under the terms of the NJPDES permit number NJ005622 (NJDEP 2001). The locations of the
18 intake and discharge for the Salem facility are shown on Figure 2-3.

19 The HCGS facility uses a closed-cycle circulating water system, with a natural draft cooling
20 tower, for condenser cooling. Like Salem, HCGS withdraws water from the Delaware River to
21 supply a SWS, which cools auxiliary and other heat exchange systems. The outflow from the
22 HCGS SWS is directed to the cooling tower basin, and serves as makeup water to replace
23 water lost through evaporation and blowdown from the cooling tower. The HCGS SWS intake is
24 located on the shore of the river, and consists of four separate bays with service water pumps,
25 trash racks, traveling screens, and fish-return systems. The structure includes an additional
26 four bays that were originally intended to serve a second HCGS unit, which was never
27 constructed. The pump capacity of the HCGS SWS is 16,500 gpm (62,459 lpm) for each pump,
28 or a total of 66,000 gpm (249,836 lpm) when all four pumps are operating. Under normal
29 conditions, only two or three of the pumps are typically operated. The HCGS SWS water is
30 treated with sodium hypochlorite to prevent biofouling (PSEG 2009b).

31 The discharge from the HCGS SWS is directed to the cooling tower basin, where it acts as
32 makeup water for the HCGS CWS. The natural draft cooling tower has a total capacity of 9
33 million gallons (34 million liters) of water, and circulates water through the CWS at a rate of
34 612,000 gpm (2.317 million liters per minute). Water is removed from the HCGS CWS through
35 both evaporative loss from the cooling tower, and from blowdown to control deposition of solids
36 within the system. Evaporative losses result in consumptive loss of water from the Delaware
37 River. The volume of evaporative losses vary throughout the year depending on the climate,
38 but range from approximately 9,600 gpm (36,340 liters per minute) in January to 13,000 gpm
39 (49,210 liters per minute) in July. Blowdown water is returned to the Delaware River (NJDEP
40 2002b).

41 The withdrawal of Delaware River water for the HCGS CWS and SWS systems is regulated
42 under the terms of the HCGS NJPDES permit, Number NJ0025411, and is also authorized by
43 the DRBC. Although it requires measurement and reporting, the NJPDES permit does not
44 specify limits on the total withdrawal volume of Delaware River for HCGS operations (NJDEP
45 2003). Actual withdrawals average 66.8 million gallons per day (253 million liters per day), of
46 which 6.7 million gallons per day (25 million liters per day) are returned as screen backwash,

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1 and 13 million gallons per day (49 million liters per day) is evaporated. The remainder
2 (approximately 46 million gallons per day [179 million liters per day]) is discharged back to the
3 river (PSEG 2009b).

4 The HCGS DRBC contract allows withdrawals up to 16.998 billion gallons (64 billion liters) per
5 year, including up to 4.086 billion gallons (15.4 billion liters) of consumptive use (DRBC 1984a,
6 1984b). To compensate for evaporative losses in the system, the DRBC authorization requires
7 releases from storage reservoirs, or reductions in withdrawal, during periods of low-flow
8 conditions at Trenton, New Jersey (DRBC 2001). To accomplish this, PSEG is one of several
9 utilities which own and operate the Merrill Creek reservoir in Washington, New Jersey. Merrill
10 Creek reservoir is used to release water during low-flow conditions as required by the DRBC
11 authorization (PSEG 2009b).

12 The SWS and cooling tower blowdown water from HCGS is discharged back to the Delaware
13 River through an underwater conduit located 1500 ft (458 m) upstream of the HCGS SWS
14 intake. The HCGS discharge pipe extends 10 ft (3 m) offshore, and is situated at mean tide
15 level. The discharge from HCGS is regulated under the terms of the NJPDES permit number
16 NJ0025411 (NJDEP 2001). The locations of the intake and discharge for the HCGS facility are
17 shown on Figure 2-4.

18 2.2 Affected Environment

19 This section provides general descriptions of the environment near Salem and HCGS as
20 background information and to support the analysis of potential environmental impacts in
21 Chapter 4.

22 2.2.1 Land Use

23 Salem and HCGS are located at the southern end of Artificial Island located on the east bank of
24 the Delaware River in Lower Alloways Creek Township, Salem County, New Jersey. The river
25 is approximately 2.5 mi wide at this location. Artificial Island is a 1500-acre island of tidal marsh
26 and grassland that was created, beginning early in the twentieth century, by the U.S. Army
27 Corps of Engineers. The island was created by disposal of hydraulic dredge spoils within a
28 progressively enlarged diked area, which was established around a natural bar that projected
29 into the river. The average elevation of the island is about 9 ft above MSL with a maximum
30 elevation of approximately 18 ft MSL (AEC 1973). The site is located approximately 17 mi south
31 of the Delaware Memorial Bridge, 30 mi southwest of Philadelphia, Pennsylvania, and 7.5 mi
32 southwest of the City of Salem, NJ (PSEG 2009d).

33 PSEG owns approximately 740 acres at the southern end of the island, with Salem located on
34 approximately 220 acres and HCGS occupying about 153 acres. The remainder of Artificial
35 Island remains undeveloped. The U.S. government owns the portions of the island adjacent to
36 Salem and HCGS (to the north and east), while the State of New Jersey owns the rest of the
37 island as well as much nearby inland property (LACT 1988a, LACT 1988b, PSEG 2009a, PSEG
38 2009b). The U.S. government also owns a one-mile wide inland strip of land abutting the island
39 (AEC 1973). The northernmost tip of Artificial Island (owned by the U. S. government) is within
40 the State of Delaware boundary, which was established based on historical land grants related
41 to the Delaware River tide line at that time (PSEG 2009a, PSEG 2009b).

42 The area within 15 mi of the site is primarily utilized for agriculture. The area also includes
43 numerous parks and wildlife refuges and preserves such as Mad Horse Creek Fish and Wildlife

1 Management Area to the east; Cedar Swamp State Wildlife Management Area to the south in
2 Delaware; Appoquinimink, Silver Run, and Augustine State Wildlife Management areas to the
3 west in Delaware; and Supawna Meadows National Wildlife Refuge to the north. The Delaware
4 Bay and estuary is recognized as wetlands of international importance and an international
5 shorebird reserve (NJSA 2008). The nearest permanent residences are located 3.4 mi south-
6 southwest and west-northwest of Salem and HCGS in Delaware. The nearest permanent
7 residence in New Jersey is located 3.6 mi east-northeast of the facilities (PSEG 2009c). The
8 closest densely populated center (with 25,000 residents or more) is located 15.5 mi from Salem
9 and HCGS (PSEG 2009a, b). There is no heavy industry in the area surrounding Salem and
10 HCGS; the nearest such industrial area is located more than 15 mi north of the site (PSEG
11 2009c).

12 Section 307(c)(3)(A) of the Coastal Zone Management Act (16 USC 1456 (c)(3)(A)) requires
13 that applicants for Federal licenses to conduct an activity in a coastal zone provide to the
14 licensing agency a certification that the proposed activity is consistent with the enforceable
15 policies of the State's coastal zone program. A copy of the certification is also to be provided to
16 the State. Within six months of receipt of the certification, the State is to notify the Federal
17 agency whether the State concurs with or objects to the applicant's certification. Salem and
18 HCGS are within New Jersey's coastal zone for purposes of the Coastal Zone Management Act.
19 PSEG's certifications that renewal of the Salem and HCGS licenses would be consistent with
20 the New Jersey Coastal Management Program were submitted to the NJDEP Land Use
21 Regulation Program concurrent with submittal of the license renewal applications for the two
22 facilities. Salem and HCGS are not within Delaware's coastal zone for purposes of the Coastal
23 Zone Management Act (PSEG 2009a, PSEG 2009b). Correspondence related to the
24 certification is in Appendix D of this SEIS. By letters dated October 8, 2009, the NJDEP Division
25 of Land Use Regulation, Bureau of Coastal Regulation concurred with the applicant's
26 consistency of certification for Salem and HCGS.

27 **2.2.2 Air Quality and Meteorology**

28 **2.2.2.1 Meteorology**

29 The climate in New Jersey is generally a function of topography and distance from the Atlantic
30 Ocean, resulting in five distinct climatic regions within the State. Salem County is located in
31 Southwest Zone, which is characterized by low elevation near sea level and close proximity to
32 Delaware Bay. These features result in the Southwest Zone generally having higher
33 temperatures, and receiving less precipitation than the northern and coastal areas of the State.
34 Wind direction is predominantly from the southwest except in winter, when winds are primarily
35 from the west and northwest (NOAA 2008).

36 The only NOAA weather station in Salem County with recent data is the Woodstown Pittsgrove
37 Station, located approximately 10 mi northeast of the Salem and NCGS facilities (NOAA 2010a).
38 A summary of the data collected from this station from 1971 to 2001 indicates that winter
39 temperatures average 35.2 degrees Fahrenheit (°F; 1.8 degrees Celsius [°C]) and summer
40 temperatures average 74.8°F (23.8°C). Average annual precipitation in the form of rain and
41 snow is 45.76 inches (116.2 cm), with most rain falling in July and August and most snow falling
42 in January (NOAA 2004).

43 Queries of the National Climate Data Center database for Salem County for the period January
44 1, 1950 to November 30, 2009 identified the following information related to severe weather
45 events:

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- 1 • 33 flood events with the majority (24) being coastal or tidal floods;
- 2 • Numerous heavy precipitation and prolonged rain events which also resulted in several
3 incidences of localized flooding, but which are not included in the flood event number;
- 4 • Five funnel cloud sightings and two tornados ranging in intensity from F1 to F2;
- 5 • 148 thunderstorm and high wind events; and
- 6 • 14 incidences of hail greater than 0.75 inches (1.9 cm) (NOAA 2010b).

7 In 2001, unusually dry conditions were related to two wildfires that burned a total of 54 ac (21.9
8 ha) and in 2009 a series of brush fires destroyed approximately 15 ac (6.1 ha) of farmland and
9 wooded area in Salem County (NOAA 2010c).

10 Climate data are available for the Woodstown Pittsgrove Station from 1901 through 2004, at
11 which time monitoring at this location was ended (NOAA 2010a). The closest facility which
12 currently monitors climate data, and has an extensive historic record, is the station located at
13 the Wilmington New Castle County Airport, located on the opposite side of the Delaware River,
14 approximately 9 mi (14.4 km) northwest of the facilities (NOAA 2010d).

15 2.2.2.2 Air Quality

16 Salem County is included with the Metropolitan Philadelphia Interstate Air Quality Control
17 Region (AQCR), which encompasses the area geographically located in five counties of New
18 Jersey, including Salem and Gloucester Counties, New Castle County Delaware, and five
19 counties of Pennsylvania (40 CFR 81.15). Air quality is regulated by the NJDEP, through their
20 Bureau of Air Quality Planning, Bureau of Air Quality Monitoring, and Bureau of Air Quality
21 Permitting (NJDEP 2009a). The Bureau of Air Quality Monitoring operates a network of
22 monitoring stations for the collection and analysis of air samples for several parameters,
23 including carbon monoxide, nitrogen dioxide, ozone, sulfur dioxide, particulate matter, and
24 meteorological characteristics. The closest air quality monitoring station to the Salem and
25 HCGS facilities is in Millville, located approximately 23 mi (36.8 km) to the southeast (NJDEP
26 2009a).

27 In order to enforce air quality standards, the EPA has developed National Ambient Air Quality
28 Standards (NAAQS) under the Federal Clean Air Act. The requirements examine the six criteria
29 pollutants including particle pollution (particulate matter[pm]), ground-level ozone, carbon
30 monoxide (CO), sulfur oxides (SO²), nitrogen oxides (NO_x), and lead; permissible limits are
31 established based on human health and/or environmental protection. When an area has air
32 quality equal to or better than the NAAQS, they are designated as an "attainment area" as
33 defined by the EPA, however; areas that do not meet the NAAQS standards are considered
34 "nonattainment areas" and are required to develop an air quality maintenance plan (NJDEP
35 2010a).

36 Salem County is designated as in attainment/unclassified with respect to the NAAQSs for PM_{2.5},
37 SO₂, NO_x, CO, and lead. The county, along with all of southern New Jersey, is a nonattainment
38 area with respect to the 1-hour primary ozone standard and the 8-hour ozone standard. For the
39 1-hour ozone standard, Salem County is located within the multi-state Philadelphia-Wilmington-
40 Trenton non-attainment area, and for the 8-hour ozone standard, it is located in the
41 Philadelphia-Wilmington-Atlantic City (Pennsylvania -New Jersey -Delaware -Maryland) non

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1 attainment area. Of the adjacent counties, Gloucester County in New Jersey is in non-
2 attainment for the 1-hour and 8-hour ozone standards, as well as the annual and daily PM_{2.5}
3 standard (NJDEP 2010a). New Castle County, Delaware, is considered to be in moderate non-
4 attainment for the ozone standards, and non-attainment for PM_{2.5} (40 CFR 81.315).

5 Sections 101(b)(1), 110, 169(a)(2) and 301(a) of the Clean Air Act (CAA) as amended
6 (42 U.S.C. 7410, 7491(a)(2), 7601(a)) established 156 mandatory Class I Federal areas where
7 visibility is an important value that cannot be compromised. There is one mandatory Class I
8 Federal area in the State of New Jersey, which is the Brigantine National Wildlife Refuge (40
9 CFR 81.420), located approximately 58 miles (93 km) southeast of the Salem and HCGS
10 facilities. There are no Class I Federal areas in Delaware, and no other areas located within
11 100 mi (161 km) of the facilities (40 CFR 81.400).

12 PSEG has a single Air Pollution Control Operating Permit (Title V Operating Permit), Number
13 BOP080001, from the NJDEP to regulate air emissions from all sources at Salem and HCGS
14 (PSEG 2009a, PSEG 2009b). This permit was last issued on February 2, 2005, and expired on
15 February 1, 2010. The facilities qualify as a major source¹ under the Title V permit program and
16 therefore are operated under a Title V permit (NJDEP 2009b). The air emissions sources
17 located at Salem which are regulated under the permit include:

Comment [C6]: Indicate re-application, under which permit it is operating since expiration in February 1, 2010, and when to expect renewal of permit by NJDEP.

- 18 • A boiler for heating purposes
- 19 • Salem Unit 3, a 40 MW fuel-oil fired peaking unit which is used intermittently
- 20 • Six emergency generators, tested monthly
- 21 • A boiler at the Circulating Water House, used for heating only in winter
- 22 • Miscellaneous volatile organic compounds (VOC) emissions from fuel tanks

23 The air emissions sources located at HCGS which are regulated under the permit include:

- 24 • The cooling tower
- 25 • A boiler for house heating and use for start-up steam for the boiling water reactor
- 26 • Four emergency generators, tested monthly
- 27 • Miscellaneous VOC emissions from fuel tanks
- 28 • A small boiler used to heat the Service Water house

29 Meteorological conditions at the facilities are monitored at a primary and a backup
30 meteorological tower located at the entrance of the facilities, on the southeast side of the
31 property. The primary tower is a 300-ft (91-m) high tower supported by guy wires, and the
32 backup tower is a 33-ft (10-m) high telephone pole located approximately 500 ft (152 m) south
33 of the primary tower. Measurements collected at the primary tower include temperature, wind

¹ Under the Title V Operating Permit program, the EPA defines a Major Source as a stationary source with the potential to emit (PTE) any criteria pollutant at a rate > 100 tons/year, or any single hazardous air pollutant (HAP) at a rate of greater than 10 tons/year or a combination of HAPs at a rate greater than 25 tons/year.

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1 speed, and wind direction at elevations of 300, 150, and 33-ft (91, 46, and 10-m) above ground
2 level, dew point measured at the 33-foot (10-m) level, and rainfall, barometric pressure and
3 solar radiation measured at less than 10 ft (3 m) above the ground surface. Measurements
4 collected at the backup tower include wind speed and wind direction (PSEG 2006).

5 **2.2.3 Ground Water Resources**

6 **2.2.3.1 Description**

7 Groundwater at the Salem and HCGS facilities is present in Coastal Plain sediments, an
8 assemblage of sand, silt, and clay formations that comprise a series of aquifers beneath the
9 facilities. Four primary aquifers underlie the facility location. The shallowest of these is the
10 shallow water-bearing zone, which is contained within the dredge spoil and engineered fill
11 sediments of Artificial Island. Groundwater is found within this zone at a depth of 10 to 40 ft (3
12 to 12 m) bgs (PSEG 2007b). The groundwater in the shallow zone is recharged through direct
13 infiltration of precipitation on Artificial Island, and is brackish. Groundwater in the shallow zone
14 flows towards the southwest, towards the Delaware River (PSEG 2009b).

15 Beneath the shallow water-bearing zone, the Vincentown aquifer is found at a depth of 55 to
16 135 ft (17 to 41 m) bgs. The Vincentown aquifer is confined and semi-confined beneath
17 Miocene clays of the Kirkwood Formation. Groundwater within the Vincentown aquifer flows
18 towards the south. Water within the Vincentown aquifer is potable, and is accessed through
19 domestic wells in eastern Salem County, upgradient of the facility. In western Salem County,
20 including near the facility, saltwater intrusion from the Delaware River has occurred, resulting in
21 brackish, non-potable groundwater within this aquifer (PSEG 2007b).

22 The Vincentown aquifer is underlain by the Hornerstown and Navesink confining units, which in
23 turn overlie the Mount Laurel-Wenonah aquifer. The Mount Laurel-Wenonah aquifer exists at a
24 depth of 170 to 270 ft (52 to 82 m) bgs, and is recharged through leakage from the overlying
25 aquifers (Rosenau et al. 1969).

26 Beneath the Mount Laurel-Wenonah aquifer is a series of clay and fine sand confining units and
27 poor quality aquifers, including the Marshalltown Formation, Englishtown Formation, Woodbury
28 Clay, and Merchantville Formation. These units overlie the Potomac-Raritan-Magothy aquifer,
29 which is found at a depth of 450 ft (145 m), with fresh water encountered to a depth of 900 ft
30 (290 m) bgs at the facility location (PSEG 2007b). The Potomac-Raritan-Magothy aquifer is a
31 large aquifer of regional importance for municipal and domestic water supply. In order to protect
32 groundwater resources within this aquifer, the state of New Jersey has established Critical
33 Water-Supply Management Area 2, in which groundwater withdrawals are limited and managed
34 through allocations (USGS 2007). Critical Water-Supply Management Area 2 includes Ocean,
35 Burlington, Camden, Atlantic, Gloucester, and Cumberland Counties, as well as the eastern
36 portion of Salem County. The area does not include the western portion of Salem County,
37 where the facility is located, so groundwater withdrawals at the facility location are not subject to
38 withdrawal restrictions associated with this management area.

39 **2.2.3.2 Affected Users**

40 The use of groundwater by the facility is discussed in Section 2.1.7.1. Groundwater is the
41 source of more than 75 percent of the freshwater supply within the Coastal Plain region and
42 wells used for public supply commonly yield 500 to more than 1000 gpm (1885 to 3770 lpm)
43 (EPA 1988). The water may have localized concentrations of iron in excess of 460 milligrams

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1 per liter (mg/L), and may be contaminated locally by saltwater intrusion and waste disposal;
2 however water quality is considered satisfactory overall (NJWSC 2009).

3 Groundwater is not accessed for public or domestic water supply within 1 mile (1.6 km) of the
4 Salem and HCGS facilities (PSEG 2009a, PSEG 2009b). However, groundwater is the primary
5 source of municipal water supply within Salem and the surrounding counties. There are 18
6 public water supply systems in Salem County. New Jersey American Water (NJAW) is the
7 largest of these, providing groundwater from the Potomac-Raritan-Magothy Aquifer to more than
8 14,000 customers in Pennsgrove, located approximately 18 miles (29 km) north of the Salem
9 and HCGS facilities (EPA 2010b, NJAW 2010). The other two major suppliers are Pennsville
10 Township and the City of Salem (EPA 2010b). The City of Salem is the closest public water
11 supply system in Salem County to the facilities, but provides water from surface water sources
12 (EPA 2010b). The Pennsville Township water system is located approximately 15 miles (24 km)
13 north of the Salem and HCGS facilities, and supplies water to approximately 13,500 residents
14 from the Potomac-Raritan-Magothy Aquifer (EPA 2010b; NJDEP 2007a).

15 There are 27 water systems in New Castle County, Delaware. Municipal and investor-owned
16 utilities provide drinking water to the county. The majority of the potable water supply is
17 provided from surface water sources (EPA 2010c). The nearest offsite use of groundwater for
18 potable water supply is located approximately 3.5 miles (5.6 km) west of the site, in New Castle
19 County, Delaware (Arcadis 2006). This water supply consists of two wells installed within the
20 Mt. Laurel aquifer, serving 132 residents (Delaware Department of Natural Resources and
21 Environmental Control [DNREC] 2003).

22 2.2.3.3 Available Volume

23 Groundwater within the Potomac-Raritan-Magothy aquifer is an important resource for water
24 supply in a region extending from Mercer and Middlesex counties in New Jersey to the north,
25 and towards Maryland to the southwest. Groundwater withdrawal from the early part of the
26 twentieth century through the 1970s resulted in the development of large-scale cones of
27 depression in the elevation of the piezometric surface, and therefore the available water quantity
28 within the aquifer (U.S. Geological Survey [USGS] 1983). Large scale withdrawals of water
29 from the aquifer are known to influence water availability at significant lateral distances from
30 pumping centers (USGS 1983). In reaction to these observations, water management
31 measures, including limitations on pumping, were instituted by the NJDEP (although not
32 including the Salem and HCGS facility area). As of 2003, NJDEP-mandated decreases in water
33 withdrawals had resulted in general recovery of water level elevations in both the Upper and
34 Middle Potomac-Raritan-Magothy aquifers in the Salem County area (USGS 2009).

35 2.2.3.4 Existing Quality

36 Annual Radiological Environmental Monitoring Program (REMP) reports document regular
37 sampling of groundwater as required by the NRC. In support of this SEIS, the annual REMP
38 reports for 2006, 2007, and 2008 (PSEG 2007a, PSEG 2008a, PSEG 2009c) were reviewed.
39 The program includes the collection and analysis of groundwater at one or two locations that
40 may be affected by station operations. Although the facility has determined that there are no
41 groundwater wells in locations that could be affected by station operations, they routinely collect
42 a sample from one location, well 3E1 at a nearby farm, as a management audit sample. These
43 samples, collected on a monthly basis, are analyzed for gamma emitters, gross alpha, gross
44 beta, and tritium. In 2006 through 2008, no results were identified which would suggest
45 potential impacts from facility operations.

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1 In 2003, a release of tritium to groundwater from the Salem Unit 1 Spent Fuel Pool was
2 identified. The initial indication of the release was the detection of low-level radiation on a
3 worker's shoes in the Unit 1 Auxiliary Building in 2002. This led to the discovery of a chalk-like
4 radioactive substance on the walls of the Mechanical Penetration Room, which had resulted
5 from the seepage of water from the Spent Fuel Pool. The seepage was caused by blockage of
6 drains by mineral deposits. Response measures, including removal of the mineral deposits and
7 installation of additional drains, were taken, and the release was stopped (Arcadis 2006).

8 A site investigation was initiated in 2003, and included the installation and sampling of 29
9 monitoring wells in the shallow and Vincentown aquifers (PSEG 2004a). The tritium was
10 released into groundwater inside of the cofferdam area that surrounds the Salem containment
11 unit. Groundwater within the cofferdam area is able to flow outside of the cofferdam through a
12 low spot in the top surface of the cofferdam, and this allowed the tritium plume to enter the flow
13 system outside of the cofferdam. From that location, the plume followed a preferential flow path
14 along the high permeability sand and gravel bed beneath the circulating water discharge pipe,
15 and thus towards the Delaware River. Tritium was detected in shallow groundwater at
16 concentrations up to 15,000,000 picoCuries per liter (pCi/L). The extent of the impact was
17 limited to within the PSEG property boundaries, and no tritium was detected in the Vincentown
18 Aquifer, indicating that the release was limited to the shallow water-bearing aquifer (PSEG
19 2009d). The release did not include any radionuclides other than tritium.

20 In 2004, PSEG developed a Remedial Action Workplan, and a Groundwater Recovery System
21 (GRS) was approved by NJDEP and became operational by September, 2005. The GRS
22 operates by withdrawing tritium-impacted groundwater from six pumping wells within the plume,
23 and a mobile pumping unit that can be moved between other wells as needed to maximize
24 withdrawal efficiency. The pumping system reverses the groundwater flow gradient and stops
25 migration of the plume towards the property boundaries. The tritium-impacted water removed
26 from the groundwater is processed in the facility's Non-Radioactive Liquid Waste Disposal
27 System (NRLWDS). As part of this system, the groundwater is collected in tanks, sampled, and
28 analyzed to identify the quantity of radioactivity and the isotopic breakdown. Upon verification
29 that the groundwater meets NRC discharge requirements, the groundwater is released under
30 controlled conditions to the Delaware River through the circulatory water system (PSEG 2009a).
31 Operation of the groundwater extraction system is monitored by a network of 36 monitoring
32 wells (PSEG 2009e). This monitoring indicates that maximum tritium concentrations have
33 dropped substantially, from a maximum of 15,000,000 pCi/L to below 100,000 pCi/L. Some
34 concentrations still exceed the New Jersey Ground Water Quality Criterion for tritium of 20,000
35 pCi/L (PSEG 2009e). However, groundwater that exceeds this criterion does not extend past
36 the property boundaries (PSEG 2009a).

37 To verify the status of the groundwater remediation program, NRC staff interviewed NJDEP
38 staff, including Ms. Karen Tucllo, the director of the NJDEP Radiation Protection Program, and
39 Jerry Humphreys, Tom Kolesnik, and Paul Schwartz of the NJDEP Bureau of Nuclear
40 Engineering, during the site audit in March 2010. The NJDEP staff confirmed that both NJDEP
41 and the New Jersey Geological Survey (NJGS) had been substantially involved in assisting
42 PSEG in developing a response to the tritium release, and that NJDEP conducts ongoing
43 confirmation sampling. Both NJDEP and NJGS review PSEG's Quarterly Remedial Action
44 Progress Reports, including confirmation of the analytical results and verification of plume
45 configurations based on those results. NJDEP staff confirm that the GRS is operating in a
46 satisfactory manner.

1 In response to an industry-wide initiative sponsored by the Nuclear Energy Institute (NEI),
2 PSEG implemented a facility-wide groundwater Radiological Groundwater Protection Program
3 (RGPP) at the Salem and HCGS facilities in 2006. The program, which is separate from the
4 monitoring associated with the groundwater recovery system, included the identification of
5 station systems that could be sources of radionuclide releases, installation of monitoring wells
6 near and downgradient of those systems, and installation of wells upgradient and downgradient
7 of the facility perimeter. The monitoring program consists of 13 monitoring wells at Salem (5
8 pre-existing and 8 new) and 13 wells at HCGS (all new). The results of the program are
9 reported in the facility's annual Radiological Environmental Operating Reports. The wells are
10 sampled on a semi-annual basis, and have detected no plant-related gamma-emitters. In the
11 2008 annual program, tritium was detected in 5 of the 13 wells at Salem, and 6 of the 13 wells
12 at HCGS. All sample results were lower than 1,000 pCi/L, which is less than the 20,000 pCi/L
13 EPA drinking water standard and New Jersey Ground Water Quality Criterion (PSEG 2009c).
14 These levels of detections are not high enough to trigger voluntary reporting that would be made
15 under the guidelines of the NEI guidance (PSEG 2009a).

16 During the site audit, PSEG provided information indicating that elevated tritium concentrations
17 had been detected in six RGPP wells at the HCGS facility in November 2009. This included
18 detection of tritium at concentrations up to 1200 picocuries per liter (pCi/L) in four wells, and at
19 approximately 3500 pCi/L in two wells (wells BH and BJ). The wells were all re-sampled in
20 December 2009, and the tritium concentrations had dropped to levels of approximately 500 to
21 800 pCi/L which still exceeded their levels prior to November 2009. The wells involved are
22 located at the HCGS facility, and are not related to the tritium plume being managed at Salem.
23 PSEG has instituted a well inspection and assessment program to identify the source of the
24 tritium, which is thought to be from either analytical error or rain-out of gaseous emissions in
25 precipitation. Based on the locations of the wells and identification of cracked caps on some
26 wells, it is possible that collection of rainwater run-on entered the wells, causing the increased
27 concentrations. In response, PSEG has replaced all well caps with screw caps, and is working
28 with NJDEP and NRC to implement a well inspection program.

29 During the site audit, PSEG also provided information on a small-scale diesel pump and treat
30 remediation system being operated near Salem Unit 1, to address a leak of diesel fuel at that
31 location. NJDEP is also involved in the operation of that system, and NJDEP staff confirmed
32 that the remediation system is operating in a satisfactory manner.

33 2.2.4 Surface Water Resources

34 2.2.4.1 Description

35 The Salem and HCGS facilities are located on Artificial Island, a man-made island constructed
36 on the New Jersey (eastern) shore of the Delaware River (PSEG 2009a, PSEG 2009b). All
37 surface water in Salem County drains to the Delaware River and Bay. Some streams flow
38 directly to the river, while others join subwatersheds before reaching their destination. The tides
39 of the Atlantic Ocean influence the entire length of the Delaware River in Salem County. Tidal
40 marshes are located along the lower stretches of the Delaware River and are heavily influenced
41 by the tides, flooding twice daily. Wetland areas, such as Mannington and Supawna Meadows,
42 make up roughly 30 percent of the county. The southwestern portion of Salem County is
43 predominately marshland, and to the north, tidal marshes are found in the western sections of
44 the county at the mouths of river systems including the Salem River and Oldmans Creek (Salem
45 County 2008).

Affected Environment

1 The Division of Land Use Regulation (LUR) is managed by the NJDEP and seeks to preserve
2 quality of life issues that affect water quality, wildlife habitat, flood protection, open space and
3 the tourism industry. Coastal waters and adjacent land are protected by several laws including
4 the Waterfront Development Law (N.J.S.A. 12:5-3), the Wetlands Act of 1970 (N.J.S.A. 13:9A),
5 New Jersey Coastal Permit Program Rules, (N.J.A.C. 7:7), Coastal Zone Management Rules,
6 (N.J.A.C. 7:7E) and the Coastal Area Facility Review Act (N.J.S.A. 13:19), which regulates
7 almost all coastal development and includes the Kilcohook National Wildlife Refuge that is
8 located in Salem County (NJDEP 2010b).

9 The facilities are located at River Mile 51 on the Delaware River. At this location, the river is
10 approximately 2.5 mi (4 km) wide. The facilities are located on the Lower Region portion of the
11 river, which is designated by the DRBC as the area of the river subject to tidal influence, and
12 located between Delaware Bay and Trenton, New Jersey (DRBC 2008a). The Lower Region
13 and Delaware Bay together form the Estuary Region of the river, which is included as the
14 Partnership for the Delaware Estuary within the EPA's National Estuary Program (EPA 2010d).

15 Water use from the river at the facility location is regulated by both the DRBC and the State of
16 New Jersey. The DRBC was established in 1961, through the Delaware River Basin Compact,
17 as a joint Federal and State body to regulate and manage water resources within the basin.
18 The DRBC acts to manage and regulate water resources in the basin by: allocating and
19 regulating water withdrawals and discharges; resolving interstate, water-related disputes;
20 establishing water quality standards; managing flow; and watershed planning (DRBC 1961).

21 As facilities that use water resources in the basin, Salem and HCGS water withdrawals are
22 conducted under contract to the DRBC. The Salem facility uses surface water under a DRBC
23 contract originally signed in 1977 (DRBC 1977), and most recently revised and approved for a
24 25-year term in 2001 (DRBC 2001). Surface water withdrawals by the HCGS facility were
25 originally approved for two units in 1975, and then revised for a single unit in 1985 following
26 PSEG's decision to build only one unit (DRBC 1984a). The withdrawal rates are also regulated
27 by NJDEP, under New Jersey Pollutant Discharge Elimination System (NJPDES) permits
28 NJ0025411 (for HCGS) and NJ005622 (for Salem).

29 **2.2.4.2 Affected Users**

30 The Delaware River Basin is densely populated, and surface water resources within the river
31 are used for a variety of purposes. Freshwater from the non-tidal portion of the river is
32 used to supply municipal water throughout New York, Pennsylvania, and New Jersey, including
33 the large metropolitan areas of Philadelphia and New York City. Approximately 75 percent of
34 the length of the non-tidal Delaware River is designated as part of the National Wild and Scenic
35 Rivers System. The river is economically important for commercial shipping, as it includes port
36 facilities for petrochemical operations, military supplies, and raw materials and consumer
37 products (DRBC 2010).

38 In the tidal portion of the river, water is accessed for use in industrial operations, including
39 power plant cooling systems. A summary of DRBC-approved water users on the tidal portion of
40 the river from 2005 lists 22 industrial facilities and 14 power plants in Pennsylvania, New Jersey,
41 and Delaware (DRBC 2005). Of these facilities, Salem is by far the highest volume water user
42 in the basin, with a reported water withdrawal volume of 1,067,892 million gallons (4,025,953
43 million liters) in 2005 (DRBC 2005). This volume exceeds the combined total withdrawal for all
44 other industrial, power, and public water supply purposes in the tidal portion of the river. The

1 withdrawal volume for HCGS in 2005 was much lower, at 19,561 million gallons (73,745 million
2 liters).

3 **2.2.4.3 Water Quality Regulation**

4 To regulate water quality in the basin, the DRBC has established water quality standards,
5 referred to as Stream Quality Objectives, to protect human health and aquatic life objectives.
6 To account for differing environmental setting and water uses along the length of the river basin,
7 the DRBC has established Water Quality Management (WQM) Zones, and has established
8 separate Stream Quality Objectives for each zone. The Salem and HCGS facilities are located
9 within Zone 5, which extends from River Mile 48.2 to River Mile 78.8.

10 The DRBC Stream Quality Objectives are used by the NJDEP to establish effluent discharge
11 limits for discharges within the basin. The EPA granted the State of New Jersey the authority to
12 issue NPDES permits, and such a permit implies water quality certification under the Federal
13 Clean Water Act (CWA) Section 401. The water quality and temperature of the discharges for
14 both the Salem and HCGS discharges are regulated by NJDEP under NJPDES permits
15 NJ0025411 (for HCGS) and NJ005622 (for Salem).

16 **2.2.4.4 Salem NJPDES Requirements**

17 The current NJPDES permit NJ005622 for the Salem facility was issued with an effective date of
18 August 1, 2001, and an expiration date of July 31, 2006 (NJDEP 2001). The permit requires
19 that a renewal application be prepared at least 180 days in advance of the expiration date.
20 Correspondence provided with the applicant's ER indicates that a renewal application was filed
21 on January 31, 2006. During the site audit, NJDEP staff confirmed that the application was still
22 undergoing review, so the 2001 permit is still considered to be in force. No substantial changes
23 in permit conditions are anticipated.

24 The Salem NJPDES permit regulates water withdrawals and discharges associated with non-
25 radiological industrial wastewater, including intake and discharge of once-through cooling water.
26 The once-through cooling water, Service Water, Non-Radiological Liquid Waste Disposal
27 System, Radiological Liquid Waste Disposal System, and other effluents are discharged through
28 the cooling water system intake. The specific discharge locations, and their associated
29 reporting requirements and discharge limits, are presented in Table 2-2.

30 Stormwater discharge is not monitored through the Salem NJPDES permit. Stormwater is
31 collected and discharged through outfalls DSN 489A (south), 488 (west) and 487/487B (north).
32 The NJPDES permit requires that stormwater discharges be managed under an approved
33 Stormwater Pollution Prevention Plan (SWPPP), and therefore does not specify discharge
34 limits. The same SWPPP is also applicable to stormwater discharges from the HCGS facility.
35 The plan includes a listing of potential sources of pollutants and associated best management
36 practices (NJDEP 2003).

37 Industrial wastewater from Salem is regulated at nine specific locations, designated Outfalls
38 DSN 048C, 481A, 482A, 483A, 484A, 485A, 486A, 487B, and 489A. DSN Outfall 048C is the
39 discharge system for the NRLWDS, and also receives stormwater from the DSN 487B outfall.
40 For DSN 048C, the permit establishes reporting requirements for discharge volume (in millions
41 of gallons per day), and compliance limits for Total Suspended Solids, ammonia, petroleum
42 hydrocarbons, and Total Organic Carbon (NJDEP 2001).

43

1

Table 2-2. NJPDES Permit Requirements for Salem

Discharge	Description	Required Reporting	Permit Limits
Discharge Serial Number (DSN) 048C.	Input is NRLWDS, and Outfall DSN 487B. Discharges to Outfall DSNs 481A, 482A, 484A, and 485A.	Effluent flow volume	None
		Total Suspended Solids	50 mg/L monthly average, 100 mg/L daily maximum
		Ammonia (Total as N)	35 mg/L monthly average, 70 mg/L daily maximum
		Petroleum hydrocarbons	10 mg/L monthly average, 15 mg/L daily maximum
		Total Organic Carbon	Report monthly average, 50 mg/L daily maximum
DSN 481A, 482A, 483A, 484A, 485A, and 486A (the same requirements for each).	Input is cooling water, Service Water, and DSN 048C. Outfall is six separate discharge pipes.	Effluent flow volume	None
		Effluent pH	6.0 daily minimum, 9.0 daily maximum
		Intake pH	None
		Chlorine-produced oxidants	0.3 mg/L monthly average, 0.2 and 0.5 mg/L daily maximum
		Temperature	None
DSN 487B	#3 Skim Tank, and stormwater from north portion.	Effluent flow pH	None
			6.0 daily minimum, 9.0 daily maximum
		Total Suspended Solids	100 mg/L daily maximum
		Temperature	43.3°C daily maximum
		Petroleum Hydrocarbons	15 mg/L daily maximum
		Total Organic Carbon	50 mg/L daily maximum
DSN 489A	Oil/Water Separator, turbine sumps, and stormwater from south portion.	Effluent flow pH	None
			6.0 daily minimum, 9.0 daily maximum
		Total Suspended Solids	30 mg/L monthly average, 100 mg/L daily maximum
		Petroleum Hydrocarbons	10 mg/L monthly average, 15 mg/L daily maximum
		Total Organic Carbon	50 mg/L daily maximum
DSN Outfall FAC A	Combined for discharges 481A, 482A, and 483A.	Net Temperature (year round)	15.3°C daily maximum
		Gross Temperature (June to September)	46.1°C daily maximum
		Gross Temperature (October to May)	43.3°C daily maximum
DSN Outfall FAC B	Combined for discharges 484A, 485A, and 486A.	Net Temperature (year round)	15.3°C daily maximum
		Gross Temperature (June to September)	46.1°C daily maximum
		Gross Temperature (October to May)	43.3°C daily maximum
DSN Outfall FAC C	Combined for discharges 481A, 482A, 483A, 484A, 485A, and 486A.	Influent flow	3024 MGD monthly average
		Effluent Thermal Discharge	30,600 MBTU/hr daily maximum

2 Source: NJDEP 2001.

Affected Environment

1 Outfalls DSN 481A, 482A, 483A, 484A, 485A, and 486A are the discharge systems for cooling
2 water, Service Water, and the Radiological Liquid Waste Disposal System. Outfalls 481A,
3 482A, and 483A are associated with Salem Unit 1, while outfalls 484A, 485A, and 486A are
4 associated with Salem Unit 2. The permit establishes similar, but separate, requirements for
5 each of these six outfalls. For each, the permit requires reporting of the discharge volume (in
6 millions of gallons per day), the pH of the intake, and the temperature of the discharge. The
7 permit also establishes compliance limits for the discharge from each outfall for pH and chlorine-
8 produced oxidants (NJDEP 2001).

9 Outfall DSN 487B is the discharge system for the #3 skim tank. The permit establishes reporting
10 requirements for discharge volume (in millions of gallons per day), and compliance limits for pH,
11 Total Suspended Solids, temperature of effluent, petroleum hydrocarbons, and Total Organic
12 Carbon (NJDEP 2001).

13 Outfall DSN 489A is the discharge system for the oil/water separator. The permit establishes
14 reporting requirements for discharge volume (in millions of gallons per day), and compliance
15 limits for pH, Total Suspended Solids, petroleum hydrocarbons, and Total Organic Carbon
16 (NJDEP 2001).

17 In addition to the reporting requirements and contaminant limits for these individual outfalls, the
18 permit establishes temperature limits for Salem Unit 1 as a whole, Salem Unit 2 as a whole, and
19 the Salem facility as a whole. Outfall FACA is the combined discharge from Outfalls 481A,
20 482A, and 483A to represent the overall thermal discharge from Salem Unit 1. For outfall
21 FACA, the permit establishes an effluent net temperature difference of 15.3°C, a gross
22 temperature of 43.3°C from October to May, and a gross temperature of 46.1°C from June to
23 September (NJDEP 2001).

24 Similarly, outfall FACB is the combined discharge from Outfalls 484A, 485A, and 486A to
25 represent the overall thermal discharge from Salem Unit 2. The temperature limits for outfall
26 FACB are the same as those established for outfall FACA (NJDEP 2001).

27 Outfall FACC is the combined results from outfalls 481A through 486A, representing the overall
28 thermal discharge and flow volume for the Salem facility as a whole. The permit establishes an
29 overall intake volume of 3024 million gallons per day on a monthly average basis, and an
30 effluent thermal discharge limit of 30,600 million British thermal Units (BTUs) per hour as a daily
31 maximum (NJDEP 2001).

32 In addition to the outfall-specific reporting requirements and discharge limits, the Salem
33 NJPDES permit includes a variety of general requirements (NJDEP 2001). These include
34 requirements for:

- 35 • Additives that may be used, where they may be used, and procedures for proposing
36 changes to additives;
- 37 • Toxicity testing of discharges and, depending on results, toxicity reduction measures;
- 38 • Implementation and operations of intake screens and fish return systems;
- 39 • Wetland restoration and enhancement through the Estuary Enhancement program;
- 40 • Implementation of a biological monitoring program;

Affected Environment

- 1 • Installation of fish ladders at offsite locations;
- 2 • Performance of studies of intake protection technologies;
- 3 • Implementation of entrainment and impingement monitoring;
- 4 • Conduct of special studies, including intake hydrodynamics and enhancements to
- 5 entrainment and impingement sampling;
- 6 • Funding of construction of offshore reefs; and
- 7 • Compliance with DRBC regulations, NRC regulations, and the NOAA Fisheries
- 8 Biological opinion.

9 In the permit, the NJDEP reserves the right to re-open the requirements for intake protection
10 technologies (NJDEP 2001).

11 2.2.4.5 HCGS NJPDES Requirements

12 The current NJPDES permit NJ0025411 for the HCGS facility was issued on in early 2003, with
13 an effective date of March 1, 2003 and expiration date of February 29, 2008 (NJDEP 2003).
14 The permit requires that a renewal application be prepared at least 180 days in advance of the
15 expiration date. Correspondence provided with the applicant's ER indicates that a renewal
16 application was filed on August 30, 2007. However, the current status of that renewal is not
17 provided within the ER and attached NJPDES permit (PSEG 2009b).

18 The HCGS NJPDES permit regulates water withdrawals and discharges associated with both
19 stormwater and industrial wastewater, including discharges of cooling tower blowdown (NJDEP
20 2003). The cooling tower blowdown and other effluents are discharged through an underwater
21 pipe located on the bank of the river, 1,500 ft (458 m) upstream of the SWS intake. The specific
22 discharge locations, and their associated reporting requirements and discharge limits, are
23 presented in Table 2-3.

24 Stormwater discharge is not monitored through the HCGS NJPDES permit. Stormwater is
25 collect and discharged through outfalls DSN 463A, 464A, and 465A. These outfalls were
26 specifically regulated, and had associated reporting requirements, in the HCGS NJPDES permit
27 through 2005. However, the revision of the permit in January 2005 modified the requirements
28 for stormwater, and the permit now requires that stormwater discharges be managed under an
29 approved SWPPP, and therefore does not specify discharge limits. The same SWPPP is also
30 applicable to stormwater discharges from the Salem facility. The plan includes a listing of
31 potential sources of pollutants and associated best management practices (NJDEP 2003).

32 Industrial wastewater is regulated at five locations, designated DSN 461A, DSN 461C, (missing
33 Part D), 516A (Oil Water Separator), and SL1A (sewage treatment plant STR-System).
34 Discharge DSN 461A is the discharge for the cooling water blowdown, and the permit
35 established reporting and compliance limits for intake and discharge volume (in millions of
36 gallons per day), pH, chlorine-produced oxidants, intake and discharge temperature, Total
37 Organic Carbon, and heat content in millions of BTUs per hour, in both summer and winter
38 (NJDEP 2003).

39

1

Table 2-3. NJPDES Permit Requirements for HCGS

Discharge	Description	Required Reporting	Permit Limits
DSN 461A	Input is cooling water blowdown, and DSN 461C. Outfall is discharge pipe.	Effluent Flow	None
		Intake Flow	None
		Effluent pH	6.0 daily minimum, 9.0 daily maximum
		Chlorine-produced oxidants	0.2 mg/L monthly average, 0.5 mg/L daily maximum
		Effluent gross temperature	36.2°C daily maximum
		Intake temperature	None
		Total organic carbon (effluent gross, effluent net, and intake)	None
		Heat content (June to August) Heat content (September to May)	534 MBTU/hr daily maximum 662 MBTU/hr daily maximum
DSN 461C	Input is low volume oily waste from oil/water separator. Outfall is to DSN 461A.	Effluent flow	None
		Total Suspended Solids	30 mg/L monthly average, 100 mg/L daily maximum
		Total Recoverable Petroleum Hydrocarbons	10 mg/L monthly average, 15 mg/L daily maximum
		Total Organic Carbon	50 mg/L daily maximum
DSN 462B	Sewage treatment plant effluent, discharges to 461A.	Effluent flow	None
		Total Suspended Solids	30 mg/L monthly average, 45 mg/L weekly average, 83% removal daily minimum
		Biological Oxygen Demand (BOD)	8 kg/day monthly average, 30 mg/L monthly average, 45 mg/L weekly average, 87.5 percent removal daily minimum
		Oil and Grease	10 mg/L monthly average, 15 mg/L daily maximum
		Fecal Coliform	200 lbs/100 ml monthly geometric, 400 lbs/100 ml weekly geometric average,
		6 separate metal and inorganic contaminants (cyanide, nickel, zinc, cadmium, chromium, and copper)	None
S16A	Oil/Water Separator residuals from 461C.	24 separate metal and inorganic contaminants	None
		24 separate organic contaminants	None
		Volumes and types of sludge produced and disposed	None
SL1A	STP System residuals from 462B.	17 separate metal and inorganic contaminants	None
		Volumes and types of sludge produced and disposed	None

Comment [C7]:

2 Source: NJDEP 2005a.

Affected Environment

1 Discharge DSN 461C is a discharge for the oil/water separator system, and has established
2 reporting and compliance limits for discharge volume, Total Suspended Solids, Total
3 Recoverable Petroleum Hydrocarbons, and Total Organic Carbon (NJDEP 2003).

4 Discharge DSN 462B is the discharge for the onsite sewage treatment plant. The permit
5 includes limits for effluent flow volume, Total Suspended Solids, oil and grease, fecal coliform,
6 and six inorganic contaminants (NJDEP 2005a).

7 Discharge 516A is the discharge from the oil/water separator system. This discharge has
8 reporting requirements established for 48 inorganic and organic contaminants, for the volume of
9 sludge produced, and for the manner in which the sludge is disposed (NJDEP 2003).

10 Discharge SL1A is the discharge from the sewage treatment plant (STP) system. This
11 discharge has reporting requirements established for 17 inorganic contaminants, as well as
12 sludge volume and disposal information (NJDEP 2003).

13 In addition to the outfall-specific reporting requirements and discharge limits, the HCGS
14 NJPDES permit includes a variety of general requirements. These include requirements for
15 additives that may be used, where they may be used, and procedures for proposing changes to
16 additives; and compliance with DRBC regulations and NRC regulations (NJDEP 2003).

17 In the permit, the NJDEP reserves the revoke the alternate temperature provision for outfall
18 DSN 461A if the NJDEP determines that the cooling tower is not being properly operated and
19 maintained (NJDEP 2003).

20 **2.2.4.6 — REMP**

21 Annual Radiological Environmental Monitoring Program (REMP) reports document regular
22 sampling of surface water, sediment, and a potable water source. In support of this SEIS, the
23 annual REMP reports for 2006, 2007, and 2008 (PSEG-2007a, PSEG-2008a, PSEG-2009c)
24 were reviewed. In addition, the NJDEP Bureau of Nuclear Engineering (BNE) conducts its own
25 independent Environmental Surveillance and Monitoring Program (ESMP) which includes
26 similar radiological monitoring and sampling of surface water, sediment, and other media. In
27 support of this SEIS, the annual ESMP reports for 2006, 2007, and 2008 were reviewed
28 (NJDEP-2007b, NJDEP-2008a, NJDEP-2009c).

29 The REMP program includes the collection and analysis of surface water and sediment samples
30 as follows:

- 31 • Five surface water locations (four indicator and one control location) sampled monthly,
32 and analyzed for gross beta, gamma emitters, and tritium;
- 33 • Seven sediment locations (six indicator and one control) sampled semi-annually, and
34 analyzed for gamma emitters; and
- 35 • One potable water sample, collected from the City of Salem Water and Sewer
36 Department, composited monthly based on daily samples, and analyzed for gross alpha,
37 gross beta, gamma emitters, tritium, and iodine-131. The source of this potable water is
38 surface water from Laurel Lake, combined with water from nearby groundwater wells.

1 Surface water results indicate that gross beta have been detected at activities that exceeded
 2 pre-operational levels at both the indicator and control locations. In 2008, the maximum pre-
 3 operational level for gross beta was 110 pCi/L, with an average of 32 pCi/L. Gross beta
 4 activities reported in the 2008 indicator samples had a maximum of 300 pCi/L, and an average
 5 of 97 pCi/L. Activities reported in the control sample had a maximum of 158 pCi/L, with an
 6 average of 73 pCi/L. Gross beta results from 2006 and 2007 were similar, indicating gross beta
 7 activities that exceeded pre-operational levels (PSEG 2007a, PSEG 2008a). For all three
 8 years, tritium and gamma emitter were detected at levels below pre-operational activities (PSEG
 9 2007a, PSEG 2008a, PSEG 2009c).

10 Sediment results for all three years indicated that no gamma emitters were detected at levels
 11 that exceeded their pre-operational activities (PSEG 2007a, PSEG 2008a, PSEG 2009c).

12 Potable water sample results for all three years indicate that gross alpha and gross beta were
 13 detected, but at activities that were lower than their pre-operational levels. Tritium and iodine-
 14 131 were not detected. Naturally occurring gamma emitters potassium 40 and radium were
 15 detected in all three years, although there was no pre-operational data for comparison. No
 16 other gamma emitters were detected (PSEG 2007a, PSEG 2008a, PSEG 2009c).

17 The BNE's ESMP reports each conclude that the data do not indicate any discharges to the
 18 environment above the NRC regulatory limits. Also, the reports state that there is no upward
 19 trend in radioactivity for those radionuclides associated with commercial nuclear operations
 20 (NJDEP 2007a, NJDEP 2008a, NJDEP 2009c).

Comment [C8]: The REMF discussion needs
 to be moved to Chapter 4!

21 2.2.5 Aquatic Resources - Delaware Estuary

22 2.2.5.1 Estuary Characteristics

23 Salem and HCGS are located at the south end of Artificial Island on the New Jersey shore of
 24 the Delaware Estuary, about 52 river mi (84 river km) north of the mouth of Delaware Bay
 25 (Figure 2-5). The estuary is the source of the cooling water for both facilities and receives their
 26 effluents. The Delaware Estuary supports an abundance of aquatic resources in a variety of
 27 habitats and biological communities. Open water habitats include salt water, tidally influenced
 28 water of variable salinities, and tidal freshwater areas. Moving south from the Delaware River to
 29 the mouth of the bay, there is a continual transition from fresh to salt water. Additional habitat
 30 types occur along the edges of the estuary in brackish and freshwater marshes. The bottom of
 31 the estuary provides many different benthic habitats, with their characteristics dictated by
 32 salinity, tides, water velocity, and substrate type. Sediments in the estuary zone that includes
 33 Artificial Island are primarily mud, muddy sand, and sandy mud (PSEG 2006c).

34 At Artificial Island, the estuary is tidal with a net flow to the south and a width of approximately
 35 16,000 ft (5000 m) (Figure 2-1). The U.S. Army Corps of Engineers maintains a dredged
 36 navigation channel near the center of the estuary and about 6600 ft (2011 m) west of the
 37 shoreline at Salem and HCGS. The navigation channel is about 40 ft (12 m) deep and 1300 ft
 38 (397 m) wide. On the New Jersey side of the channel, water depths in the open estuary at
 39 mean low water are fairly uniform at about 20 ft (6 m). Predominant tides in the area are semi-
 40 diurnal, with a period of 12.4 hr and a mean tidal range of 5.5 ft (1.68 m). The maximum tidal
 41 currents occur in the channel, and currents flow more slowly over the shallower areas (NRC
 42 1984, Najarian Associates 2004).

43

Affected Environment

1 Salinity is an important determinant of biotic distribution in estuaries, and salinity near the
2 Salem and HCGS facilities depends on river flow. The NRC (1984) reported that average
3 salinity in this area during periods of low flow ranged from 5 to 18 parts per thousand (ppt) and
4 during periods of higher flow ranged from 0 to 5 ppt. Najarian Associates (2004) and PSEG
5 Services Corp. (2005b) characterized salinity at the plant as ranging between 0 and 20 ppt
6 and, in summer during periods of low flow, typically exceeding 6 ppt. Based on temperature
7 and conductivity data collected by the USGS at Reedy Island, just north of Artificial Island,
8 Najarian Associates (2004) calculated salinity from 1991 through 2002. Visual examination of
9 their Figure B6 indicates that salinity appears to have a median of about 5 ppt, exceeded 12
10 ppt in only two years and 13 ppt in only one year, and never exceeded about 15 ppt during the
11 entire 11-year period. Based on these observations, NRC staff assumes that salinity in the
12 vicinity of Salem and HCGS is typically from 0 to 5 ppt in periods of low flow (usually, but not
13 always, summer) and 5 to 12 ppt in periods of high flow (Table 2-4). Within these larger
14 patterns, salinity at any specific location also varies with the tides (NRC 2007).

15 **Table 2-4. Salinities in Delaware Estuary in the Vicinity of Salem and HCGS**

Condition	Salinity Range (ppt)
High Flow	0-5
Low Flow	5-12

16 Source: NRC 2007.

17 Monthly average surface water temperatures in the Delaware Estuary vary with season.
18 Between 1977 and 1982, water temperatures ranged from -0.9°C (30.4°F) in February 1982 to
19 30.5°C (86.9°F) in August 1980. Although the estuary in this reach is generally well mixed, it
20 can occasionally stratify, with surface temperatures 1° to 2 °C (2° to 4°F) higher than bottom
21 temperatures and salinity increasing as much as 2.0 ppt per meter of water depth (NRC 1984).

22 Estuarine waters are classified into three categories based on salinity: oligohaline (0 to 5 ppt),
23 mesohaline (5 to 18 ppt), and polyhaline (greater than 18 ppt). These categories describe
24 zones within the estuary. The estuary reach adjacent to Artificial Island is at the interface of the
25 oligohaline and mesohaline zones; thus, it is oligohaline during high flow and mesohaline during
26 low flow conditions. Based on water clarity categories of good, fair, or poor, The EPA (1998)
27 classified the water clarity in this area of the estuary as generally fair, which it described as
28 meaning that a wader in waist-deep water would not be able to see his feet. The EPA
29 classified the water clarity directly upstream and downstream of this reach as poor, which it
30 described as meaning that a diver would not be able to see his hand at arm's length. Most
31 estuarine waters in the Mid-Atlantic have good water clarity, and lower water clarity typically is
32 due to phytoplankton blooms and suspended sediments and detritus (EPA 1998).

33 2.2.5.2 Plankton

34 Planktonic organisms live in the water column and are characterized by a relative inability to
35 control their movements. They drift with the water currents and are usually very small (Sutton et
36 al. 1996). Plankton can be primary producers (phytoplankton), secondary producers,
37 consumers (zooplankton), and decomposers (bacteria and fungi). Some organisms spend their
38 entire lives in the plankton (holoplankton) and others spend only specific stages as plankton
39 (meroplankton). Meroplankton include larval fish and invertebrates that use the planktonic life
40 stage to disperse and feed before transitioning to another stage.

1 Phytoplankton

2 Phytoplankton are microscopic, single-celled algae that are responsible for the majority of
3 primary production in the water column. Species composition, abundance, and distribution are
4 regulated by water quality parameters such as salinity, temperature, and nutrient availability. As
5 such, seasonal fluctuations are observed, with high abundances in spring, when high runoff
6 from land (nutrients), warmer temperatures, and increasing light levels are experienced.
7 Primary production is limited to the upper 2 m (6.6 ft) of the water column due to light limitation
8 from high turbidity (NRC 1984). These blooms tend to proceed up the estuary over time,
9 presumably due to anthropogenic nutrient increases (Versar 1991). Species found in the upper
10 estuary are generally freshwater species and those in the lower areas are marine species. In
11 the highly variable, tidally influenced zone, species with a high tolerance for widely fluctuating
12 environments are found. Species composition also fluctuates seasonally, with flagellates
13 dominating in the summer and diatoms becoming more abundant in the fall, winter, and spring
14 (DRBC 2008b).

15 Studies of phytoplankton in the Delaware Estuary which were conducted prior to the operation
16 of Salem Units 1 and 2, are rare and difficult to obtain. These organisms were quantitatively
17 and qualitatively sampled as part of the pre-operation ecological investigations for Salem
18 performed by Ichthyological Associates in the late 1960s and early 1970s (PSEG 1983). These
19 studies revealed that the phytoplankton was dominated by a few highly abundant and
20 productive species, mainly the chain-forming diatoms *Skeletonema costatum*, *Melosira* sp., and
21 *Chaetoceros* sp. Additionally, species normally found in freshwater (including *Ankistrodesmus*
22 *falcatus* and *Cyclotella* sp.) were found in the samples, having been transported downriver to
23 the vicinity of the plant. These studies also postulated that phytoplankton were not sufficiently
24 numerous to produce enough primary productivity to sustain the estuarine system, making
25 detritus an important contributor to the trophic structure in Delaware Bay (PSEG 1983). Data
26 published later (PSEG 1984) noted dominance by *S. costatum*, *Melosira* sp., and *Nitzschia* sp.
27 Phytoplankton studies related to operation of Salem Units 1 and 2 were discontinued in 1978,
28 as NJDEP and NRC agreed that operation had no effect on phytoplankton populations (PSEG
29 1984).

30 A major literature survey for the Delaware Estuary Program assessed the various biological
31 resources of the estuary and possible trends in their abundance or health (Versar 1991). This
32 study found that phytoplankton formed the basis of the primary production in the estuary,
33 contrary to the studies related to the Salem facility, which postulated a large detrital contribution
34 to trophic dynamics. This study divided the estuary into three regions: bay, mid-estuary or
35 transitional, and tidal fresh. Phytoplankton assemblages in the bay region were dominated by
36 *S. costatum*, *Leptocylindrus* sp., and *Thalassiosira* sp. This area of the estuary also experiences
37 a seasonal dominance shift, switching to an assemblage dominated by flagellates in the
38 summer months. The tidal fresh region was dominated by *Cyclotella meneghiniana*, *Closterium*
39 sp., *Melosira* sp., *Nitzschia* sp., *Scenedesmus* sp., and *Pediastrum* sp. Species dominant in the
40 mid-estuary region were *S. costatum*, *Asterionella* sp., *Cyclotella* spp., *Melosira* sp., *Chlorella*
41 sp., *Closterium* sp., and *Scenedesmus* sp. (Versar 1991).

42 More recent studies have summarized the data of many older and qualitative surveys and
43 investigations. Phytoplankton in the lower bay (in less turbid water) account for most of the
44 primary production in the system, which is subsequently transferred to other areas by the
45 currents. Detritus is no longer considered a major source of energy in the trophic structure.
46 Several hundred phytoplankton species have been recorded in the Delaware Estuary, but the
47 assemblage is most often dominated by a few highly abundant species. These species include

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1 *S. costatum*, *Asterionella glacialis*, *Thalassiosira nordenskiöldii*, *Rhizosolenia* sp., and
2 *Chaetoceros* sp. (Sutton et al. 1996). In the fresher reaches of the Delaware River,
3 assemblages are dominated by the diatom *Skeletonema potamos* and various cyanobacteria
4 and green algae.

5 Phytoplankton are currently surveyed by the New Jersey Department of Environmental
6 Protection (NJDEP). These surveys are conducted in order to monitor harmful algal blooms,
7 and samples are mostly collected for chlorophyll measurements only. Blooms are highly
8 variable between years but most often occur in the spring (NJDEP 2005b). Algal blooms can
9 have large consequences for the entire estuary because they can contain flagellates that may
10 make fish and shellfish inedible, and they can deplete the oxygen in the water column so
11 severely that large fish kills can result. The EPA also monitors algal blooms using helicopter
12 surveys (NJDEP 2005c).

13 Zooplankton

14 Zooplankton live in the water column but are not primary producers. They serve as a vital link
15 between the micro algae and the larger organisms in the Delaware Estuary, some of which are
16 called secondary producers. These animals consume the algae, but are still very small, have
17 limited mobility, and provide a source of food for many other organisms including filter feeders,
18 larvae of fish and invertebrates, and larger zooplankton. Two types of zooplankton occur in the
19 water column: holoplankton, which spend their entire life cycle in the water column, and
20 meroplankton, which spend only part of the time in the water column.

21 Holoplankton include various invertebrates such as shrimps, mysids, amphipods, copepods,
22 ctenophores (comb jellies), jellies, nemerteans, rotifers, and oligochaetes. They are dependent
23 on either phytoplankton or smaller zooplankton for food. In turn, they are either eaten by larger
24 organisms or contribute to the energy web by being decomposed by the detritivores after they
25 settle to the substrate. These organisms also show seasonal and spatial variability in
26 abundance and species composition. During times when runoff is low, more marine species
27 occur farther upstream. Numerical abundance is related to water temperatures and food
28 availability, which are seasonal factors (PSEG 1983). Smaller-scale distribution of holoplankton
29 can be affected by currents, salinity, temperature, and light intensity (NRC 1984). The main
30 factor dictating the distribution of individual species is salinity. There also are seasonal peaks in
31 abundance. In the lower estuary, high densities typically occur in spring and additional peaks
32 can occur in summer and fall. The species composition also varies seasonally, with *Acartia*
33 *tonsa* more dominant in the winter and summer months. In the upper estuary, cladocerans and
34 *Cyclops viridis* are highly abundant in spring, and gammarid amphipods and *Halicyclops fosteri*
35 are dominant in summer (Versar 1991).

36 Holoplankton in the Delaware estuary have been more studied than phytoplankton dating back
37 to 1929. Early research observed a large diversity of organisms in the zooplankton
38 assemblage. These studies also revealed the dominance of three copepod species throughout
39 estuary: *A. tonsa*, *Eurytemora hirundoides*, and *Eurytemora affinis*, amounting to 84 percent of
40 all zooplankton. Five species dominated by volume: an amphipod crustacean, or scud
41 (*Gammarus fasciatus*), *A. tonsa*, *E. hirundoides*, *E. affinis* and an opossum shrimp (*Neomysis*
42 *americanus*). Generally, the lower bay was dominated by marine species and species tolerant
43 of high salinity, such as calanoid copepods, and the fresher areas contained less tolerant
44 species, such as cyclopoid copepods, cladocerans, and gammarid amphipods (Versar 1991).

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1 These organisms also were sampled as part of the pre-operational ecological studies for Salem
2 Units 1 and 2. The assemblage was dominated mostly by mysids, primarily opossum shrimp,
3 but also *Mysidopsis bigelowi*, *Metamysidopsis munda*, and *Gastrosaccus dissimilis*. Other
4 species observed during these collections were the medusae of *Blackfordia manhattensis*, the
5 estuarine copepods *E. hirundooides* and *A. tonsa*, and the amphipods *Corophium cylindricum*, *C.*
6 *lacustre*, *C. acherusicum*, *G. fasciatus*, *G. daiberi*, and *Melita nitida* (AEC 1973). Later
7 collections included additional species, such as *E. affinis*, *Brachionus angularis*, *H. fosteri*,
8 *Notholca* sp., ctenophores, and several rotifer species (PSEG 1983). During the late winter and
9 spring, when large amounts of runoff occur, freshwater zooplankton, such as *B. angularis*, *H.*
10 *fosteri* and *Notholca* sp, were found to be more common. When freshwater input was low, more
11 marine forms were found, including *A. tonsa*, and *Pseudodiaptomus coronatus* (PSEG 1984).
12 Studies related to plant operations registered 110 microzooplankton taxa in the early to mid
13 1970s. Larger zooplankton collections resulted in a total of 46 taxa that were extremely
14 numerically dominated by opossum shrimp and *Gammarus* spp. This dominance resulted in the
15 selection of these species for future ecological studies related to Salem operations because
16 they were deemed important due to their abundance and their status as known prey items for
17 many of the fishes in the estuary. General studies of the zooplankton in the estuary were
18 discontinued in favor of an approach more focused on individual species (PSEG 1984).

19 Recent studies have not shown a major change in the zooplankton assemblage since the early
20 1960s. In 1982, over 50 taxa were collected in one study, and copepods were the most
21 dominant species, including *A. tonsa* and *Oithone* sp. throughout and *Temora longicornis*,
22 *Pseudocalanus minutus*, and *Centropages hamatus* in the more saline regions. Copepods are
23 a major prey resource for fish and larval fish in the Delaware Estuary (Sutton et al. 1996).

24 Macroplankton are large enough to have some control over their movement in the water
25 column, usually accomplished by making use of the tidal currents. Macroplankton species
26 encountered in early studies related to HCGS included opossum shrimp, *Gammarus* spp., sand
27 shrimp (*Crangon septemspinosa*), *Corophium lacustre*, and *Edotia triloba* (PSEG 1983). Due to
28 their dominance and importance to the fish species in the estuary, opossum shrimp and a group
29 of *Gammarus* species were selected as target species in the PSEG ecological monitoring
30 program (PSEG 1984). Although data were collected for these macroplankton, no specific trend
31 analyses were done with respect to changes in their populations (PSEG 1999). Later studies
32 conducted independent of the Salem facility often did not differentiate between macroplankton
33 and zooplankton but noted that there had not been any significant changes in the zooplankton in
34 general since the early 1900s (Versar 1991).

35 Meroplankton consists of larval fish and invertebrates that have a planktonic stage before their
36 development into a pelagic, demersal, or benthic adult form is complete. This stage provides an
37 important dispersal mechanism, ensuring that larvae arrive in as many appropriate habitats as
38 possible (Sutton et al. 1996). Studies in the Salem pre-operational phase found many such
39 larval organisms in large numbers, including estuarine mud crab (*Rhithropanopeus harrisi*),
40 fiddler crab (*Uca minax*), grass shrimp (*Palaemonetes pugio*), and copepod nauplii (PSEG
41 1983).

42 Due to the fact that many of the fish species found in the Delaware Estuary are managed, either
43 Federally or by the individual states, there have been extensive studies of ichthyoplankton
44 (larval fish and eggs). Additionally, fish have been monitored by PSEG and the states of New
45 Jersey and Delaware since before the operation of Salem Units 1 and 2. Ichthyoplankton
46 studies initially were general surveys but then were focused on the 11 target species
47 established during the NPDES permitting process. These studies included impingement and

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1 entrainment studies and general sampling consisting of plankton tows and beach seines (PSEG
2 1984). Versar reviewed an extensive amount of data with respect to ichthyoplankton, including
3 both the power plant studies and more general surveys focused on managed fish species. The
4 ichthyoplankton of the tidal freshwater region upstream was found to be dominated by the
5 alosids: American shad (*Alosa sapidissima*), hickory shad (*A. mediocris*), alewife (*A.*
6 *pseudoharengus*), blueback herring (*A. aestivalis*), and other anadromous species. Due to
7 alosid lifecycles, both eggs and larvae have seasonal peaks in abundance and distribution,
8 depending on the species. The ichthyoplankton of the transitional region, in which Artificial
9 Island is located, is dominated by the bay anchovy (*Anchoa mitchilli*); other species include
10 naked goby (*Gobiosoma bosc*), blueback herring, alewife, Atlantic menhaden (*Brevoortia*
11 *tyrannus*), weakfish (*Cynoscion regalis*), and silverside (*Menidia menidia*). Species diversity
12 was highest in the spring and summer months, but bay anchovy generally always constituted a
13 large portion of the ichthyoplankton samples (Versar 1991). The lifecycles, habitats, and other
14 characteristics of fish species identified among the ichthyoplankton are described in Section
15 2.2.5.4.

16 2.2.5.3 Benthic Invertebrates

17 Benthic invertebrates (or benthos) are organisms that live within (infauna) or on (epifauna) the
18 substrates at the bottom of the water column, including groups such as worms, mollusks,
19 crustaceans, and microorganisms. Parabenthos are organisms that spend some time in or on
20 the substrate but can also be found in the water column, including crabs, copepods, and
21 mysids. The various benthos discussed here are macroinvertebrates – invertebrates large
22 enough to be seen with the naked eye. The species composition, distribution, and abundance
23 of benthic invertebrates is affected by physical conditions such as salinity, temperature, water
24 velocity, and substrate type. Substrates within the Delaware Estuary include mud, sand, clay,
25 cobble, shell, rock, and various combinations of these.

26 The estuarine community of benthic invertebrates performs many ecological functions. Some
27 benthic species or groups of species form habitat by building reefs (such as oysters and some
28 polychaete worms) or by stabilizing or destabilizing soft substrates (such as some bivalves,
29 amphipods, and polychaetes). Some benthic organisms are filter feeders that clean the
30 overlying water (such as oysters, other bivalves, and some polychaetes), and others consume
31 detritus. While the benthic community itself contains many trophic levels, it also provides a
32 trophic base for fish and shellfish (such as crabs) valued by humans.

33 A review of benthic data for the Delaware Estuary was included in a report for the Delaware
34 Estuary Program (Versar 1991). Benthic data have been collected in the estuary since the early
35 1800s. Most of the earlier reports were surveys describing species; however, large amounts of
36 quantitative data were collected in the 1970s. Generally, benthic invertebrate species
37 distributions are limited by salinity and substrate type. Additionally, localized poor water quality
38 can have a major effect on species composition. Species found in the lower bay, such as
39 *Spisula solidissima*, are limited by salinity gradients; estuarine species, such as the razor clam
40 (*Ensis directus*) and the polychaete *Heteromastus filiformis*, are found throughout the entire
41 bay; and freshwater and oligohaline species, such as the clam *Gemma gemma*, occur in lower
42 salinity waters in the upper bay. Overall, densities of benthic macroinvertebrates in the
43 Delaware Estuary are lower than in other east coast estuaries and generally are below 1000
44 individuals per square meters (m²). Secondary production, however, appears to be similar to
45 other estuaries, with the bivalves *E. directus*, *Mytilus edulis*, and *Tellina agilis* and the
46 polychaete *Asabellides oculata* responsible for most of the energy produced (Versar 1991).

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1 The tidal fresh portion of the estuary is dominated by species that are typical of other North
2 American estuaries, such as tubificid worms, chironomid larvae, sphaerid clams, and unionid
3 mussels. These assemblages are greatly influenced by anthropogenic impacts to the water
4 quality in the area due to the proximity of pollutant sources. Highly tolerant species are found
5 here, often with only one extremely dominant species (for example, along one 10-mi [16-km]
6 segment, 90 percent were *Limnodrillus* spp., and 90 percent of these were *L. heffmeisterii*).
7 The transition zone generally is dominated by oligochaetes and amphipods. The bay region has
8 abundant bivalves (*T. agilis* and *E. directus*) and polychaetes (*Glycera dibranchiata* and *H.*
9 *filiformis*) (Versar 1991).

10 Near the Salem and HCGS facilities, estuarine substrates include mud, sand, clay, and gravel
11 (PSEG 1983). Pre-operational studies for Salem Units 1 and 2 found mostly euryhaline species
12 in the vicinity of the plant. Such species are tolerant of a wide variety of salinity conditions,
13 which can change rapidly both daily and seasonally (NRC 1984). The assemblage near the
14 facilities was highly dominated by a few species that could inhabit the available substrate types.
15 These species were the polychaetes *Scolecopelides viridis* and *Polydora* sp., the oligochaete
16 *Paranais litoralis*, the barnacle *Balanus improvisus*, and the isopod *Cyathura polita*. The lowest
17 species richness and density were found in sand due to its tendency to be scoured by rapid
18 currents and its lack of attachment surfaces. Organisms dominating these sandy areas
19 included *S. viridis*, the isopod *Chiridotea almyra*, *Parahaustorius* sp., *Gammarus* spp., opossum
20 shrimp, flat worms (*Turbellaria* sp.) and *P. litoralis*. Clay is also a difficult substrate for most
21 species to colonize, and benthos density and biomass in these areas were reported to be
22 moderate. Dominant species in clay included *Gammarus* spp., *Corophium lacustre*, *S. viridis*,
23 *C. polita*, and the polychaetes *Polydora* sp. and *Nereis succinea* (now *Neanthes succinea*).
24 Mud habitats also had moderate species richness and abundance, dominated by *P. litoralis*, *S.*
25 *viridis*, *C. polita*, the nemertean *Rhynchocoela* sp., and unidentified oligochaetes. Gravel
26 substrates had the highest species diversity and richness, although they were still dominated by
27 a few species. Species found living within gravel substrates included *B. improvisus*, *P. litoralis*,
28 *S. viridis*, *N. succinea*, and *C. lacustre*. Other species were found attached to hard surfaces,
29 including the ribbed mussel (*Modiolus demissus*, now *Geukensia demissa*), *Crassostrea*
30 *virginica*, the ghost anemone *Diadumene leucolela*, and bryozoans (PSEG 1983).

31 Species composition also was found to vary seasonally, reflecting higher diversity and
32 abundance during periods of higher salinity. This was reported to be a result of both recruitment
33 dynamics and immigration from the lower bay. Seasonal immigrants include *G. dibranchiata*, *G.*
34 *solitaria*, the polychaete *Sabellaria vulgaris*, *Mulinia lateralis*, the pelecypod *Mya arenaria*, and
35 the tunicate *Molgula manhattensis* (PSEG 1983).

36 Species composition and abundance of benthic organisms are often used as indicators of
37 ecosystem health. Generally, the greater the diversity of species and the more abundant those
38 species are, the healthier the system is considered. The EPA collected benthic samples in the
39 Delaware Estuary between 1990 and 1993 in an effort to assess the health of the system.
40 These samples resulted in the determination that 93 percent of the tidal river between the
41 Chesapeake and Delaware Canal and Trenton, New Jersey was either degraded or severely
42 degraded. South of this area, only 2 percent of the benthic invertebrate community was
43 classified as impaired, and none was considered severely impaired (Delaware Estuary Program
44 1996). More recently, the Delaware-Maryland-Virginia coastal bays are considered impacted
45 over one-fourth of their total area. In the Delaware Bay itself, the upper portions are considered
46 severely impacted, the transition area is classified impacted, and the lower bay is mostly
47 considered in good condition, with a large central area impacted, possibly due to scouring from

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1 high currents or eutrophication resulting in high organic carbon levels in the sediments (EPA
2 1998).

3 Studies conducted during the 1984 NPDES 316(b) permitting process included data from over
4 1000 grab samples in the Delaware Estuary. A total of 57 taxa in eight phyla were identified.
5 These were dominated by the same species as found in previous studies (*S. viridis*, *Polydora*
6 *sp.*, *P. littoralis*, *B. improvisus*, and *C. polita*). No other changes in the dominant species per
7 substrate type were reported, but additional species (*E. triloba* and the cumacean *Leucon*
8 *americanus*) were enumerated among the seasonal immigrants. General densities of benthic
9 organisms ranged between 17,000 per m² and 25,000 per m². Benthic studies were
10 discontinued as part of the monitoring program for PSEG in 1984 due to the determination that
11 benthic invertebrates would not be substantially affected by plant operations (PSEG 1984).

12 The most prominent types of parabenenthos in the Delaware Estuary are mysids (mostly opossum
13 shrimp), sand shrimp, and amphipods. Mysids are a key biological resource in the bay because
14 they are highly abundant and are a prey item for many other species, especially fish. They also
15 are important predators of other invertebrates. Opossum shrimp are found in water with a
16 salinity of 4 ppt or higher, most often in deeper areas. They migrate vertically into the water
17 column at night and settle on the sediments during the day. Sand shrimp are more common in
18 shallower waters and play the same ecological role as opossum shrimp. Amphipods dominate
19 in the transition region and are primarily represented by the genus *Gammarus*. These
20 crustaceans also form a link between the smaller plankton and the larger fish species in this part
21 of the estuary (Versar 1991).

22 Epifauna and parabenenthos in the Delaware estuary also include mollusks, crabs, and other large
23 crustaceans, such as the blue crab (*Callinectes sapidus*) and horseshoe crab (*Limulus*
24 *polyphemus*). These species can be difficult to sample with the equipment usually used for
25 benthos, sediment grab samplers (PSEG 1984). Blue crabs were often caught in the bottom
26 trawl samples. Opossum shrimp and *Gammarus* spp. also are difficult to sample because they
27 often inhabit vegetation in shallow marsh areas. These species were selected as target species
28 during the early ecological studies with respect to operation of Salem Units 1 and 2, but they
29 were later determined to be unaffected by the facility and were no longer specifically monitored.
30 The life histories and habitats of the blue crab, horseshoe crab, and American oyster
31 (*Crassostrea virginica*) in Delaware Bay are described below.

32 Blue Crab

33 The blue crab is an important ecological, cultural, commercial, and recreational resource in
34 Delaware Bay. It is found in estuaries on the east coast of the United States from
35 Massachusetts to the Gulf of Mexico (Hill et al. 1989). The blue crab is highly abundant in
36 estuaries and, therefore, in addition to its economic importance, it plays an important role in the
37 coastal ecosystem. It is an omnivore, feeding on many other commercially important species,
38 such as oysters and clams. Young blue crabs are also prey items for other harvested species,
39 especially those that use the estuary as a nursery area (Hill et al. 1989). Natural mortality rates
40 for the blue crab are hard to define as they vary non-linearly with life stage and environmental
41 parameters. The maximum age reached by blue crabs has been estimated to be 8 years
42 (Atlantic States Marine Fisheries Commission [ASMFC] 2004).

43 Blue crabs mate in low-salinity portions of estuaries during the summer, usually from May
44 through October (ASMFC 2004). Males can mate several times, but females mate only once,
45 storing the sperm in seminal receptacles for subsequent spawning events (ASMFC 2004).

1 Once the female has been fertilized, she migrates to higher-salinity regions to complete the
2 spawning process. The fertilized eggs are extruded over several months and remain attached to
3 the abdomen of the female. The eggs hatch and are released after 1 to 2 weeks, initiating a
4 series of larval transitions. The first larval stage is the zoea. Zoea larvae are planktonic filter
5 feeders approximately 0.009 inch (0.25 millimeter [mm]) long and develop in higher-salinity
6 waters outside of the estuary. These larvae molt seven to eight times in 31 to 49 days before
7 progressing to the next stage, the megalops, which are more like crabs, with pincers and jointed
8 legs (Hill et al. 1989). Megalops larvae are approximately 0.04 inches (1 mm) in length and can
9 swim but are found more often near the bottom in the lower estuary (ASMFC 2004). After 6 to
10 20 days, this stage molts into the first crab stage, resembling an adult crab. These juveniles
11 migrate up the estuary into lower salinity regions (Hill et al. 1989). This migration takes
12 approximately 1 year, after which the crabs are adults. Initially, sea grass beds are an important
13 habitat, but crabs then make extensive use of marsh areas as nurseries (ASMFC 2004).

14 Adult male crabs usually stay in the upper estuary once they are mature, but females will
15 migrate annually to higher-salinity areas to release their young. Crabs bury themselves in the
16 mud during the winter months, and females will do this near the mouth of the estuary so they
17 can release hatchlings in the spring. Adult crabs are unlikely to travel between estuaries, but
18 they are good swimmers and can travel over land. Movements within an estuary are related to
19 life stage, environmental conditions (temperature and salinity), and food availability. Growth
20 and molting rates are controlled by environmental variables (Hill et al. 1989).

21 Blue crabs are important in energy transfer within estuarine systems (ASMFC 2004). They play
22 different roles in the ecosystem depending on their life stage. Zoea larvae consume other
23 zooplankton as well as phytoplankton. Megalops larvae also are omnivorous and consume fish
24 larvae, small shellfish, aquatic plants, and each other. Post-larval stages also are omnivorous
25 scavengers, consuming detritus, carcasses, fish, crabs, mollusks, and organic debris. Blue
26 crabs are prey for a variety of predators, depending on life stage. Crab eggs are eaten by fish.
27 Larval stages are eaten by other planktivores, including fish, jellyfish, and shellfish. Juvenile
28 crabs are consumed by shore birds, wading birds, and fish, including the spotted sea trout
29 (*Cynoscion nebulosus*), red drum (*Sciaenops ocellatus*), black drum (*Pogonius cromis*), and
30 sheepshead (*Archosargus robatocephalus*). Adult crabs are consumed by mammals, birds, and
31 large fish, including the striped bass (*Morone saxatilis*), American eel (*Anguilla rostrata*), and
32 sandbar shark (*Carcharhinus plumbeus*) (Hill et al. 1989).

33 Blue crab population estimates are difficult, as recruitment is highly variable and dependent on
34 temperature, dissolved oxygen, rainfall, oceanographic conditions, parasitism, and contaminant
35 and predation levels (Hill et al. 1989, ASMFC 2004). Landings of blue crabs on the east coast
36 were in decline in the early 2000s, prompting a symposium led by the ASMFC in an attempt to
37 assess the status of the fishery and to assist in developing sustainable landing limits (ASMFC
38 2004). Declines in blue crab populations could be a result of attempts to increase populations
39 of other fisheries species that prey upon crabs (ASMFC 2004).

40 Horseshoe Crab

41 The horseshoe crab is an evolutionarily primitive species that has remained relatively
42 unchanged for 350 million years. It is not a true crab but is more closely related to spiders and
43 other arthropods (U.S. Fish and Wildlife Service [FWS] 2006). Horseshoe crabs play a major
44 ecological role in the migration patterns of shore birds from the Arctic to the southern Atlantic.
45 They also are used for bait in the American eel and conch (*Busycon carica* and *B.*
46 *canaliculatum*) fisheries. The biomedical industry uses their blood to detect contaminated

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1 medicines. The crabs are bled and released, although up to 15 percent of them do not survive
2 the procedure.

3 Around the turn of the 20th century, between 1.5 and 4 million horseshoe crabs were harvested
4 annually for use by the livestock and fertilizer industries. By 1960, catches had declined to
5 42,000 crabs. In 2007, the estimated harvest was 811,000 crabs, a decrease from the 2.75
6 million caught in 1998. This reduction is partially due to management and partially due to a
7 decrease in demand. Stock status is currently unknown due to lack of commercial fishing data.
8 Evidence from trawl surveys suggests that the population is growing in Delaware Bay. Harvests
9 have been reduced in Delaware, but are increasing in Massachusetts and New York (ASMFC
10 2008a). The management plan for the horseshoe crab prohibits harvesting of all horseshoe
11 crabs in New Jersey and Delaware between January 1 and June 7 and females between June 8
12 and December 31. It also limits New Jersey and Delaware to 100,000 crabs per year (ASMFC
13 2008b). Annual revenues from the horseshoe crab fishery amount to approximately \$150
14 million for the biomedical industry and \$21 million for the American eel and conch bait industry
15 (FWS 2003). Threats to their habitat include coastal erosion, development (particularly
16 shoreline stabilization structures such as bulkheads, groins, seawalls and revetments), sea level
17 rise/land subsidence, channel dredging, contaminants, and oil spills in spawning areas.
18 Habitats of concern include nearshore shallow water and intertidal sand flats, and beach
19 spawning areas (ASMFC 2010a).

20 Horseshoe crabs are found along the Atlantic coast from the Gulf of Maine to Florida and into
21 the Gulf of Mexico to the Yucatan Peninsula (ASMFC 2008a). They are most abundant
22 between New Jersey and Virginia (ASMFC 2010a). The largest spawning population in the
23 world inhabits Delaware Bay. They migrate offshore during the winter months and return to
24 shore in spring to spawn on beaches (ASMFC 2008a). Spawning peaks in May and June, and
25 crabs spawn repeatedly during the season (ASMFC 2010a). Spawning occurs during high
26 spring tides on sandy beaches with low wave action (ASMFC 2008a). Females climb up the
27 beach with a male attached to their backs. Other males in the area will also try to fertilize the
28 eggs, resulting in up to five males converging on one female. The female will partially burrow
29 into the sand and deposit several thousand eggs. Eggs hatch in 3 to 4 weeks, and the larvae
30 will enter the water about 1 month later. Temperature, moisture, and oxygen content of the nest
31 environment affect egg development and timing (FWS 2006). The larvae resemble adult crabs
32 without the tails. They spend their first 6 days swimming in shallow water then settle to the
33 bottom (FWS 2006, ASMFC 1998a). Juveniles will spend their first 2 years on intertidal sand
34 flats. Older juveniles and adults are found in subtidal habitats, except when actively spawning
35 (ASMFC 2010a). Once the juvenile stage is reached, molting continues, with each on
36 increasing the crab's size by up to 25 percent. Sexual maturity is reached after about 17 molts,
37 or 9 to 12 years (ASMFC 2008a). Molting ceases when maturity is reached, and crabs can live
38 up to 10 additional years (ASMFC 2010a). Horseshoe crabs exhibit limited beach fidelity,
39 usually returning to their native beaches to spawn (FWS 2003). However, crabs tagged in
40 Delaware Bay have been recaptured in New Jersey, Delaware, Maryland, and Virginia (ASMFC
41 2008b).

42 Juvenile and adult horseshoe crabs eat mostly mollusks such as clams and mussels but also
43 arthropods, annelids, and nemertean. Larvae consume small polychaetes and nematodes
44 (ASMFC 1998a). Horseshoe crab eggs that have been exposed on the beach are an important
45 food source for migrating shorebirds using the Atlantic flyway (ASMFC 2008a, FWS 2006). In
46 addition to providing a rich food source for birds, eggs and larvae are consumed by fish such as
47 striped bass, white perch, American eel, killifish (*Fundulus* spp.), silver perch, weakfish, kingfish
48 (*Menticirrhus saxatilis*), silversides, summer flounder, and winter flounder, crabs, gastropods,

1 and loggerhead sea turtles (*Caretta caretta*) (ASMFC 1998a). Overturned adults are often
2 attacked and eaten by gulls (FWS 2003).

3 American Oyster

4 The American oyster is also known as the eastern oyster and the Atlantic oyster. The oyster is
5 a commercially and environmentally important species and has been harvested in Delaware
6 Bay since the early 1800s (Delaware Estuary Program 2010). Oysters not only support an
7 important fishery in both New Jersey and Delaware, but they are ecologically important as
8 filterers (enhancing water quality) and provide a complex three-dimensional habitat used by a
9 variety of fishes and invertebrates (DNREC 2010). By the mid 1850s, oyster fisherman had
10 begun transplanting oysters from the naturally occurring seed beds of New Jersey to other
11 areas in the bay for growth, due to concern over the smaller size of oysters being harvested.
12 The natural seed beds are now protected outside of the leasing system, as these are the
13 sources of the oysters transplanted to other beds. In the early 1900s, one to two million bushels
14 were harvested from the bay annually, concurrent with the use of the new oyster dredge.
15 Production remained relatively stable until the mid 1950s when disease decimated the
16 population. Currently the oyster harvest is limited, mainly due to diseases such as MSX
17 ("multinucleated sphere unknown," later classified as *Haplosporidium nelsoni*) and Dermo
18 (caused by the southern oyster parasite, *Perkinsus marinus*). MSX is thought to have been
19 imported into Delaware Bay in the 1950s from infected Chesapeake Bay populations. As a
20 result, harvests dropped to 49,000 bushels in 1960. When imports were banned, the disease
21 disappeared, but it resurfaces periodically when water temperatures are high. The populations
22 recovered slowly, but in the 1985 an additional outbreak of MSX crashed the industry again. In
23 1990, Dermo decimated the oyster population in Delaware Bay. Oysters are now directly
24 harvested from the seed beds. A portion of the revenue has been directed at placing shell for
25 increasing the size of existing beds and creating new seed beds down bay (Delaware Estuary
26 Program 2010).

27 There is currently a joint effort involving Delaware, New Jersey, and the USACE to reestablish
28 oyster beds and an oyster fishery in Delaware Bay. The majority of these efforts are focused on
29 increasing recruitment and sustaining a population by shell and bed planting and seeding.
30 Since 2001, despite management, oyster abundance has continued to decline due to below
31 average recruitment. Recruitment enhancement is deemed important to stabilize stock
32 abundance, to permit continuation and expansion of the oyster industry, to guarantee increased
33 abundance that produces the shell necessary to maintain the bed, and to minimize the control of
34 oyster population dynamics by disease, all of which will allow the oyster to play its ecological
35 role as a filterer, enhancing general water quality. Approximately 290,000 and 478,650 bushels
36 of shell were planted in Delaware Bay in 2005 and 2006, respectively. The program also has a
37 monitoring and assessment portion to evaluate its efficacy (USACE 2007).

38 Oysters are found along the Atlantic coast in sounds, bays, estuaries, drowned river mouths,
39 and behind barrier beaches from Canada to the Gulf of Mexico (Burrell 1986, Sellers and
40 Stanley 1984). They are found in the Delaware Bay from the mouth of the bay to Bombay Hook
41 on the Delaware side and to just south of Artificial Island on the New Jersey side (USACE
42 2007). There are three physiological races recognized coast wide, each spawning at different
43 temperatures. The oysters in Delaware Bay are part of the population that spawns at 20 °C.
44 Spawning is begun by the males who release their sperm and a pheromone into the water
45 column, the females respond by releasing their eggs. Spawning occurs in the summer months,
46 with several events per season. Larvae remain in the water column for 2 to 3 weeks, dispersing
47 with the water currents. While in this stage, larvae pass through several morphological changes

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1 from the blastula (3.2 hr) to the gastrula (4.5 hr), trochophore (10 hr), and prodissoconch I
2 stage, at which point they develop a shell and cilia for locomotion. The prodissoconch II stage
3 is a very active swimmer, with eyes, a foot, and a byssal gland. These larvae show evidence of
4 directed motions in relation to the salinity of the water. Most larvae will die before reaching the
5 settlement stage. The next larval stage settles on a hard surface, preferably other oyster shells.
6 The larva attaches to the substrate and loses the foot and vellum, becoming stationary. Adult
7 oysters are sessile found in beds or reefs in dense masses. They are often the only large
8 organism in the bed and can change water currents enough to affect the deposition rate of the
9 local environment. They are dioecious, but capable of changing sex, with more oysters
10 becoming female as they age. Growth is affected by environmental variables such as
11 temperature, salinity, intertidal exposure, turbidity, and food availability (Sellers and Stanley
12 1984).

13 Oyster larvae feed on plankton such as naked flagellates and algae. They are eaten by a wide
14 variety of other filter feeders. Adults are stationary filter feeders, feeding on plankton as well.
15 They can filter up to 1.5 liters of water an hour, making them an important ecological resource.
16 Due to their reef building abilities, they are also important because they create three-
17 dimensional habitat, which can be home to over 300 other species. Predators of adult oysters
18 include gastropod oysterdrills (*Urosalpinx cinerea* and *Eupleura caudata*), the whelk *Busycon*
19 *canaliculatum*, the starfish *Asterias forbesi*, the boring sponge (*Cliona* sp.), the flatworm
20 *Stylochus ellipticus*, and crabs. Competitors for resources include slipper limpets (*Crepidula*
21 sp.), jingle shells (*Anomia* sp.), barnacles, and the mussel *Brachiodontes exustus* (Sellers and
22 Stanley 1984).

23 Oysters are tolerant of a wide array of environmental variables, as they have evolved to live in
24 estuaries, which experience high and low temperatures, high and low salinities, submersion and
25 exposure, and clear to muddy water. Optimal temperatures for adults are between 68 and 86 °F
26 (20 and 30 °C). Salinities higher than 7.5 ppt are required for spawning, but adults will tolerate
27 salinities between 5 and 30 ppt. Because oysters are filter feeders, water velocity is highly
28 important. The water above a bed must be recharged 72 times every 24 hours for maximum
29 feeding. Tidal flows of greater than 5 to 8.5 fps (156 to 260 centimeters per second [cm/sec])
30 provide for optimal growth (Sellers and Stanley 1984).

31 2.2.5.4 Fish

32 The Delaware Bay, Estuary, and River make up an ecologically and hydrologically complex
33 system that supports many fish species. Most estuarine fish species have complex life cycles
34 and are present in the estuary at various life stages; thus, they may play several ecological roles
35 during their lives. Changes in the abundance of these species can have far-reaching effects,
36 both within the bay and beyond, including effects on commercial fisheries. Given the complexity
37 of the fish community of this system, the description below is based on species considered to be
38 of particular importance for a variety of reasons.

39 Representative Species

40 To determine the impacts of operation from Salem and HCGS on the aquatic environment of the
41 Delaware Estuary, monitoring has been performed in the estuary annually since 1977. The
42 1977 permitting rule for Section 316(b) of the Clean Water Act included a provision to select
43 Representative Species (RS) to focus such investigations (the terms target species or
44 Representative Important Species also have been used) (PSEG 1984, PSEG 1999). RS were
45 selected based on several criteria: susceptibility to impingement and entrainment at the facility,

1 importance to the ecological community, recreational or commercial value, and threatened or
2 endangered status. PSEG currently monitors 12 species as RS: blueback herring (*Alosa*
3 *aestivalis*), alewife (*Alosa pseudoharengus*), American shad (*Alosa sapidissima*), bay anchovy
4 (*Anchoa mitchilli*), Atlantic menhaden (*Brevoortia tyrannus*), weakfish (*Cynoscion regalis*), spot
5 (*Leiostomus xanthurus*), Atlantic silverside (*Menidia menidia*), Atlantic croaker (*Micropogonias*
6 *undulatus*), white perch (*Morone americana*), striped bass (*Morone saxatilis*), and bluefish
7 (*Pomatomus saltatrix*). These species are described below.

8 Blueback Herring and Alewife

9 Blueback herring and alewife can be difficult to differentiate and are collectively known and
10 managed as "river herring." Both species are currently listed as species of concern by the
11 National Marine Fisheries Service (NMFS) (NMFS 2009). River herring are used for direct
12 human consumption, fish meal, fish oil, pet and farm animal food, and bait. The eggs (roe) are
13 also canned for human consumption. River herring are managed by the ASMFC. They are
14 ecologically important due to their trophic position in both estuarine and marine habitats. As
15 planktivores, they link the zooplankton to the piscivores, providing a vital energy transfer
16 (Bozeman and VanDen Avyle 1989).

17 River herring are anadromous, migrating inshore to spawn in freshwater rivers and streams in a
18 variety of habitats. They are reported to return to their natal rivers, suggesting a need for
19 management more focused on specific populations as opposed to establishing fishery-wide
20 limits. Spawning migration begins in spring, with the alewife arriving inshore approximately 1
21 month before the blueback herring (NMFS 2009). The entire length of the Delaware River and
22 portions of Delaware Bay are confirmed spawning runs for river herring (NJDEP 2005d). The
23 adults of both species return to the ocean after spawning. While at sea, river herring are
24 consumed by many predators, including marine mammals, sharks, tuna, and mackerel. While
25 in the estuaries, they are consumed by American eel, striped bass, largemouth bass, mammals
26 and birds. Interspecific competition between alewife and blueback herring is minimized by
27 several mechanisms, including the timing of spawning, juvenile feeding strategies and diets, and
28 ocean emigration timing. Both blueback herring and alewife can be found in land-locked lakes.
29 These populations are genetically distinct from the anadromous ones (ASMFC 2009a).

30 Blueback herring are found in estuaries and offshore along the east coast of the United States
31 from Nova Scotia to Florida. They can reach 16 inches (41 cm) long and have an average life
32 span of 8 years. Males usually mature at 3 to 4 years of age, females at 5 years. Young of the
33 year and juveniles of less than 2 inches (5 cm) are found in fresh and brackish estuarine
34 nursery areas. They then migrate offshore to complete their growth. This species migrates
35 inshore to spawn in late spring, and spends winters offshore in deeper waters. It uses many
36 habitats in the estuaries including submerged aquatic vegetation, rice fields, swamps, and small
37 tributaries outside the tidal zone (NMFS 2009). Blueback herring prefer swiftly flowing water for
38 spawning in their northern range. Eggs hatch within 5 days and the yolk sac is absorbed within
39 3 days after hatching. The eggs are initially demersal but soon become pelagic. Juveniles feed
40 on benthic organisms and copepods, cladocerans and larval dipterans at or just below the water
41 surface (ASMFC 2009a). While offshore, blueback herring feed on plankton, including
42 ctenophores, copepods, amphipods, mysids, shrimp, and small fish (NMFS 2009). During the
43 spawning migration (unlike the alewife, which does not feed), the blueback herring feeds on
44 copepods, cladocerans, ostracods, benthic and terrestrial insects, molluscs, fish eggs,
45 hydrozoans, and stratoblasts. They are consumed in all life stages and in all habitats by other
46 fish, birds, amphibians, mammals, and reptiles. Adults in the ocean are consumed by spiny

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1 dogfish, American eel, cod, Atlantic salmon, silver hake, white hake, Atlantic halibut, bluefish,
2 weakfish, striped bass, seals, gulls, and terns (ASMFC 2009a).

3 Alewife have a smaller range than the blueback herring, from Newfoundland to North Carolina.
4 They reach maturity at approximately 4 years and can live 10 years, reaching up to 15 inches
5 long (NMFS 2009). They spawn over gravel, sand, detritus and submerged aquatic vegetation
6 in slow-moving water. Spawning is more likely to occur at night, and a single female may
7 spawn with 25 males simultaneously. The eggs initially stick to the bottom, but they soon
8 become pelagic and hatch within 2 to 25 days. The yolk sac is absorbed within 5 days and the
9 larvae may remain in the spawning areas or migrate downstream to more brackish waters.
10 Juveniles are found in the brackish areas in estuaries, near their spawning location. As they
11 develop and the temperature drops, they migrate toward the ocean, completing this process in
12 the beginning of the winter months. Eggs and juveniles are eaten by white perch, yellow perch,
13 shiners, American eel, grass pickerel, walleye and alewife; larvae are consumed by a variety of
14 fish, birds, and mammals. Young alewife are also a high quality food source for turtles, snakes,
15 birds and mink. Juveniles are opportunistic feeders, consuming midges, cladocerans,
16 chironomids, odonates, epiphytic fauna, ostracods, and oligochaetes (ASMFC 2009a). Alewife
17 are schooling pelagic omnivores while offshore, feeding mainly on zooplankton, but also small
18 fishes and their eggs and larvae (NMFS 2009). Food items include euphausiids, calanoid
19 copepods, hyperiid amphipods, chaetognaths, pteropods, decapod larvae, salps, Atlantic
20 herring, other alewife, eel, sand lance, and cunner (ASMFC 2009a). Alewife not only migrate
21 seasonally to spawn in response to temperatures but also migrate daily in response to
22 zooplankton availability (NMFS 2009). Adult alewife are eaten by bluefish, weakfish, striped
23 bass, dusky shark, spiny dogfish, Atlantic salmon, goosfish, cod, pollock, and silver hake.
24 Alewife also are important as hosts to parasitic larvae of freshwater mussels, some species of
25 which are threatened or endangered (ASMFC 2009a).

26 The river herring fishery has been active in the United States for 350 years. Until the 1960s, it
27 was mainly an inland fishery, but thereafter expanded offshore. Alewife landings peaked in the
28 1950s and the 1970s, then abruptly declined (NMFS 2009). Blueback herring landing data are
29 limited, but a severe decline was observed in the early 2000s. In addition to the commercial
30 industry, there is an extensive recreational fishery which harvested over 350,000 fish in 2004.
31 Commercial landings declined from over 50 million lbs (22.6 million kgs; before 1970 to under 1
32 million lbs [453 thousand kg] in 2007. Blueback herring are exhibiting signs of overfishing in
33 several of the estuary systems on the east coast, including the Connecticut, Hudson and
34 Delaware Rivers (ASMFC 2009a). River herring population declines have been attributed to
35 overfishing and the loss of historic spawning habitat all along the eastern coast of the United
36 States (NMFS 2009). Reasons for habitat loss include dam construction, streambank erosion,
37 pollution, and siltation (ASMFC 2009a). River herring are also often taken as bycatch in other
38 fisheries (NMFS 2009). New Jersey currently has a small commercial river herring small-mesh
39 gillnet fishery; the catch is mostly used as bait. Delaware also has a small river herring fishery,
40 which is associated with the white perch fishery. Neither state has specific regulations for river
41 herring, but pending legislation in Delaware could eliminate the fishery in that state. Although
42 data are lacking, it is estimated that large numbers of river herring are harvested recreationally
43 for use as bait (ASMFC 2009a).

44 American Shad

45 American shad have been a commercially and culturally important species on the east coast of
46 the United States since colonial times. The range of the American shad extends from
47 Newfoundland to Florida (ASMFC 2007a). They are most abundant between Connecticut and

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1 North Carolina (MacKenzie et al. 1985). Huge numbers of these fish were historically harvested
2 during their annual spring spawning runs. Up to 1850, 91 million pounds (41,000 metric tons)
3 were harvested annually in the Chesapeake Bay (Chesapeake Bay Program 2009). The
4 Atlantic catch in 1896 was 50 million lbs (22,680 metric tons) (MacKenzie et al. 1985). By the
5 end of the 19th century, only 17.6 million lbs (8000 metric tons) were caught, representing a
6 severe decline in the American shad stock, and the fishery began fishing in the waters of the
7 lower bays. Stock has continued to decline, with only 1000 metric tons landed in the
8 Chesapeake in the 1970s (Chesapeake Bay Program 2009). By 1983, the Atlantic catch was
9 only 3.5 million lbs (1585 metric tons). Several states, including Maryland, had closed the
10 American shad fishery by 1985 (MacKenzie et al. 1985).

11 American shad are schooling anadromous fish, migrating to freshwater to spawn in winter,
12 spring, or summer, with the timing depending on water temperature. Mature shad can spawn
13 up to six times over their lifetimes of 5 to 7 years. Spawning is accomplished by one female and
14 several males swimming to the surface to release their gametes. Preferred substrates include
15 sand, silt, muck, gravel, and boulders. Water velocity must be rapid enough to keep the eggs
16 off the bottom. Eggs are spawned in areas that will allow them to hatch before drifting
17 downstream into saline waters. They hatch in approximately 8 to 12 days, and the yolk sac is
18 absorbed when the larvae are between 0.35 and 0.47 inches (9 and 12 mm) long. At 4 weeks
19 the larvae become juveniles, which spend their first summer in the freshwater systems
20 (MacKenzie et al. 1985). The juveniles migrate toward the ocean in the fall months, cued by
21 water temperature changes, and will remain in the estuary until they are 1 year old (ASMFC
22 1999b). In the Delaware River, this happens when the water reaches 68°F (20 °C), usually in
23 October and November. Juveniles remain in the ocean until they are mature, approximately 3
24 to 5 years for males and 4 to 6 years for females. American shad are likely to return to their
25 natal rivers to spawn (MacKenzie et al. 1985).

26 Ecologically, American shad play an important role in the coastal estuary systems, providing
27 food for some species and preying on others. They also transfer nutrients and energy from the
28 marine system to the freshwater areas as many shad die after they spawn (ASMFC 1999b).
29 Young American shad in the river systems feed in the water column on a variety of
30 invertebrates. While at sea, they feed on invertebrates, fish eggs, and small fish (MacKenzie et
31 al. 1985, ASMFC 1999b). During the spawning run, shad consume mayflies and small fish.
32 Shad are preyed upon by many species while they are small, including striped bass, American
33 eels, and birds. Adults are eaten by seals, porpoises, sharks, bluefin tuna (*Thunnus thynnus*),
34 and kingfish (*Scomberomorus regahni*) (Weiss-Glanz et al. 1986). Much of the American shad's
35 life cycle is dictated by changes in ambient temperature. The peak of the spawning run and the
36 ocean emigration happen when the water temperature is approximately 68°F (20 °C).
37 Deformities develop if eggs encounter temperatures above 72°F (22 °C) and they do not hatch
38 above 84°F (29 °C). Juveniles have been shown to actively avoid rises in temperature of 39 °F
39 (4 °C) (MacKenzie et al. 1985).

40 American shad are managed by the ASMFC. A stock assessment completed in 2007 showed
41 that American shad stocks are still severely depleted and are not recovering, with Atlantic
42 harvests of approximately 550 tons (500 metric tons). The shad coastal intercept fishery in the
43 Atlantic has been closed since 2005, additionally there is a 10 fish limit for the recreational
44 inshore fishery. The reasons for their decline include dams, habitat loss, pollution and over
45 fishing (ASMFC 2007a). Increased predation by the striped bass has also been named as a
46 factor in their decline (ASMFC 1999b). The entire length of the Delaware River is a confirmed
47 spawning run for the American shad. There is no confirmed information available on Delaware
48 Bay itself, although shad would have to migrate through the bay to get to the river (NJDEP

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1 2005d). Adults are highly abundant in Delaware Bay, potentially confirming the American
2 shad's use of the estuary as part of the spawning run (ASMFC 1999**8b**).

3 Bay Anchovy

4 The bay anchovy is an abundant forage fish found along the Atlantic coast from Maine to the
5 Gulf of Mexico, including the Yucatan Peninsula. It is a small, schooling, euryhaline fish that
6 grows to approximately 4 inches (10 cm) and can live for several years (Morton 1989,
7 Smithsonian Marine Station 2008). It can be found in freshwater and in hypersaline water over
8 almost any bottom type including sand, mud, and submerged aquatic vegetation. It is highly
9 important ecologically and commercially due to its abundance and widespread distribution
10 (Morton 1989). It plays a large role in the food webs that support many commercial and sport
11 fisheries by converting zooplankton biomass into food for piscivores (Morton 1989, Newberger
12 and Houde 1995).

13 Bay anchovy spawn almost all year typically in waters of less than 65 ft (20 m) deep. In the
14 Middle Atlantic region, spawning occurs in estuaries in water of at least 54°F (12 °C) and over
15 10 ppt salinity. The eggs are pelagic and hatch after about 24 hours, the yolk sac is absorbed
16 after another 25 hours. Newly hatched fish move upstream into lower salinity areas to feed,
17 eventually migrating to the lower estuary in the fall. Young bay anchovies feed mainly on
18 copepods, and adults consume mysids, small crustaceans, mollusks, and larval fish. Copepods
19 have been reported as the primary food source of bay anchovies in Delaware Bay. Adult bay
20 anchovies are tolerant of a range of temperatures and salinities and move to deeper water for
21 the winter (Morton 1989).

22 There is no bay anchovy fishery, so they are not directly economically important. However, they
23 support many other commercial fisheries as they are often the most abundant fish in coastal
24 waters (Morton 1989). They have been reported to be the most important link in the food web,
25 and are a primary forage item for many other fish, birds, and mammals (Morton 1989;
26 Smithsonian Marine Station 2008; Newberger and Houde 1995). Bay anchovy eggs are
27 consumed by various predators, including juvenile fish and gelatinous predators such as sea
28 nettles and ctenophores. Bay anchovy often account for over half the fish, eggs, or larvae
29 caught in research trawls (Smithsonian Marine Station 2008). Studies in the Chesapeake Bay
30 found that striped bass are heavily dependent on bay anchovies as larvae, juveniles and adults,
31 especially since the menhaden and river herring populations have declined in recent years
32 (Chesapeake Bay Ecological Foundation, Inc. 2010).

33 Atlantic Menhaden

34 Atlantic menhaden have been an important commercial fish along the Atlantic Coast since
35 colonial times. Ecologically, they are a vital forage fish for larger piscivorous species including
36 fish, birds, and mammals, and they play an important role in the aquatic system as filter feeders
37 (ASMFC 2005a). They are used in the reduction industry (producing fish meal and oil) and are
38 used as bait by both commercial and recreational fisheries. This species has been fished since
39 the early 1800s and landings increased over time as new technologies developed. Their
40 populations suffered in the 1960s when they were severely overfished, but they recovered in the
41 1970s. The reduction fishery landed 203,320 tons (184,450 metric tons) in 2004 and the bait
42 fishery has become increasingly important, with the most bait fish landed in New Jersey and
43 Virginia. A stock assessment completed in 2003 declared the Atlantic menhaden not
44 overfished, and a review in 2004 resulted in a decision not to require an assessment in 2006

1 (ASMFC 2005a). The 2008 Atlantic menhaden fishing season resulted in a catch of 141,133
2 tons (128,030 metric tons) for the reduction industry (NOAA 2009a).

3 Atlantic menhaden are small schooling fish found along the Atlantic Coast from Nova Scotia to
4 northern Florida in estuarine and nearshore coastal waters. They migrate seasonally, spending
5 early spring through early winter in estuaries and nearshore waters, with the larger and older
6 fish moving farther north during summer (ASMFC 2005a). Spawning occurs almost year round
7 along the Atlantic Coast (ASMFC 2001). They spawn offshore in fall and early winter between
8 New Jersey and North Carolina (ASMFC 2005a). Spawning is concentrated over the
9 continental shelf off the North Carolina Capes between December and February, in water 328 to
10 656 ft (100 to 200 m) deep at mid-depths. The eggs are pelagic and hatch in 1 to 2 days. Once
11 the yolk sac is absorbed at 4 days old, larvae begin to feed on plankton. Areas that do not have
12 sufficient plankton densities may not produce many surviving larvae, leading to a poor year
13 class. Larvae enter estuary nursery areas after 1 to 3 months between October and June in the
14 Mid-Atlantic. Prejuvenile fish use the shallow, low-salinity areas in estuaries as nurseries,
15 preferring vegetated areas in fresh tidal marshes and swamps, where they become juveniles
16 (Rogers and Van Den Avyle 1989). Juveniles spend approximately 1 year in the estuarine
17 nurseries before joining the adult migratory population in late fall (ASMFC 2005a). Larvae that
18 entered the nursery areas late in the year may remain until the next fall. Once juveniles
19 metamorphose to adults, they switch from individual capture to a filter feeding strategy. Young
20 fish leaving the estuaries tend to migrate south along the North Carolina coast during the winter
21 months. Fish are mature at age 2 or 3 and will then begin the spawning cycle (Rogers and Van
22 Den Avyle 1989). Atlantic menhaden can live up to 8 years, but fish older than 6 years are rare
23 (ASMFC 2001).

24 Due to their high abundance and positioning in the nearshore and estuarine ecosystems,
25 Atlantic menhaden are ecologically vital along the Atlantic coast (Rogers and Van Den Avyle
26 1989). They are filter feeders, straining plankton from the water column. They provide a trophic
27 link between the primary producers and the larger predatory species in nearshore waters.
28 (ASMFC 2005a). It has been hypothesized that due to their abundance and migratory
29 movements, Atlantic menhaden may change the assemblage structure of plankton in the water
30 column. Larvae in the estuaries feed preferentially upon copepods and copepodites, and they
31 may eat detritus as well. As young fish and adults, they filter feed on anything larger than 7 to 9
32 micrometers including zooplankton, large phytoplankton, and chain diatoms (Rogers and Van
33 Den Avyle 1989). Atlantic menhaden provide a food source for bluefish, striped bass, bluefin
34 tuna, king mackerel, Spanish mackerel, pollock, cod, weakfish, silver hake, tunas, swordfish
35 (*Xiphias gladius*), and sharks (ASMFC 2001, Rogers and Van Den Avyle 1989). They establish
36 a direct link between the phytoplankton primary producers and the higher level predators,
37 including transferring energy in and out of estuary systems and on and off the coastal shelf
38 (Rogers and Van Den Avyle 1989). They are especially important in this regard, as most
39 marine fish species cannot use phytoplankton as a food source (ASMFC 2001). Their filter-
40 feeding habits have also lead to a variety of physiological characteristics, such as high lipid
41 content, enabling survival during periods of low prey availability (Rogers and Van Den Avyle
42 1989).

43 Weakfish

44 Weakfish are part of a mixed stock fishery that has been economically vital since the early
45 1800s (ASMFC 2009b). They were highly abundant in Delaware Bay. They topped commercial
46 landings in the state of Delaware until the 1990s and were consistently within the top five
47 species in recreational landings (DNREC 2006a). Weakfish biomass has declined significantly

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1 in recent years, with non-fishing pressures such as increased natural mortality, predation,
2 competition, and environmental variables hypothesized as the cause for the decline (ASMFC
3 2009b). Commercial landings have fluctuated since the beginning of the fishery, without
4 apparent trend or sufficient explanation (ASMFC 2009b, Mercer 1989). Landings along the
5 Atlantic coast peaked in the 1970s at 36 million lbs (over 16 million kg), then declined
6 throughout the 1980s, ending in a low of 6 million lbs (approximately 2.7 million kg) in 1994.
7 Management measures increased stock and commercial harvest until 1998, when the fishery
8 declined again, this time continuously until 2008 (ASMFC 2009b). Between 1995 and 2004,
9 commercial landings in Delaware dropped by 82 percent and the recreational harvest dropped
10 by 98 percent, reflecting a coast-wide drop of 78 percent (DNREC 2006a). The results of the
11 2009 stock assessment defined the fishery as depleted, but not overfished, with natural sources
12 of mortality listed as the cause of the low biomass levels. The ASMFC is currently developing
13 an amendment to the management plan to address the decline (ASMFC 2009b).

14 Weakfish range along the Atlantic coast from Nova Scotia to southern Florida, but are more
15 common between New York and North Carolina (ASMFC 2009b). Their growth varies, with
16 northern populations becoming much larger (up to 32 inches [810 mm]) and living longer (11
17 years) than the more southern populations (28 inches [710 mm] and 6 years). Within Delaware
18 Bay, a survey in 1979 found the oldest females (age 9 years) to be an average of 710 mm long,
19 and the oldest males (six years) to be an average of 27 inches [681 mm] long (Mercer 1989).
20 Spring warming induces inshore migration from offshore wintering areas and spawning (ASMFC
21 2009b). Weakfish are batch spawners, continuously producing eggs during the spawning
22 season, allowing more than one spawning event per female (ASMFC 2002). Larval weakfish
23 migrate into estuaries, bays, sounds, and rivers to nursery habitats where they remain until they
24 are 1 year old, after which they are considered mature (ASMFC 2009b, Mercer 1989).
25 Spawning occurs in estuaries and nearshore areas between May and July in the New York
26 Bight (Delaware Bay to New York). Eggs are pelagic and hatch between 36 and 40 hours after
27 fertilization. Larvae become demersal soon after this, when they have reached 8 mm in length.
28 Juvenile weakfish use the deeper waters of estuaries, tidal rivers, and bays extensively but are
29 not often found in the shallower areas closer to shore. Within Delaware Bay, juvenile weakfish
30 have been shown to migrate toward lower salinities in the summer, higher salinities in the fall,
31 and offshore for the winter months. Adults migrate inshore seasonally to spawn in large bays or
32 the nearshore ocean. Spawning is initiated with warming water temperatures. As temperatures
33 cool for the winter, weakfish migrate to ocean wintering areas, the most important of which is
34 the continental shelf between Chesapeake Bay and North Carolina (Mercer 1989).

35 Weakfish play an important ecological role as both predators and prey in the estuarine and
36 nearshore food webs (Mercer 1989). Adults feed on peneid and mysid shrimps, anchovies,
37 clupeid fishes, other weakfish, and a variety of other fishes, including butterfish, herrings,
38 silversides, Atlantic croaker, spot, scup, and killifishes. Younger weakfish consume mostly
39 mysids and other zooplankton and invertebrates, including squids, crabs, annelid worms, and
40 clams (Mercer 1989, ASMFC 2002). More fish species are taken as the fish grow to larger
41 sizes. In Chesapeake Bay eelgrass beds, weakfish have been shown to be important top
42 carnivores, feeding mostly on blue crabs and spot. Weakfish are tolerant of a relatively wide
43 variety of temperatures and salinities. In Delaware Bay, weakfish have been collected in
44 temperatures between approximately 62.6 and 82.4 °F (17 and 28 °C) and salinities of 0 to 32
45 ppt (Mercer 1989).

46

1 Spot

2 Spot are not only an important commercial and recreational fish species on the Atlantic coast,
3 they also support many other important fisheries as a forage species (ASMFC 2008b). They
4 are used for human consumption and as part of the scrap fishery. Spot make up a major
5 portion of the fish biomass and numbers in estuarine waters of the mid-Atlantic region (Phillips
6 et al. 1989). They are also a large component of the bycatch in other fisheries, including the
7 South Atlantic shrimp trawl fishery. Commercial landings fluctuate widely due to the fact that
8 spot are a short-lived species (4 to 6 years) and most landings constitute a single age class
9 (ASMFC 2008c). Commercial landings fluctuated between 3.8 and 14.5 million lbs (1.7 and 6.6
10 million kg) between 1950 and 2005 (ASMFC 2006a). They are also a very popular recreational
11 species, with recreational landings sometimes surpassing commercial ones (ASMFC 2006a).

12 The range of spot along the Atlantic coast stretches from Maine to Florida. They are most
13 abundant from Chesapeake Bay to North Carolina (ASMFC 2008c). During fall and summer,
14 they are highly abundant in estuarine and near-shore areas from Delaware Bay to Georgia
15 (Phillips et al. 1989). Spot migrate seasonally, spawning offshore in fall and winter at 2 to 3
16 years of age, and spending the spring months in estuaries (ASMFC 2008c). Spawning occurs
17 offshore, over the continental shelf, from October to March. The eggs are pelagic and hatch
18 after approximately 48 hours, producing buoyant preflexion larvae. During the flexion stage,
19 larvae become more demersal, migrating from the mid depths during the day to the surface at
20 night. These larvae move slowly toward shore, entering the post-larval stages when they reach
21 nearshore areas, and developing into juveniles when they reach the inlets (Phillips et al. 1989).
22 Juveniles move into the low salinity coastal estuaries where they grow, moving into higher
23 salinity areas as they mature (ASMFC 2008c). Seagrass beds and tidal creeks are important
24 nursery habitat for spot, which often make up 80 to 90 percent of the total number of fish found
25 in these habitats. Juveniles remain in the nursery areas for approximately a year, migrating
26 back to the ocean in September or October (Phillips et al. 1989).

27 Due to their large numbers and use of a variety of habitats throughout their lifetimes, spot are an
28 ecologically important species as both prey and predators. Spot may significantly reduce
29 zooplankton biomass during their migration to the ocean. Juvenile and young spot eat
30 pteropods, larval pelecypods, and cyclopoid copepods. Juveniles are benthic opportunistic
31 feeders, preferring sand and mud bottoms, but capable of feeding anywhere. Larger spot will
32 consume copepods, mysids, nematodes, clam siphons, dipterans, and amphipods. Adult spot
33 are also benthic feeders, scooping up sediments and consuming large numbers of polychaetes,
34 copepods, decapods, nematodes, and diatoms. Over the continental shelf, cheatognaths are
35 both predators and competitors with early larval spot stages. Large predatory fish are more
36 likely to eat adult spot than juveniles, as these are found in the estuarine shallows. Larger spot
37 are an important source of food for cormorants, spotted seatrout, and striped bass. Spot are
38 tolerant of a wide variety of environmental variables. They have been found in temperatures
39 between 46.4 and 87.8 °F (8 and 31 °C) and salinities between 0 and 61 ppt (Phillips et al.
40 1989).

41 Atlantic Silverside

42 Atlantic silverside are a highly abundant forage fish on the Atlantic coast, providing a food
43 resource for many commercially and recreationally important fish species such as striped bass
44 (*Morone saxatilis*), Atlantic mackerel (*Scomber scombrus*), and bluefish (*Pomatomus saltatrix*).
45 Atlantic silverside are found in salt marshes, estuaries, and tidal creeks along the Atlantic coast
46 from Nova Scotia to Florida. It can be the most abundant fish in these habitats. There is no

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1 direct commercial or recreational fishery for this species, although many recreational fishers net
2 and use these minnows as bait (Fay et al. 1983a).

3 Spawning by the Atlantic silverside is initiated by a combination of water temperature,
4 photoperiod, tidal cycle, and lunar cycle. Spawning occurs in the intertidal zones of estuaries
5 between March and July in the Mid-Atlantic Region. The initial spawning event is during the
6 daytime, usually accompanied by a high tide and a full or new moon. Subsequent events are
7 spaced by 14 or 15 days, tracking the lunar cycle (Fay et al. 1983b). Most fish die after their
8 first spawning season (fish may spawn between 5 and 20 times in one season), but some
9 individuals do return for a second season (New York Natural Heritage program [NYNHP] 2009).
10 Atlantic silverside spawning is a complex behavior in which fish swim parallel to the shore until
11 the appropriate tidal level is reached, then the school rapidly turns shoreward to spawn in the
12 shallows in areas where eggs may attach to vegetative substrates. Eggs are demersal and
13 adhesive, sticking to eel grass, cordgrass, and filamentous algae. They hatch after 3 to 27
14 days, depending on temperature. The yolk sac is absorbed between 2 and 5 days later.
15 Atlantic silverside become either males or females, but the sex of an individual fish is
16 determined by water temperature during the larval stage. Thus, colder temperatures produce
17 more females and warmer temperatures produce more males. Larvae usually inhabit shallow,
18 low-salinity (8 to 9 ppt) water in estuaries and are most often found at the surface.
19 Transformation to the juvenile stage is usually at 0.86 inches (20 mm) in length, and juveniles
20 continue to grow until late fall, when they reach adult size. Juveniles and adults are found in
21 intertidal creeks, marshes and shore areas in bays and estuaries during spring, summer, and
22 fall. During winter in the Mid-Atlantic Region, they often migrate to deeper water within the bays
23 or offshore (Fay et al. 1983a).

24 Ecologically, the Atlantic silverside is an important forage fish and plays a large role in the
25 aquatic food web and in linking terrestrial production to aquatic systems. Little is known about
26 the larval diet. Due to their short life span and high winter mortality (up to 99 percent), they play
27 a vital part in the export of nutrients to the near and offshore ecosystem. Juvenile and adult fish
28 are opportunistic omnivores and eat copepods, mysids, amphipods, cladocerans, fish eggs,
29 squid, worms, molluscan larvae, insects, algae, diatoms, and detritus. They feed in large
30 schools over gravel and sand bars, open beaches, tidal creeks, river mouths, and tidally flooded
31 zones of marsh vegetation. Eggs, larvae, juveniles, and adults are eaten by striped bass, Atlantic
32 mackerel, bluefish, egrets, terns, gulls, cormorants, blue crabs, mummichogs (*Fundulus*
33 *heteroclitus*), and shorebirds (Fay et al. 1983a).

34 Eggs and larvae tolerate wide degree of environmental conditions, but rapid increases in
35 temperature can prevent eggs from hatching and kill larvae. Juveniles and adults appear to
36 prefer temperatures of between 64.4 and 77 °F (18 and 25 °C). The optimum salinity for
37 hatching and early development is 30 ppt, but a wide range of salinities (0 ppt to 38 ppt) is
38 tolerated by juveniles and adults (Fay et al. 1983a).

39 Atlantic Croaker

40 Atlantic croaker are an important commercial and recreational fish on the Atlantic Coast and are
41 the most abundant bottom-dwelling fish in this region. They have been taken as part of a mixed
42 stock fishery since the 1880s. Commercial landings appear to be cyclical, with catches ranging
43 between 2 million and 30 million lbs (0.9 and 13.6 million kg). This is may be due to variable
44 annual recruitment, which appears to be dependent on natural environmental variables.
45 Recreational landings have been increasing, with 10.6 million lbs (4.8 million kg) caught in 2005.
46 The 2003 stock assessment (reported in 2004) determined that Atlantic croaker were not

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1 overfished in the Mid-Atlantic Region (ASMFC 2007b). An amendment to the management plan
2 was developed in 2005 using the 2004 stock assessment data, establishing fishing mortality and
3 spawning stock biomass targets and thresholds. There are no recreational or commercial
4 management measures in this amendment, but some states have adopted internal
5 management measures for the Atlantic croaker fishery (ASMFC 2005b).

6 Atlantic croaker are a migratory species, although movements have not been well defined.
7 They appear to move inshore in the warmer months and southward in winter (ASMFC 2007b).
8 They range from Cape Cod to Argentina and are uncommon north of New Jersey. Gulf of
9 Mexico and Atlantic populations appear to be genetically separate (ASMFC 2005b). They are
10 estuarine dependant at all life stages, especially as postlarvae and juveniles (Lassuy 1983).
11 Spawning occurs at 1 to 2 years of age in nearshore and offshore habitats between July and
12 December (ASMFC 2007b). Atlantic croaker can live for up to 12 years, and will spawn more
13 than once in a season. Eggs are pelagic and are found in polyhaline and euryhaline waters.
14 Larvae have been found from the continental shelf to inner estuaries, recruitment to the nursery
15 habitats in the estuaries depends largely on currents and tides. Recruitment of young fish to the
16 shallow marsh habitats of estuaries is variable but appears to show seasonal peaks depending
17 on latitude. This peak is in August through October in the Delaware River. The long spawning
18 period and the variable recruitment peaks make the aging of recruits to estuary areas difficult,
19 ages could vary from 2 to 10 months of age at recruitment. Larvae complete their development
20 into juveniles in brackish shallow bottom habitats. Juveniles slowly migrate downstream,
21 preferring stable salinity regimes in deeper water, and eventually enter the ocean in late fall as
22 adults. They prefer mud bottoms with detritus and grass beds, which provide a stable food
23 source, but they are considered generalists (ASMFC 2005b).

24 Atlantic croaker are bottom feeders eating benthic invertebrate fauna such as polychaetes,
25 mollusks, ostracods, copepods, amphipods, mysids, and fish. Larvae tend to consume large
26 amounts of zooplankton, and juveniles feed on detritus. Their predators include striped bass,
27 southern flounder, bluefish, weakfish, and spotted seatrout. They are able to live with other
28 competitive fishes (such as spot) by utilizing temporal and spatial habitat niches within the
29 overall bottom environment. Juvenile Atlantic croaker are sensitive to pollution and anoxic
30 areas as these conditions deplete or change the composition of their prey. Shoreline alterations
31 such as bulkheads and rock jetties can also negatively affect juvenile populations. Adult
32 croaker are usually found in estuaries in spring and summer and move offshore for the winter;
33 their distribution is related to temperature and depth. They prefer muddy and sandy substrates
34 that can support plant growth, but have also been found over oyster reefs. They are euryhaline,
35 depending on the season, and are sensitive to low oxygen levels (ASMFC 2005).

36 White Perch

37 White perch are members of the bass family. They are a commercially and recreationally
38 important species found in coastal waters from Nova Scotia to South Carolina, with their highest
39 abundance in New Jersey, Delaware, Maryland, and Virginia (Stanley and Danie 1983). The
40 largest landings were made at the turn of the century, then catch levels decreased, rising
41 sporadically to reflect large year classes. White perch are a popular recreational fish in
42 freshwater and in estuaries. They are often the dominant species caught recreationally in the
43 northern Atlantic states. White perch fill a vital trophic niche as both predator and prey to many
44 species (Stanley and Danie 1983). They are managed by the Maryland Department of Natural
45 Resources, but not by the ASMFC. Populations in Maryland are considered stable with
46 approximately 1.5 million lbs (680 metric tons) harvested commercially and 0.5 million lbs (226

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1 metric tons)harvested recreationally in 2004 (Maryland Department of Natural Resources
2 [MDNR] 2008).

3 White perch are schooling fish that can grow up to 10-inches (25.4-cm) long in freshwater and
4 15-inches (38.1-cm) long in brackish water and may live up to 10 years (Pennsylvania Fish and
5 Boat Commission 2010, MDNR 2008). They spawn in a wide variety of habitats, such as rivers,
6 streams, estuaries, lakes, and marshes, usually in freshwater. Water speed and turbidity are
7 not important in choosing a spawning location. Spawning is induced by rising water
8 temperature and occurs in April through May in freshwater and May through July in estuaries
9 (Stanley and Danie 1983). Marine and estuarine populations migrate to freshwater areas to
10 spawn and thus are anadromous (Pennsylvania Fish and Boat Commission 2010). Spawning is
11 accomplished by a single female and several males. The eggs attach to the bottom
12 immediately. Females may spawn two or three times per season and older fish produce many
13 more eggs than younger ones. Eggs hatch in 30 to 108 hours, depending on water
14 temperature. Hatchlings remain in the spawning area for up to 13 days, then they drift
15 downstream or with estuarine currents, becoming more demersal as they grow. Larvae can
16 tolerate up to 5 ppt salinity, adults can tolerate full seawater. Juveniles are often found in upper
17 estuarine nurseries, where they may stay for a year, preferring habitats with silt, mud, or plant
18 substrates. Older juveniles have been reported to move to offshore beach and shoal areas
19 during the day, but return to the more protected nursery areas at night. Maturity is usually
20 reached by year 2, but may take up to 4 years. Growth to maturity and beyond is affected by
21 temperature, food supply and population density, with growth becoming stunted in high density
22 areas (Stanley and Danie 1983).

23 Ecologically, white perch play several important roles throughout their lifecycle. The white perch
24 is omnivorous, depending on age, season, and food availability. It will feed on both plankton
25 and benthic species, but concentrates on fish after it is fully grown. Freshwater populations
26 feed on aquatic insects, crustaceans, fishes, and detritus (Stanley and Danie 1983). Estuarine
27 populations consume fish such as alewife, gizzard shad, and smelt; amphipods; crayfish;
28 shrimp; squid; crabs; and fish eggs (Stanley and Danie 1983, Pennsylvania Fish and Boat
29 Commission 2010). White perch are preyed upon by Atlantic salmon, brook trout, chain
30 pickerel, smallmouth bass, largemouth bass, and other piscivorous fish and terrestrial
31 vertebrates. Juveniles are often eaten by copepods (Stanley and Danie 1983).

32 Striped Bass

33 Striped bass are historically one of the most important fishery species along the Atlantic Coast
34 from Maine to North Carolina, with recreational landings exceeding commercial landings
35 (ASMFC 2003, ASMFC 2008d). Their population has recovered since a sharp decline from its
36 peak in the 1970s of 15 million lbs (6800 metric tons) to 3.5 million lbs (1590 metric tons) by
37 1983 (ASMFC 2008d). In 1981 ASMFC approved a management plan focusing on size limits
38 and spawning season closures to recover population levels. This plan proved ineffective, and
39 several states closed the fishery entirely, reopening in the early 1990s once the population had
40 grown. Several amendments were made to the management plan, and the fishery was
41 declared recovered in 1995 (ASMFC 2003, ASMFC 2008d). The most recent amendment in
42 2003, focused on increasing the proportion of the population over 15 years of age and creating
43 a biomass target and threshold (ASMFC 2003). The 2007 stock assessment declared the
44 fishery recovered, fully exploited and not overfished. This recovery is considered one of the
45 greatest successes in the fisheries management field, with commercial and recreational
46 landings totaling 3.8 million fish (29.3 million lbs [13,290 metric tons] recreationally) in 2006
47 (ASMFC 2008). The recovery of the striped bass fishery has been hypothesized to be the

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1 cause of the decline in weakfish, which it preys upon (DNREC 2006b). Striped bass are found
2 on the Atlantic coast from the St. Lawrence River in Canada to northern Florida. They are
3 highly abundant in both Delaware Bay and Chesapeake Bay. Females can grow up to 65 lbs
4 (29.4 kg) and live for 29 years whereas males over 12 years old are uncommon (Fay et al.
5 1983b).

6 Striped bass migrate along the coast seasonally and are anadromous, spawning in rivers and
7 estuaries after reaching an age of 2 years (males) to 4 years (females) (ASMFC 2008d). There
8 are known riverine and estuarine spawning areas in upper Delaware and Chesapeake Bays.
9 Spawning occurs in April through June in the Mid-Atlantic Region, with some of the most
10 important spawning areas found in upper Chesapeake Bay and the Chesapeake-Delaware
11 Canal (Fay et al. 1983b). In the Delaware River, the main spawning grounds are located
12 between Wilmington, Delaware and Marcus Hook, Pennsylvania (Delaware Division of Fish and
13 Wildlife 2010). Males arrive in the spawning area first. Up to 50 males will spawn with a single
14 female at the water surface. The eggs are pelagic and hatch from 29 to 80 hours after
15 fertilization, depending on the temperature. The yolk sac is absorbed in 3 to 9 days, during
16 which time water turbulence is required to keep the larvae from sinking to the bottom. The
17 larvae then develop into the finfold stage, lasting approximately 11 days, then transform to the
18 postfinfold stage, lasting up to 65 days. Both eggs and larvae tend to remain in the spawning
19 area throughout these developmental stages. Fish are considered juveniles in between the
20 lengths of 1 and 12 inches (2.5 and 30.5 cm) for males and 1 and 20 inches (2.54 and 50.8 cm)
21 for females. Most juveniles also remain in the estuaries where they were spawned until they
22 reach adult size, tending to move downstream after the first year. On the Atlantic coast, some
23 adults leave the estuaries and join seasonal migrations to the north in the warmer months, while
24 others remain in the estuaries. Some of these adults also will migrate into coastal estuaries to
25 overwinter. Reproduction is highly variable, with several poorly successful seasons between
26 each strong year class. Variability in adult and juvenile behavior and the unpredictable
27 importance of strong year classes makes management of the fishery challenging. There are
28 four different stocks identified along the Atlantic Coast, including the Roanoke River-Albemarle
29 Sound, Chesapeake Bay, Delaware River, and Hudson River stocks (Fay et al. 1983b).

30 Striped bass are tolerant of a wide variety of environmental variables, but require specific
31 habitats for successful reproduction. Adults spawn in a large variety of habitats, but only some
32 of these produce an adequate amount of surviving young. Higher water flows and colder
33 winters are hypothesized to produce successful year classes. Eggs are tolerant of
34 temperatures between 57.2 and 73.4 °F (14 °C and 23 °C), salinities of 0 to 10 ppt, dissolved
35 oxygen of 1.5 to 5.0 mg/L, turbidity of 0 to 500 mg/L, pH of 6.6 to 9.0, and a current velocity of
36 1.4 to 197 inches/sec (30.5 to 500 cm/sec). Larvae are slightly more tolerant of variables
37 outside these ranges, and juveniles are even more tolerant (Fay et al. 1983b). Young and
38 juveniles tend to be found over sandy bottoms in shallow water, but can also inhabit areas over
39 gravel, mud, and rock. Adults are found in a wide variety of bottom types, such as rock, gravel,
40 sand and submerged aquatic vegetation (ASMFC 2010a). Larvae and juveniles consume
41 nauplii, copepods, chironomid larvae, and fish eggs and larvae. Young striped bass eat mysids,
42 insect larvae, gobies, shrimp, amphipods, and small fish. Adults are mainly piscivorous,
43 consuming schooling bait fish such as bay anchovy, Atlantic menhaden, spot, and croaker, but
44 they will also consume invertebrates in the spring, including blue crabs, amphipods, and mysids
45 (Fay et al. 1983b, DNREC 2006). Young striped bass are fed upon by weakfish, bluefish, white
46 perch, and other large fishes; larvae and eggs are eaten by a variety of predators. Adult striped
47 bass probably compete with weakfish and bluefish and juveniles are likely to compete with white
48 perch in the nursery areas (Fay et al. 1983b). Striped bass do not feed while on spawning runs
49 (DNREC 2006b).

50

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1 Bluefish

2 Bluefish are a highly important recreational fish species, popular since the 1800s. They are
3 commercially harvested for human consumption, but there is no commercial bluefish industry.
4 In the early 1980s, an average of 16.3 million lbs (7.4 million kg) of bluefish per year were
5 caught, making up only 0.5 percent of the Atlantic finfish landings. As of 1989, bluefish made
6 up 15 percent of recreational landings on the Atlantic coast, and 90 percent of these were
7 caught in the mid-Atlantic Region. Slightly less than half the recreational catch is in inland bays
8 and estuaries. A management plan was developed in 1984, but was rejected as bluefish
9 represent such a small portion of the commercial fisheries; therefore, federal regulation was
10 deemed unnecessary (Pottern et al. 1989). Recreation landings averaged 60 million lbs per
11 year between 1981 and 1993. A bluefish management plan was developed in 1990 due to the
12 continuous decline in landings since the early 1980s (ASMFC 2006b, ASMFC 1998be). By
13 2002, bluefish landings had declined to 11 million lbs (4.9 million kg) per year, but recent
14 numbers have been rising in response the management amendment that was developed in
15 1998 (ASMFC 2006b). Although it is unknown if bluefish are estuary dependent, NOAA has
16 designated essential fish habitat (EFH) for the species as including all major estuaries from
17 Penobscot Bay, Maine to St. Johns River, Florida for juvenile and adult bluefish (NOAA 2006,
18 NOAA 2010eb).

19 Bluefish are a migratory schooling fish, found in estuaries and over the continental shelf in
20 tropical and temperate waters globally. They occur in the Atlantic from Nova Scotia to northern
21 Mexico. Adults migrate north during the summers, between Cape Hatteras and New England,
22 winters are spent to the south, near Florida in the Gulf Stream. They reach sexual maturity at
23 age 2 and spawn in the open ocean (Pottern et al. 1989). There is a single spawning event that
24 begins in the south in the late winter and continues northward into the summer as the fish
25 migrate (ASMFC 1998b). Eggs are pelagic and hatch in approximately 48 hours, and larvae
26 drift with the offshore currents until coastal water become warmer (Pottern et al. 1989, ASMFC
27 1998be). These larvae transform to a pelagic-juvenile stage at 18 to 25 days, improving
28 swimming ability (NOAA 2006). Spring spawned juveniles then migrate into bays and estuaries
29 at 1 to 2 months old, where they complete their development, joining the adult population in the
30 fall (Pottern et al. 1989). Summer spawned juveniles enter the estuaries for only a short time
31 before migrating south for the winter (ASMFC 1998be). Some juveniles will spend a second
32 summer in the estuaries (Pottern et al. 1989). Bluefish can live for up to 12 years and reach
33 lengths of 39 inches (91.4 cm) and weights of 31 lbs (14 kg) (ASMFC 2006b).

34 Due to their large size and numbers, bluefish probably play a large role in the community
35 structure of forage species along the Atlantic coast. As they are pelagic, larval bluefish
36 consume available zooplankton, mostly copepods, in large quantities in the open ocean (Pottern
37 et al. 1989, NOAA 2006). Juveniles in the estuaries eat small shrimp, anchovies, killifish,
38 silversides, and other available small prey, depending upon availability. Adult bluefish are
39 mostly piscivorous, but a wide array of prey items have been found in the stomachs of adult
40 bluefish, including invertebrates. Adults are preyed upon by large coastal and estuarine
41 species, such as sharks, tuna, and swordfish. Bluefish would compete with other large
42 piscivorous species in the Atlantic region, such as striped bass, spotted sea trout, and weakfish
43 (Pottern et al. 1989). Recent studies have hypothesized that juvenile and adult bluefish eat
44 whatever is locally abundant (ASMFC 1998be).

45 Bluefish are highly sensitive to temperature regimes, with an optimum range of 64.4 to 68 °F (18
46 °C to 20 °C). Temperatures above or below this range can induce rapid swimming, loss of
47 interest in food, loss of equilibrium, and changes in schooling and diurnal behaviors. They are

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1 The description of the general location and New Jersey shoreline within this square confirm
2 that it includes Artificial Island and the Salem and HCGS facilities (NOAA 2010e):

3 "Atlantic Ocean waters within the square within the Delaware River, within the mixing water
4 salinity zone of the Delaware Bay affecting both the New Jersey and Delaware coasts. On the
5 New Jersey side, these waters affect: from Hope Creek on the south, north past Stoney Point,
6 and Salem Nuclear Power Plant on Artificial Island, to the tip of Artificial Island as well as
7 affecting Baker Shoal."

8 NMFS identified 14 fish species with EFH in the Delaware Estuary in the vicinity of Salem and
9 HCGS (NMFS 2010a). These species and their life stages with EFH in this area are identified in
10 Table 2-5. The salinity requirements of these species and life stages are provided in Table 2-6.
11 Salinities in the vicinity of Artificial Island are described above in Section 2.2.5.1 and
12 summarized in Table 2-4. For each of these EFH species, the NRC staff compared the range of
13 salinities in the vicinity of Salem and HCGS with the salinity requirements of the potentially
14 affected life stages (Table 2-6). The salinity requirements of many of these EFH species and
15 life stages were found to be higher than salinity ranges in the vicinity of Salem and HCGS or to
16 overlap these salinity ranges only during periods of low flow (Table 2-6). This comparison
17 allowed the list of species with EFH that potentially could be affected by Salem or HCGS to be
18 further refined. If the salinity requirements of an EFH species life stage were not met in the
19 vicinity of the Salem and HCGS facilities, the EFH for that species and life stage was eliminated
20 from further consideration because its potential to be affected by the proposed action would be
21 negligible. As a result, four species were identified that have potentially affected EFH in the
22 vicinity for one or more life stages (Table 2-7): winter flounder (*Pleuronectes americanus*),
23 windowpane flounder (*Scophthalmus aquosus*), summer flounder (*Paralichthys dentatus*), and
24 Atlantic butterfish (*Peprilus triacanthus*). Descriptions of these four species are included below.

25 **Table 2-5. Designated EFH by species and life stage in NMFS' 10' x 10' square of**
26 **latitude and longitude in the Delaware Estuary that includes Salem and HCGS**

Scientific Name	Common Name	Eggs	Larvae	Juveniles	Adults
<i>Urophycis chuss</i>	Red hake				
<i>Pleuronectes americanus</i>	Winter flounder	X	X	X	X
<i>Scophthalmus aquosus</i>	Windowpane flounder	X	X	X	X
<i>Pomotomus saltatrix</i>	Bluefish			X	X
<i>Paralichthys dentatus</i>	Summer flounder			X	X
<i>Peprilus triacanthus</i>	Atlantic butterfish			X	
<i>Stenotomus chrysops</i>	Scup	n/a	n/a	X	
<i>Centropristes striatus</i>	Black sea bass	n/a		X	
<i>Scomberomorus cavalla</i>	King mackerel	X	X	X	X
<i>Scomberomorus maculatus</i>	Spanish mackerel	X	X	X	X
<i>Rachycentron canadum</i>	Cobia	X	X	X	X
<i>Leucoraja eglantaria</i>	Clearnose skate			X	X

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<i>Leucoraja erinacea</i>	Little skate	X	X
<i>Leucoraja ocellata</i>	Winter skate	X	X

1 X indicates designated EFH within this area. Blank indicates no designated EFH in this area. n/a
 2 indicates that the species does not have this life stage or has no EFH designation for this life stage.
 3 Sources: NOAA 2010e, NOAA 2010f.

4

5 **Table 2-6. Potential EFH species eliminated from further consideration**
 6 **due to salinity requirements**

Species, Life Stage	EFH Salinity Requirement (ppt) ^(a)	Site Salinity ^(e) Matches Requirement?
Windowpane, juvenile	5.5-36	low flow only
Windowpane, adult	5.5-36	low flow only
Windowpane, spawner	5.5-36	low flow only
Bluefish, juvenile	23-36	no
Bluefish, adult	>25	no
Scup, juvenile	>15	no
Black Sea Bass, juvenile	>18	no
King Mackerel	>30	no
Spanish Mackerel	>30	no
Cobia	>25	no
Clearnose Skate, juvenile	probably >22 ^(b)	no
Clearnose Skate, adult	probably >22 ^(b)	no
Little Skate, juvenile	mostly 25-30 ^(c)	no
Little Skate, adult	probably >20 ^(c)	no
Winter Skate, juvenile	probably >20 ^(d)	no
Winter Skate, adult	probably >20 ^(d)	no

7 ^(a) Salinity data from NOAA table "Summary of Essential Fish Habitat (EFH) and General Habitat
 8 Parameters for Federally Managed Species" unless otherwise noted.

9 ^(b) Packer et al. (2003a) NOAA Technical Memorandum NMFS-NE-174. (NOAA, 2003a).

10 ^(c) Packer et al. (2003b) NOAA Technical Memorandum NMFS-NE-175. (NOAA, 2003a).

11 ^(d) NOAA (2003) NOAA Technical Memorandum NMFS-NE-179 NOAA (2003).

12 ^(e) Salinities in Delaware Estuary in vicinity of Salem/HCGS: high flow 0-5 ppt, low flow 5-12 ppt.

13

14

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1 **Table 2-7. Fish Species and Life Stages with Potentially Affected EFH in the**
 2 **Vicinity of Salem and HCGS**

Species	Eggs	Larvae	Juveniles	Adults
Winter Flounder	X	X	X	X
Windowpane	X	X	X	X
Summer Flounder			X	X
Atlantic Butterfish			X	

3 Source: NRC 2007.

4 Winter Flounder (*Pleuronectes americanus*)

5 Winter flounder are highly abundant in estuarine and coastal waters and therefore are one of
 6 the most important commercial and recreational fisheries species on the Atlantic coast (Buckley
 7 1989). They are managed by the NEFMC and ASMFC as part of the multi-species groundfish
 8 fishery. This plan manages a total of 15 demersal species (NEFMC 2010). The winter trawl
 9 fishery was established in the 1920s when northern trawlers began to make use of the waters
 10 off Cape Hatteras. This fishery targets multiple species and landings between 1974 and 1978
 11 totaled approximately 18.5 million lbs (8.4 million kg) annually (Grimes et al. 1989). Winter
 12 flounder are also very popular recreational fish, with the recreational catch sometimes
 13 exceeding the commercial catch (Buckley 1989). Biomass in the New England-Mid Atlantic
 14 winter flounder stock declines from 30,000 million tons in 1981 to 8500 million tons in 1992 and
 15 the fishery was declared overexploited. As of 1999, biomass remains significantly lower than
 16 prior to overexploitation (NOAA 1999a). As part of the management program, EFH has been
 17 established for the winter flounder along the Atlantic coast. Delaware Bay's mixing and saline
 18 waters are EFH for all parts of the winter flounder lifecycle including eggs, larvae, juveniles,
 19 adults and spawning adults (NEFMC 1998a).

20 There are two major populations of winter flounder in the Atlantic, one is found in estuarine and
 21 coastal waters from Newfoundland to Georgia, the other is found offshore on Georges Bank and
 22 Nantucket Shoal (Buckley 1989). In the Mid-Atlantic it is most common between the Gulf of
 23 Saint Lawrence and Chesapeake Bay (Grimes et al. 1989). They spawn in coastal waters
 24 beginning in December in the south Atlantic through June in Canada (February and March in
 25 the Delaware Bay region). Spawning occurs in depths of 6.5 to 262 ft (2 to 80 m) over sandy
 26 substrates in inshore coves and inlets between 31 to 32.5 ppt (Buckley 1989, NOAA 1999).
 27 Sexual maturity is dependent on size, rather than age, with southern individuals (age two or
 28 three) reaching spawning size more rapidly than northern fish (age six or seven). The eggs are
 29 demersal, stick to the substrate, and are most often found at salinities between 10 and 30 ppt
 30 (Buckley 1989). They hatch in two to three weeks, depending on water temperature (NOAA
 31 1999a). The yolk sac is absorbed at 12 to 14 days, and metamorphosis to the juvenile stage is
 32 complete in 49 to 80 days, also dependant on temperature (Buckley 1989). Larvae are
 33 planktonic initially, but become increasingly benthic with developmental stage (NOAA 1999a).
 34 Juveniles and adults are completely benthic, with juveniles preferring a sandy or silty substrate
 35 in estuarine areas (Buckley 1989). Juveniles move seaward as they grow, remaining in
 36 estuaries for the first year (Buckley 1989, Grimes et al. 1989a). Adult movements appear to be
 37 dictated by water temperature as well, with three distinct population ranges, Georges Bank, and
 38 north and south of Cape Cod. South of Cape Cod, winter flounder will spend the colder months

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1 in inshore and estuarine waters, moving further off shore in the warmer summer months (Buckley
2 1989). Winter flounder can live for 15 years and may reach 22.8 inches (58 cm) in length
3 (NOAA 1999a).

4 As larvae, winter flounder feed on copepods, nauplii, harpacticoids, calanoids, polychaetes,
5 invertebrate eggs, and phytoplankton, moving on to larger prey such as small polychaetes,
6 nemerteans and ostracods and they grow larger (Buckley 1989, NOAA 1999a). Adults feed on
7 benthic invertebrates including polychaetes, cnidarians, mollusks and hydrozoans. They find
8 their prey by sight, therefore are more active in the daylight and in shallow water. They have
9 few competitors due to their use of the highly productive estuarine and coastal habitats, and
10 their omnivorous diet. Due to their high abundance, they prey upon by many other large coastal
11 species. Larvae are eaten in large numbers by hydromedusae (Buckley 1989). Juveniles are
12 eaten by bluefish, (*Pomatomus saltatrix*), gulls, cormorants, sevenspine bay shrimp, (*Crangon*
13 *septemspinosa*), summer flounder, (*Paralichthys dentatus*), sea robins (*Prionotus evolans*), and
14 windowpane (*Scophthalmus aquosus*) (NOAA 1999a). Adults and juveniles are an important
15 food source for striped bass (*Morone saxatilis*), bluefish (*Pomatomus saltatrix*), goosefish
16 (*Lophius americanus*), spiny dogfish (*Squalus acanthias*), oyster toadfish (*Opsanus tau*), sea
17 raven (*Hemitripterus americanus*), great cormorant (*Phalacrocorax carbo*), great blue heron
18 (*Ardea herodias*) and the osprey (*Pandion haliaetus*) (Buckley 1989).

19 Winter flounder are found at temperatures of between 32 and 77 °F (0 and 25 °C), but will
20 burrow into the sediments above 71.6 °F (22 °C), and higher temperatures for extended periods
21 can cause wide-scale mortality. They are relatively euryhaline, tolerating salinities of 5 to 35
22 ppt (Buckley 1989). Larvae are susceptible to thermal shock, four minutes at temperatures
23 elevated by 28 to 30°C will produce 100 percent mortality (Buckley 1989). Increases of less
24 than 80.6 °F (27 °C), however, appear to be well tolerated if the shock lasts for less than 32
25 minutes (NOAA 1999a). Additionally, winter flounder catch has been negatively correlated with
26 high temperatures in the preceding 30 months, and a minor increase in temperature of less
27 than 32.9 °F (0.5 °C) may cause a decrease in recruitment (Grimes et al. 1989).

28 Windowpane Flounder (*Scophthalmus aquosus*)

29 Windowpane flounder is one of the 15 groundfish species managed by the NEFMC under the
30 multispecies plan (NEFMC 2010). Although it is not directly targeted by the fishery, it is caught
31 as bycatch in the groundfish trawls, although they are exploited for human consumption (NOAA
32 1999b, Morse and Able 1995). The ground fish fishery has been highly important for the
33 economy of the New England region, with 100 million dollars in landings reported in 2000
34 (NEFMC 2010). Due to their demersal habitat, windowpane flounder are found in close
35 association with other groundfish species such as yellowtail flounder (*Limanda ferruginea*),
36 ocean pout (*Macrozoarces americanus*), little skate (*Raja erinacea*), northern searobin
37 (*Prionotus carolinus*), and spiny dogfish (*Squalus acanthias*) (NOAA 1999b). Between 1975
38 and 1982, landings of windowpane flounder fluctuated between 532 and 838 million tons.
39 Between 1984 and 1990, landings increased to between 890 and 2065 million tons, after which
40 they gradually declined to between 39 and 85 million tons during the time range of 2002 to 2007
41 (Northeast Fisheries Science Center [NEFSC] 2008).

42 Windowpane flounder are found in estuaries, coastal waters and over the continental shelf
43 along the Atlantic coast from the Gulf of Saint Lawrence to Florida. They are most abundant in
44 bays and estuaries south of Cape Cod in shallow waters over sand, sand and silt or mud
45 substrates (NOAA 1999b). They spawn from April to December, but in the Mid-Atlantic region
46 spawning occurs with two peaks in spring and fall, in May and September (NOAA 1999b, Morse

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1 and Able 1995). They tend to spawn on the bottom of the water column in waters of 16 to 19 °C
2 (Morse and Able 1995). The eggs are pelagic and buoyant and hatch at approximately eight
3 days. Larvae begin life as plankton, but soon settle to the bottom (at 0.39 to 0.78 inches [10 to
4 20 mm] in length) and become demersal. This settling occurs in estuaries and over the shelf for
5 spring spawned fish, and these individuals are found in the polyhaline portions of the estuary
6 throughout the summer. Fall spawned fish settle mostly on the shelf. Juveniles will migrate to
7 coastal waters from the estuaries as they grow larger during the autumn, they overwinter in
8 deeper waters. Adults remain offshore throughout the year, and are highly abundant off of
9 southern New Jersey. Sexual maturity is reached between 3 and 4 years of age, and growth
10 generally does not exceed 18.1 inches (46 cm) (NOAA 1999b).

11 Juvenile and adult windowpane flounder have similar food sources including small crustaceans
12 such as mysids and decapod shrimp, and fish larvae including hake, tomcod and windowpane
13 flounder. Juvenile and small windowpane flounder are eaten by spiny dogfish, thorny skate,
14 goosefish, Atlantic cod, black sea bass, weakfish and summer flounder (NOAA 1999b).

15 Adult windowpane are tolerant of a wide range of temperatures and salinities, from 23 to 80.2 °F
16 (0 to 26.8 °C), and 5.5 to 36 ppt. They are, however, sensitive to low oxygen concentrations,
17 they have not been found in areas where dissolved oxygen was below 3 mg/L. Adults and
18 juveniles are abundant in the mixing and saline zones of the Delaware Bay, and are common in
19 the inland bays (NOAA 1999b). Both the Delaware Bay mixing and saline zones and the inland
20 bays have been established for all life stages of the windowpane flounder, including eggs,
21 larvae, juveniles, adults and spawning adults (NEFMC 1998b).

22 Summer Flounder

23 The summer flounder, also known as fluke, is a highly important commercial and recreational
24 species along the Atlantic Coast. The commercial and recreational fishery is managed by both
25 the ASMFC and the MAFMC, under the summer flounder, scup, and black sea bass fishery
26 management plan. The recreational harvest makes up a sizeable portion of the total and is
27 occasionally larger than the commercial harvest. Stock biomass declined in the 1980s after a
28 peak landing total of 26,100 million tons in 1983. Between 1986 and 1995, total landings
29 averaged 13,100 million tons per year, and have fluctuated between 8600 and 12,500 since
30 then. In 1999, the summer flounder stock was considered overexploited, but as of 2005, the
31 stock has been considered not overfished (NOAA 1999c, NEFSC 2006a). In 2009, the ASMFC
32 increased total allowable landings due to the results of the 2008 stock assessment. Although
33 the stock is currently considered not overfished, it has not reached rebuilt status (ASMFC
34 2008e).

35 NOAA has designated EFH for summer flounder larvae, juveniles, and adults in Delaware Bay
36 (NOAA 2010g). Summer flounder adults and juveniles are present in Delaware Bay and
37 Delaware inland bays in salinity zones of 0.5 to above 25 ppt, and larvae are only present in the
38 inland bays in salinities of 0.5 to above 25 ppt (NOAA 2005). Delaware Bay is important as a
39 habitat for adults and as a nursery for juveniles. Summer flounder are found most often in the
40 middle and lower portions of the estuary, but juveniles especially also are found in the inland
41 bays (NOAA 1999c).

42 The summer flounder is a demersal fish found in coastal waters over sandy substrates from
43 Nova Scotia to Florida, but it is most abundant between Cape Cod and Cape Fear (ASMFC
44 2008e). It occurs in bays and estuaries in spring, summer, and autumn, and migrates offshore
45 for the winter (NEFSC 2006a). Migrating adults tend to return to the same bay or estuary every

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1 year (NOAA 1999c). Spawning occurs in autumn and early winter, as the fish are migrating for
2 the winter over the continental shelf (NEFSC 2006a, NOAA 1999c). Eggs are pelagic and
3 buoyant, as are the early stages of larvae. Larvae hatch between 56 and 216 hours after
4 fertilization, depending on temperature, and begin to feed after 3 to 4 days (NOAA 1999c).
5 Larvae are transported inshore between October and May, where they develop in estuaries and
6 bays (NEFSC 2006a, ASMFC 2008e). Larvae become demersal as soon as the right eye
7 migrates to the top of the head. They then bury themselves in the substrate while they are in
8 the inshore nursery areas. Within the estuaries, marsh creeks, seagrass beds, mud flats, and
9 open bay areas are important habitats for juveniles. Some juveniles stay in the estuary habitat
10 until their second year, while others migrate offshore for the winter. Juveniles are found in the
11 deeper parts of Delaware Bay throughout the winter (NOAA 1999c). Sexual maturity is reached
12 by age 2, females may live up to 20 years and reach 26.5 lbs (12 kg) in weight, but males
13 generally live for only 10 years (NEFSC 2006a).

14 Tidal movements of juveniles have been hypothesized to be due to the desire to stay within a
15 desired set of environmental variables, including temperature, salinity and dissolved oxygen.
16 Larvae and juveniles are found in temperatures between 32 and 73.4 °F (0 °C and 23 °C) and
17 usually are found in the higher-salinity portions of estuaries. Newly recruited juveniles are found
18 over a variety of substrates, including mud, sand, shell hash, eelgrass beds, and oyster bars,
19 but as they grow, they are more often found over sand. They are visual predators, so they feed
20 mostly during the daylight hours. While they are pelagic, larvae feed on copepodites, copepods,
21 nauplii, tintinnids, bivalve larvae, appendicularians, and copepod eggs. Larger larvae and
22 juveniles eat crustaceans, polychaetes, and small fish, including the copepod *Temora*
23 *longicornis*, Atlantic silversides, mummichogs, juvenile spot, northern pipefish (*Syngnathus*
24 *fuscus*), grass shrimp, sand shrimp, blue crabs, and the mysid *Neomysis americana*, with
25 benthic prey items becoming increasingly important with age. Larvae and small juveniles of the
26 summer flounder are consumed by spiny dogfish, goosefish, cod, silver hake, red hake, spotted
27 hake, sea raven, longhorn sculpin (*Myoxocephalus octodecemspinosus*), fourspot flounder
28 (*Paralichthys oblongus*), striped killifish (*Fundulus majalis*), blue crabs, and sea robin (*Prionotus*
29 spp.). Adult summer flounder are most often found over substrates of sand, coarse sand or
30 shell fragments, but are also found over mud and in marsh creeks and seagrass beds. Their
31 diet consists of crustaceans, other invertebrates, and fish, including Atlantic silversides,
32 herrings, juvenile spot, windowpane, winter flounder, northern pipefish, Atlantic menhaden, bay
33 anchovy, red hake, silver hake, scup, American sand lance, bluefish, weakfish, mummichog,
34 rock crabs, squids (*Loligo* sp.), small bivalve and gastropod mollusks, small crustaceans (sand
35 shrimp, mysids, grass shrimp, hermit crabs [*Pagurus longicarpus*], mantis shrimp [*Squilla*
36 *empusa*], and isopods, marine worms, and sand dollars. Summer flounder are eaten by large
37 predators, such as sharks, rays, and goosefish (NOAA 1999c).

38 Atlantic Butterfish

39 Atlantic butterfish is an important commercial fish species that also is caught as bycatch in other
40 fisheries such as the fluke, squid, mixed groundfish, and silver hake fisheries (NEFSC 2006b,
41 2004). Butterfish are an ecologically important species as forage fish for many larger fishes,
42 marine mammals, and birds. The fishery has been in operation since the late 1800s. Between
43 1920 and 1962, U. S. landings averaged 3000 million tons annually (NOAA 1999ce). U. S.
44 commercial landings averaged 3200 million tons annually between 1965 and 2002. They
45 peaked in 1984 at 11,972 million tons, with an estimated annual bycatch of 1000 to 9200 million
46 tons. A record low catch occurred in 2005 at 432 million tons (NEFSC 2006b). The Atlantic
47 butterfish fishery is managed by the MAFMC under the Atlantic mackerel, squid, and butterfish
48 fishery management plan (NEFSC 2006b). Due to a lack of data, it has not been established if

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1 overfishing is currently occurring, but during the last stock assessment in 1993, it was
2 established that biomass was at medium levels, the catch was not excessive, and recruitment
3 was high (NEFSC 2004). NOAA has designated EFH for Atlantic butterfish in Delaware Bay
4 (NOAA 2010b). According to the NOAA EFH source document, larvae, juveniles, and adults
5 are common in Delaware Bay, with larvae and adults found in the saline zones and juveniles
6 found in both the mixing and the saline zones. Juveniles and adults are also common in the
7 saline zones of the Delaware inland bays; thus, these areas are considered EFH for this species
8 (NOAA 1999ce).

9 The Atlantic butterfish is a pelagic schooling fish. Its range includes the Atlantic coast from
10 Newfoundland to Florida, but it is most abundant between the Gulf of Maine and Cape Hatteras
11 (NEFSC 2006b, NOAA 1999e). Butterfish are found in bays, estuaries, and coastal waters up
12 to 200 mi offshore during the summer over sand, mud, and mixed substrates. Butterfish spawn
13 offshore and in large bays and estuaries from June through August after a northward migration.
14 They are broadcast spawners; spawning occurs at night in the upper part of the water column in
15 water of 15 °C or more. Eggs are pelagic and buoyant, hatching between 48 and 72 hours after
16 fertilization, depending on the temperature. The yolk sac is absorbed by the time the larval fish
17 is 0.1 inches (2.6 mm) long (NOAA 1999ce). Larvae of more than 0.4 inches (10 mm) in length
18 become nektonic, with these larvae and juveniles often associating with jellyfish during their first
19 summer as a strategy to avoid predators (NEFSC 2006b, NOAA 1999ce). Adults migrate
20 seasonally, moving south and offshore in the Middle Atlantic Bight for the winter, and inshore in
21 the spring (NOAA 1999ce). Sexual maturity is reached by age 1, fish rarely live more than 3
22 years, and they reach a weight of up to 1.1 lbs (0.5 kg) (NEFSC 2006b).

23 Butterfish feed on small fish, mollusks (primarily squids), crustaceans, and other pelagic animals
24 such as thaliaceans, copepods, amphipods, decapods, coelenterates (primarily hydrozoans),
25 polychaetes, euphausiids, and ctenophores. They are eaten by haddock, silver hake, goosefish,
26 weakfish, bluefish, swordfish, sharks, spiny dogfish, long-finned squid, pilot whales, common
27 dolphins, greater shearwaters (*Puffinus gravis*), and northern gannets (*Morus bassanus*)
28 (NEFSC 2006b, NOAA 1999ce, NEFSC 2004). Butterfish are eurythermal, found between 39.9
29 and 79.5 °F (4.4 and 26.4 °C), and euryhaline, found in waters of 5 to 32 ppt (NOAA 1999ce).

30 2.2.6 Terrestrial Resources

31 This section describes the terrestrial resources in the immediate vicinity of the Salem and
32 HCGS facilities on Artificial Island and within the transmission line ROWs connecting these
33 facilities to the regional power grid. For this assessment, terrestrial resources were considered
34 to include plants and animals of non-wet uplands, as well as non-tidal wetlands and bodies of
35 freshwater located on Artificial Island or the ROWs.

36 2.2.6.1 Artificial Island

37 As discussed above in the site description, Artificial Island, on which the Salem and HCGS
38 facilities were constructed, is a man-made island approximately 3-mi (4.8-km) long and 5-mi (8-
39 km) wide that was created by the deposition of dredge spoil material. All terrestrial resources
40 on the island have become established since creation of the island began approximately 100
41 years ago. Consequently, Artificial Island contains poor quality soils and very few trees.
42 Approximately 75 percent of the island is undeveloped and dominated by tidal marsh, which
43 extends from the higher areas along the river eastward to the marshes of the former natural
44 shoreline of the mainland (Figure 2.9). The terrestrial, non-wetland habitats of the island consist
45 principally of areas covered by grasses and other herbs, with some shrubs and planted trees

1 present in developed areas. Small, isolated, freshwater impoundments and associated wetland
 2 areas also are present.

3 The Salem and HCGS facilities
 4 were constructed on adjacent
 5 portions of the PSEG property,
 6 which occupies the southwest
 7 corner of Artificial Island. The
 8 PSEG property is low and flat
 9 with elevations rising to about
 10 18 ft (5.5 m) above the level of
 11 the river at the highest point.
 12 Developed areas covered by
 13 facilities and pavement occupy
 14 over 70 percent of the site
 15 (approximately 266 ac [108
 16 ha]). Maintained areas of
 17 grass, including two baseball
 18 fields, cover about 12 ac (5 ha)
 19 of the site interior. The
 20 remaining 25 percent of the
 21 PSEG property (approximately
 22 100 ac [40 ha]) consists
 23 primarily of marsh dominated
 24 by the common reed

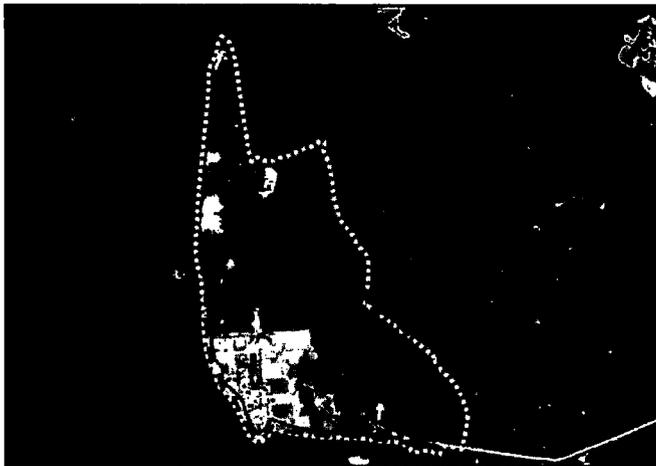


Figure 2-9. Aerial showing the Boundaries of Artificial Island (dotted yellow), PSEG property (red dashed), and Developed Areas (solid blue)

25 (*Phragmites australis*) and several cordgrass species (*Spartina* spp.) (PSEG 2009b). The U.S.
 26 Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) classifies
 27 all land on the project site as urban, while the soils on Artificial Island are Udorthents consisting
 28 of dredged fine material (NRCS 2010). The National Wetlands Inventory (NWI) identifies an
 29 inland marsh/swamp area on the periphery of the project site adjacent to Hope Creek Road and
 30 two small freshwater ponds immediately north of the Hope Creek reactor. NWI classifies the
 31 rest of Artificial Island as estuarine emergent marsh, with the exception of the northernmost 1 mi
 32 (1.6 km) of the island, which is occupied by freshwater emergent wetlands and freshwater
 33 ponds (FWS 2010a).

34 The site is within the Middle Atlantic coastal plain of the eastern temperate forest ecoregion
 35 (EPA 2007). The tidal marsh vegetation of the site periphery and adjacent areas is dominated
 36 by common reed, but other plants present include big cordgrass (*Spartina cynosuroides*), salt
 37 marsh cordgrass (*S. alterniflora*), saltmeadow cordgrass (*S. patens*), and saltmarsh bulrush
 38 (*Scirpus robustus*) (PSEG 2009b). Fragments of this marsh community exist along the eastern
 39 edge of the PSEG property. The non-estuarine vegetation on the undeveloped areas within the
 40 facilities consists mainly of small areas of turf grasses and planted shrubs and trees around
 41 buildings, parking lots, and roads.

42 The animal species present on Artificial Island likely are typical of those inhabiting estuarine
 43 tidal marshes and adjacent habitats within the Delaware Estuary. Tidal marshes in this region
 44 are commonly used by many migrant and resident birds because they provide habitat for
 45 breeding, foraging, and resting (PSEG 2004b). In 1972, Salem pre-construction surveys
 46 conducted within a 6 km (4 mi) radius of the project site recorded 44 avian species, including
 47 many shorebirds, wading birds, and waterfowl associated with open water and emergent marsh
 48 areas of the estuary. During construction of the Salem facility, several avian species were

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1 observed on the project site, including the red-winged blackbird (*Agelaius phoeniceus*), common
2 grackle (*Quiscalus quiscula*), northern harrier (*Circus cyaneus*), song sparrow (*Melospiza*
3 *melodia*), and yellowthroat (*Geothlypis trichas*) (AEC 1973). HCGS construction studies
4 reported the occurrence of 178 bird species within 16 km (10 mi) of the project site.
5 Approximately half of these species were recorded primarily from tidal marsh and the open
6 water of the Delaware River (habitat similar to the project site) and roughly 45 of the 178 total
7 observed species were classified as permanent resident species (PSEG 1983). The osprey
8 (*Pandion haliaeetus*) has been observed nesting on transmission line towers on Artificial Island
9 (PSEG 1983, NRC 1984, NJDFW 2009b). Resident songbirds, such as the marsh wren
10 (*Cistothorus palustris*), and migratory songbirds, such as the swamp sparrow (*Melospiza*
11 *georgiana*), have been observed using the nearby Alloway Creek Estuary Enhancement
12 Program restoration site for breeding purposes (PSEG 2004b). These and other marsh species
13 likely occur in the marsh habitats on Artificial Island.

14 Mammals reported to occur on Artificial Island in the area of the Salem and HCGS facilities
15 before their construction include the eastern cottontail (*Sylvilagus floridanus*), Norway rat
16 (*Rattus norvegicus*), and house mouse (*Mus musculus*) (AEC 1973). Signs of raccoon
17 (*Procyon lotor*) have been observed near Salem, and other mammals likely to occur in the
18 vicinity of the two facilities include the white-tailed deer (*Odocoileus virginianus*), muskrat
19 (*Ondatra zibethica*), opossum (*Didelphis marsupialis*), and striped skunk (*Mephitis mephitis*).
20 Surveys conducted in association with the construction of HCGS identified 45 mammals that
21 could be expected to occur within 16 km (10 mi) of the project site (PSEG 1983). Of the 45
22 species identified, eight were species associated with marsh habitats, such as the meadow vole
23 (*Microtus pennsylvanicus*) and marsh rice rat (*Oryzomys palustris*).

24 Eight of 26 reptile species observed during surveys related to the early operation of HCGS were
25 recorded from tidal marsh (PSEG 1983). Three species, the snapping turtle (*Chelydra*
26 *serpentina*), northern water snake (*Natrix sipedon*), and eastern mud turtle (*Kinosternon*
27 *subrubrum*), prefer freshwater habitats but also occur in brackish marsh. The northern
28 diamondback terrapin (*Malaclemys terrapin*), inhabits saltwater and brackish habitats and could
29 occur in tidal marsh adjacent to the project site.

30 Two Wildlife Management Areas (WMAs) managed by the New Jersey Division of Fish and
31 Wildlife are located near Salem and HCGS:

- 32 • Abbotts Meadow WMA encompasses approximately 1000 acres (405 ha) and is located
33 about 4 mi (6.4 km) northeast of HCGS.
- 34 • Mad Horse Creek State WMA encompasses roughly 9500 acres (3844 ha), of which the
35 northernmost portion is situated approximately 0.5 mi (0.8 km) from the site. The southern
36 portion of this WMA includes Stowe Creek, which is designated as an Important Bird Area
37 (IBA) in New Jersey. Stowe Creek IBA provides breeding habitat for several pairs of bald
38 eagles (*Haliaeetus leucocephalus*), which are State-listed as endangered, and the adjacent
39 tidal wetlands support large populations of the northern harrier, which also is State-listed as
40 endangered, as well as many other birds dependent on salt marsh/wetland habitats
41 (National Audubon Society 2010).

42 2.2.6.2 Transmission Line ROWs

43 Section 2.2.1 describes the existing power transmission system that distributes electricity from
44 Salem and HCGS to the regional power grid. There are four 500-kV transmission lines within

1 three ROWs that extend beyond the PSEG property on Artificial Island. Two ROWs extend
2 northeast approximately 40 mi (64 km) to the New Freedom substation south of Philadelphia.
3 The other ROW extends north then west approximately 25 mi (40 km), crossing the Delaware
4 River to end at the Keeney substation in Delaware (Figure 2.8 – Salem and HCGS
5 Transmission Line System)

6 In total, the three ROWs for the Salem and HCGS power transmission system occupy
7 approximately 4376 ac (1771 ha) and pass through a variety of habitat types, including marshes
8 and other wetlands, agricultural or forested land, and some urban and residential areas (PSEG
9 2009a). When the ROWs exit Salem and HCGS, they initially pass through approximately 3 mi
10 (5 km) of estuarine emergent marsh east of the property boundary. The primary land cover type
11 then crossed by the north and south New Freedom ROWs (approximately 30 mi [48 km]) within
12 their middle segments is a mixture of agricultural and forested land. The Keeney ROW exits
13 HCGS and heads north, traversing approximately 5 mi (8 km) of emergent marsh and swamp
14 paralleling the New Jersey coast, before it crosses 8 mi (13 km) of agricultural, sparsely
15 forested, and rural residential property. The Keeney corridor then continues west across the
16 Delaware River for approximately 3.25 mi (5.25 km) until it reaches the Red Lion substation.
17 From the substation, the Red Lion-Keeney portion of the line within the Keeney ROW remains
18 exclusively within Delaware, crossing primarily highly developed, residential land.

19 For approximately the last one-quarter of the length, the New Freedom ROWs, before their
20 termination at the New Freedom substation, traverse the New Jersey Pinelands National
21 Reserve (PNR) (National Park Service [NPS] 2006a). Temperate broadleaf forest is the major
22 ecosystem type of the reserve, which was designated a U.S. Biosphere Reserve in 1988 by the
23 United Nations Educational, Scientific and Cultural Organization (UNESCO). Biosphere
24 Reserves are areas of terrestrial and coastal ecosystems with three complementary roles:
25 conservation, sustainable development, and logistical support for research, monitoring, and
26 education (UNESCO 2010). PNR is protected and its future development is guided by the
27 Pinelands Comprehensive Management Plan, which is implemented by the New Jersey
28 Pinelands Commission. The commission is also responsible for regulating the maintenance of
29 all bulk electric transmission (> 69 kV) ROWs in the Pinelands area and, therefore, oversees
30 maintenance of the portions of the north and south Salem/HCGS New Freedom ROWs that fall
31 within the PNR (New Jersey Pinelands Commission 2009). The two New Freedom corridors
32 also cross the Great Egg Harbor River, a designated National Scenic and Recreational River
33 located within the PNR. This 129-mi (208-km) river system (including 17 tributaries) starts in
34 suburban towns near Berlin, New Jersey and meanders for approximately 60 mi (97 km),
35 gradually widening as tributaries enter, until terminating at the Atlantic Ocean.

36 The Endangered and Nongame Species Program of the NJDFW identifies critical habitat for
37 bald eagles, including areas the species uses for foraging, roosting, and nesting. All three
38 ROWs traverse land classified as critical bald eagle foraging habitat (NJDEP 2006). Typical
39 foraging habitat for this species consists of tall trees for perching near large bodies of water.
40 The tideland marshes of southern New Jersey are particularly good locations for winter foraging
41 (NJDFW 2010a).

42 **2.2.7 Threatened and Endangered Species**

43 This discussion of threatened and endangered species is organized based on the principal
44 ecosystems in which such species may occur in the vicinity of the Salem and HCGS facilities
45 and the associated transmission line ROWs. Thus, Section 2.2.7.1 discusses aquatic species
46 that may occur in adjacent areas of the Delaware Estuary, and Section 2.2.7.2 discusses

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1 terrestrial species that may occur on Artificial Island or the three ROWs, as well as freshwater
 2 aquatic species that may occur in the relatively small streams and wetlands within these
 3 terrestrial areas.

4 **2.2.7.1 Aquatic Species of the Delaware Estuary**

5 There are five aquatic species with a Federal listing status of threatened or endangered that
 6 have the potential to occur in the Delaware Estuary in the vicinity of the Salem and HCGS
 7 facilities. These species include four sea turtles and one fish (Table 2-8). In addition, there is
 8 one fish species that is a Federal candidate for listing (NMFS 2010b, FWS 2010b). These six
 9 species also have a State listing status of threatened or endangered in New Jersey and/or
 10 Delaware (NJDEP 2008b, DNREC 2008). These species are discussed below.

11 **Table 2-8. Threatened and Endangered Aquatic Species of the Delaware Estuary**

Scientific Name	Common Name	Status ¹		
		Federal	New Jersey	Delaware
Reptiles				
<i>Caretta caretta</i>	loggerhead sea turtle	T	E	E
<i>Chelonia mydas</i>	green sea turtle	T	T	E
<i>Lepidochelys kempii</i>	Kemp's ridley sea turtle	E	E	E
<i>Dermochelys coriacea</i>	leatherback sea turtle	E	E	E
Fish				
<i>Acipenser brevirostrum</i>	shortnose sturgeon	E	E	-
<i>A. oxyrinchus oxyrinchus</i>	Atlantic sturgeon	C	-	E

12 ¹ E = Endangered; T = Threatened; C = Candidate

13

14 Kemp's Ridley, Loggerhead, Green, and Leatherback Sea Turtles

15 Sea turtles are air-breathing reptiles with large flippers and streamlined bodies. They inhabit
 16 tropical and subtropical marine and estuarine waters around the world. Of the seven species in
 17 the world, six occur in waters of the U.S., and all are listed as threatened or endangered. The
 18 four species identified by the NMFS as potentially occurring in the Delaware Estuary are the
 19 threatened loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) and the endangered
 20 Kemp's ridley (*Lepidochelys kempii*), and leatherback (*Dermochelys coriacea*) sea turtles.
 21 Kemp's ridley, loggerhead, and green sea turtles have been documented in the Delaware
 22 Estuary at or near the Salem and HCGS facilities, while the leatherback sea turtle is less likely
 23 to occur in the vicinity (NMFS 2010b).

24 Kemp's ridley, loggerhead, and green sea turtles have a similar appearance, though they differ
 25 in maximum size and coloration. The Kemp's ridley is the smallest species of sea turtle; adults
 26 average about 100 lbs (45 kg) with a carapace length of 24 to 28 inches (61 to 71 cm) and a
 27 shell color that varies from gray in young individuals to olive green in adults. The loggerhead is
 28 the next largest of these three species; adults average about 250 lbs (113 kg) with a carapace
 29 length of 36 inches (91 cm) and a reddish brown shell color. The green is the largest of the
 30 three; adults average 300 to 350 lbs (136 to 159 kg) with a length of more than 3 ft (1 m) and
 31 brown coloration (its name comes from its greenish colored fat). The leatherback is the largest
 32 species of sea turtle and the largest living reptile; adults can weigh up to about 2000 lbs (907

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1 kg) with a length of 6.5 ft (2 m). The leatherback is the only sea turtle that lacks a hard, bony
2 shell. Instead, its carapace is approximately 1.5 inches (4 cm) thick with seven longitudinal
3 ridges and consists of loosely connected dermal bones covered by leathery connective tissue.
4 The Kemp's ridley has a carnivorous diet that includes fish, jellyfish, and mollusks. The
5 loggerhead has an omnivorous diet that includes fish, jellyfish, mollusks, crustaceans, and
6 aquatic plants. The green has a herbivorous diet of aquatic plants, mainly seagrasses and
7 algae, that is unique among sea turtles. The leatherback has a carnivorous diet of soft-bodied,
8 pelagic prey such as jellyfish and salps (NMFS 2010c).

9 All four of these sea turtle species nest on sandy beaches; none nest on the Delaware River
10 (NMFS 2010c). They are distributed generally in tropical and subtropical waters worldwide,
11 and there is evidence that they return to their natal beaches to nest. The leatherback has the
12 widest distribution of all the species, as it has physiological adaptations that allow survival and
13 foraging in much colder water than the other species (NMFS, FWS 2007a). Major threats to
14 these sea turtles include the destruction of beach nesting habitats and incidental mortality from
15 commercial fishing activities. Sea turtles are killed by many fishing methods, including longline,
16 bottom and mid-water trawling, dredges, gillnets, and pots/traps. The required use of turtle
17 exclusion devices has reduced bycatch mortality. Additional sources of mortality due to human
18 activities include boat strikes and entanglement in marine debris (NMFS and FWS 2007a,
19 NMFS and FWS 2007b, NMFS and FWS 2007c, NOAA 2010h).

20 Shortnose Sturgeon

21 The shortnose sturgeon (*Acipenser brevirostrum*) is a primitive fish, similar in appearance to
22 other sturgeon (NOAA 2010i), and has not evolved significantly for the past 120 million years
23 (Northeast Fisheries Science Center [NEFSC] 2006). This species was not specifically targeted
24 as a commercial fishery species, but has been taken as bycatch in the Atlantic sturgeon and
25 shad fisheries. As they were not easily distinguished from Atlantic sturgeon, early data is
26 unavailable for this species (NMFS 1998). Furthermore, since the 1950s, when the Atlantic
27 sturgeon fishery declined, shortnose sturgeon data has been almost completely lacking. Due to
28 this lack of data, the FWS believed that the species had been extirpated from most of its range;
29 reasons noted for the decline included pollution and overfishing. Later research indicated that
30 the construction of dams and industrial growth along the larger rivers on the Atlantic coast in the
31 late 1800s also contributed to their decline due to loss of habitat.

32 In 1967, the shortnose sturgeon was listed as endangered under the recently implemented
33 Endangered Species Preservation Act of 1966. After the Endangered Species Act was passed
34 in 1973, NMFS assumed responsibility for the species in 1974. NMFS established a recovery
35 plan in 1998 listing actions that would assist in increasing population sizes (NOAA 2010i). The
36 overall objective of the recovery plan is to maintain genetic diversity and avoid extinction of the
37 species (NEFSC 2006). The recovery plan recognizes 19 different populations along the
38 Atlantic Coast due to the fact that sturgeon in each population return to their natal rivers to
39 spawn, making genetic intermingling unlikely. The populations are still managed together,
40 however, as not enough data currently exist to definitively separate the breeding populations
41 (NMFS 1998). The ASMFC currently manages the shortnose sturgeon along with the Atlantic
42 sturgeon under a management plan that was implemented in 1990. An amendment was added
43 in 1998 prohibiting all sturgeon harvesting in response to a rapid decline in abundance. This
44 amendment requires 20 year classes of females to be present in any population before any
45 fishing is considered. As of 2006, no shortnose sturgeon had been caught in the NMFS bottom
46 trawl survey program (NEFSC 2006).

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1 The shortnose sturgeon is found along the Atlantic coast from Canada to Florida in a variety of
2 habitats. They occur in fast-flowing riverine waters, estuaries, and, in some locations, offshore
3 marine areas over the continental slope. They are anadromous, spawning in coastal rivers and
4 later migrating into estuaries and nearshore environments during the non-spawning periods.
5 They do not appear to make long distance offshore migrations like other anadromous fishes
6 (NOAA 2010i). Migration into freshwater to spawn occurs between late winter and early
7 summer, dependent on latitude (NEFSC 2006). Spawning occurs in deep, rapidly flowing water
8 over gravel, rubble, or boulder substrates (FWS 2001a). Eggs are deposited on hard surfaces
9 to which they adhere before hatching after 9 to 12 days. The yolk sac is absorbed in an
10 additional 9 to 12 days (NMFS 1998). Juveniles remain in freshwater or the fresher areas of
11 estuaries for 3 to 5 years, then they move to more saline areas, including nearshore ocean
12 waters (NEFSC 2006). Shortnose sturgeon can live up to 30 years (males) to 67 years
13 (females), can grow up to 4.7 ft (143 cm) long, and can reach a weight of 51 lbs (23 kg). Age at
14 sexual maturity varies within their range from north to south, with individuals in the Delaware
15 Bay area reaching maturity at 3 to 5 years for males and approximately 6 years for females
16 (NOAA 2010i). Shortnose sturgeon are demersal and feed on benthos. Juveniles feed on
17 benthic insects such as *Hexagenia* sp., *Chaoborus* sp., *Chironomus* sp., and small crustaceans
18 (*Gammarus* sp., *Asellus* sp., *Cyathura polita*) (NMFS 1998). Adults feed over gravel and mud
19 substrates, in deep channels and nearshore ocean waters (USWFS 2001a), where they
20 consume mostly mollusks and larger crustaceans (NOAA 2010i). Prey species for adults
21 include *Physa* sp., *Heliosoma* sp., *Corbicula manilensis*, *Ammicola limnosa*, *Valvata* sp.,
22 *Pisidium* sp., *Elliptio complanata*, *Mya arenaria*, *Macoma balthica*, gammarid amphipods, and
23 zebra mussels (*Dreissena polymorpha*) (NMFS 1998). Additional food items for both juveniles
24 and adults include worms, plants, and small fish (NEFSC 2006).

25 In the Delaware Estuary, shortnose sturgeon most often occur in the Delaware River and may
26 be found occasionally in the nearshore ocean. Their abundance is greatest between Trenton,
27 New Jersey and Philadelphia, Pennsylvania. Adults overwinter in large groups between
28 Trenton and Bordentown, New Jersey, but little is known of the distribution of juveniles in the
29 Delaware estuary (USACE 2009). A review of the status of the shortnose sturgeon was initiated
30 in 2007 and was still underway as of 2008, when the latest biennial report to Congress
31 regarding the Endangered Species Act was completed. Due to its distinct populations, the
32 status of the species varies depending on the river in question. The population estimate for the
33 Delaware Estuary (1999-2003) was 12,047 adults. Current threats to the shortnose sturgeon
34 also vary among rivers. Generally, over the entire range, most threats are related to dams,
35 pollution, and general industrial growth in the 1800s. Drought and climate change are
36 considered aggravators of the existing threats due to lowered water levels which can reduce
37 access to spawning areas, increase thermal injury and concentrate pollutants. Additional
38 threats include discharges, dredging or disposal of material into rivers, development activities
39 involving estuaries or riverine mudflats and marshes, and mortality due to bycatch in the shad
40 gillnet fishery. The Delaware River population is most threatened by dredging operations and
41 water quality issues (NMFS 2008).

42 Atlantic Sturgeon

43 Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) are an evolutionarily ancient fish, remaining
44 relatively unchanged for the past 70 million years. They were originally considered a junk fish,
45 used as fertilizer and fuel. As the demand for caviar grew, they were harvested for human
46 consumption. By 1870, a large commercial fishery for Atlantic sturgeon was established. This
47 fishery crashed in approximately 100 years due to overfishing, exacerbated by the fact that this
48 species takes a very long time to reach sexual maturity. They were caught for many reasons:

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1 their flesh and eggs were processed for human consumption, their skin was made into leather
2 products such as book bindings, and their swim bladders were used to make gelatin and small
3 windows. Landings at the turn of the century averaged seven million pounds per year. They
4 declined to 100,000 to 250,000 lbs by the 1990s. The ASMFC adopted a Fishery Management
5 Plan (FMP) in 1990 that implemented harvest quotas. The FMP was amended in 1998 with a
6 coast-wide moratorium on Atlantic sturgeon harvest that will remain in place until 2038. This
7 moratorium was mirrored by the Federal government in 1999, prohibiting harvest in the
8 exclusive economic zone offshore (ASMFC 2009c). Recommendations in the FMP with respect
9 to habitat conservation include identifying, characterizing, and protecting critical spawning and
10 nursery areas, identifying critical habitat characteristics of spawning staging and oceanic areas,
11 determining environmental tolerance levels (dissolved oxygen, pH, temperature, river flow,
12 salinity, etc.) for all life stages, and determining the effects of contaminants on all life stages,
13 especially eggs, larvae, and juveniles (ASMFC 2010c).

14 The current status of the Atlantic sturgeon stock is unknown due to little reliable data. In 1998,
15 a coast wide stock assessment determined that biomass was much lower than it had been in
16 the early 1900s. This assessment resulted in the coast wide moratorium in an effort to
17 accumulate 20 years worth of breeding stock. Concurrent with the assessment, it was decided
18 that listing the Atlantic sturgeon as threatened or endangered was not warranted. The NMFS
19 reviewed the status again in 2005 and concluded that the stock should be broken into five
20 distinct populations, the Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South
21 Atlantic stocks. Three of these are likely to become endangered (Carolina, Chesapeake Bay,
22 and New York Bight). The other two populations have a moderate chance of becoming
23 endangered. Due to a lack of appropriate data, the NMFS could not list the species as
24 threatened or endangered at that time. Threats to the Atlantic sturgeon and its habitat include
25 bycatch mortality, poor water quality, lack of adequate State and/or Federal regulatory
26 mechanisms, dredging activities, habitat impediments (dams blocking spawning areas) and ship
27 strikes (ASMFC 2009c). As of 2009, the Atlantic sturgeon over its entire range is listed as a
28 species of concern and a candidate species by the NMFS. Reasons for the listing include
29 genetic diversity (distinct populations) and lack of population size estimates (only the Hudson
30 and Altamaha River populations are adequately documented) (NOAA 2009b).

31 Atlantic sturgeon are found along the Atlantic coast in the ocean, large rivers, and estuaries
32 from Labrador to northern Florida. They have been extirpated from most coastal systems
33 except for the Hudson River, the Delaware River, and some South Carolina systems (ASMFC
34 2010c). They are anadromous, migrating inshore to coastal estuaries and rivers to spawn in the
35 spring. A single fish will only spawn every 2 to 6 years (ASMFC 2009c). Spawning is
36 accomplished by broadcasting eggs in fast-flowing, deep water with hard bottoms (ASMFC
37 2010c). Eggs are demersal and stick to the substrate after 20 minutes of dispersal time.
38 Larvae are pelagic, swimming in the water column, becoming benthic juveniles within 4 weeks
39 (ASMFC 2009a). Juveniles remain where they hatch for 1 to 6 years before migrating to the
40 ocean to complete their growth (ASMFC 2009c). Little is known about the distribution and
41 timing of juveniles and their migration, but aggregations at the freshwater/saltwater interface
42 suggest that these areas are nurseries (ASMFC 2010c). At between 30 and 36 inches (76 to 91
43 cm) in length, juveniles move offshore (NOAA 2009b). Data are lacking regarding adult and
44 sub-adult distribution and habitats in the open ocean (ASMFC 2010c). Atlantic sturgeon can
45 live for up to 60 years and can reach 14 ft (4.3 m) long and 800 lbs (363 kg). Sexual maturity is
46 reached by females between 7 and 30 years of age and by males between 5 and 24 years
47 (ASMFC 2009c).

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1 Atlantic sturgeon are benthic predators and feed on mussels, worms, shrimps, and small fish
2 (ASMFC 2009c). Juveniles are known to consume sludgeworms, annelid worms, polychaete
3 worms, isopods, amphipods, chironomid larvae, mayfly and other insect larvae, small bivalve
4 mollusks, mysids, and amphipods. Little is known of the adult and subadult feeding habits in the
5 marine environment, but some studies have found that these life stages consume mollusks,
6 polychaetes, gastropods, shrimps, amphipods, isopods, and small fish. Juveniles and adults
7 may compete for food with other benthic feeders such as shortnose sturgeon, suckers
8 (*Moxotoma* sp.), winter flounder (*Pleuronectes americanus*), tautog (*Tautoga onitis*), cunner
9 (*Tautoglabrus adspersus*), porgies (Sparidae), croakers (Sciaenidae), and stingrays (*Dasyatis*
10 sp.). Juveniles are preyed upon by sea lampreys (*Petromyzon marinus*), gar (*Lepisosteus* sp.),
11 striped bass, common carp (*Cyprinus carpio*), northern pikeminnow (*Ptychocheilus*
12 *oregonensis*), channel catfish (*Ictalurus punctatus*), smallmouth bass (*Micropterus dolomieu*),
13 walleye (*Sander vitreus*), fallfish (*Semotilus corporalis*), and grey seal (*Halichoerus grypus*)
14 (ASMFC 2009d).

15 The Delaware River and associated estuarine habitats may have historically supported the
16 largest Atlantic sturgeon stock on the east coast. Juveniles were once caught as bycatch in
17 numbers large enough to be a nuisance in the American shad fishery. It has been estimated
18 that over 180,000 females spawned annually in the Delaware River before 1870. Juveniles
19 have more recently been captured in surveys near Trenton, New Jersey. Gill net surveys by the
20 DNREC have captured juveniles frequently near Artificial Island and Cherry Island Flats. The
21 DNREC also tracks mortality during the spawning season. In 2005 and 2006, 12 large adult fish
22 carcasses were found with severe external injuries, presumed to be caused by boat strikes
23 (ASMFC 2009d).

24 2.2.7.2 Terrestrial and Freshwater Aquatic Species

25 There are seven terrestrial species with a Federal listing status of threatened or endangered
26 that have recorded occurrences or the potential to occur either in the county in Salem County, in
27 which the Salem and HCGS facilities are located, or the additional counties crossed by the three
28 ROWs (Gloucester and Camden Counties in New Jersey, New Castle County in Delaware).
29 These species include a turtle, a beetle, and five plants (Table 2-9) (FWS 2010b). Six of these
30 species (all except one plant) also have a State listing status of endangered in New Jersey, and
31 the turtle has a state status of endangered in both states (NJDEP 2008c, DNREC 2008). In
32 letters provided in accordance with the consultation requirements under Section 7 of the
33 Endangered Species Act, FWS confirmed that no federally listed species under their jurisdiction
34 are known to occur in the vicinity of the Salem and HCGS facilities (FWS 2009a, FWS 2009b).
35 However, two of the species Federally listed as threatened were identified by the New Jersey
36 Field Office of FWS (FWS 2009a) as having known occurrences or other areas of potential
37 habitat along the New Freedom North and South transmission line ROWs: the bog turtle
38 (*Clemmys muhlenbergii*) and the swamp pink (*Helonias bullata*). These species are discussed
39 below.

40 Bog Turtle

41 The bog turtle (now also referred to as *Glyptemys muhlenbergii*) has two discontinuous
42 populations. The northern population, which occurs in Connecticut, Delaware, Maryland,
43 Massachusetts, New Jersey, New York, and Pennsylvania, was federally listed as threatened in

Table 2-9. Threatened and Endangered Terrestrial and Freshwater Aquatic Species Recorded in Salem County and Counties Crossed by Transmission Lines

Scientific Name	Common Name	Status		County ^(c)	Habitat ^(d)
		Federal ^(a)	State ^{(a),(b)}		
Mammals					
<i>Lynx rufus</i>	bobcat	-	E	Salem	Rock outcrops, caves, swamps, bogs dense thickets of briars; and conifers in contiguous forest; and forests fragmented by agricultural areas. ⁽¹⁾
Birds					
<i>Accipiter cooperii</i>	Cooper's hawk	-	T/T	Gloucester, Salem	Deciduous, coniferous, and mixed riparian or wetland forests; specifically remote red maple or black gum swamps. ⁽¹⁾
<i>Ammodramus henslowii</i>	Henslow's sparrow	-	E	Gloucester	Open fallow fields with high, thick herbaceous vegetation (not woody) with a few scattered shrubs; and grassy fields between salt marsh and uplands along the Delaware Bay coast. ⁽¹⁾
<i>A. savannarum</i>	grasshopper sparrow	-	T/S	Salem	Grasslands, pastures, agricultural lands, and other habitats with short- to medium-height grasses scattered with patches of bare ground. ⁽¹⁾
<i>Bartramia longicauda</i>	upland sandpiper	-	E	Gloucester, Salem	Open meadows and fallow fields often associated with pastures, airports or farms with a mixture of tall and short grasses. ⁽¹⁾
<i>Buteo lineatus</i>	red-shouldered hawk	-	E/T	Gloucester	Deciduous, riparian, or mixed woodlands in remote, old growth forests; and hardwood swamps with standing water, or vast

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Table 2-9. Threatened and Endangered Terrestrial and Freshwater Aquatic Species Recorded in Salem County and Counties Crossed by Transmission Lines

Scientific Name	Common Name	Status		County ^(c)	Habitat ^(d)
		Federal ^(a)	State ^{(a),(b)}		
					contiguous, freshwater wetlands. ⁽¹⁾
<i>Circus cyaneus</i>	northern harrier	-	E/U	Salem	Freshwater, brackish, and saline tidal marshes; emergent wetlands; fallow fields; grasslands; meadows; airports; and agricultural areas. ⁽¹⁾
<i>Cistothorus platensis</i>	sedge wren	-	E	Salem	Wet meadows, freshwater marshes, bogs, and drier portions of salt or brackish coastal marshes. ⁽¹⁾
<i>Dolichonyx oryzivorus</i>	bobolink	-	T/T	Salem	Hayfields, pastures, grassy meadows, and other low-intensity agricultural areas; may occur in coastal and freshwater marshes during migration. ⁽¹⁾
<i>Falco peregrinus</i>	peregrine falcon	-	E	Camden, Gloucester, Salem	Nest on buildings, bridges, man-made structures and forage in open area near water. ⁽¹⁾
<i>Falco sparverius</i>	American kestrel		SC	Camder, Gloucester, Salem	Open fields and pastures with scattered trees for perching and nesting sites, power line ROWs. ⁽²⁴⁾
<i>Haliaeetus leucocephalus</i>	bald eagle	-	E	Gloucester, Salem	Large, perch trees in forested areas associated with water and tidal areas. ⁽¹⁾
<i>Hylocichla mustelina</i>	wood thrush	-	SC/S	Camder, Gloucester, Salem	Moist woodlands, hillsides, parks, orchards, and woodlots in suburbs. ⁽²¹⁾
<i>Melanerpes</i>	red-headed	-	T/T	Camden, Gloucester,	Upland and wetland open woods

Table 2-9. Threatened and Endangered Terrestrial and Freshwater Aquatic Species Recorded in Salem County and Counties Crossed by Transmission Lines

Scientific Name	Common Name	Status		County ^(c)	Habitat ^(d)
		Federal ^(a)	State ^{(a),(b)}		
<i>erythrocephalus</i>	woodpecker			Salem	that contain dead or dying trees, and sparse undergrowth. ⁽¹⁾
<i>Pandion haliaetus</i>	osprey	-	T/T	Gloucester, Salem	Dead trees or platforms near coastal/inland rivers, marshes, bays, inlets, and other areas associated with bodies of water that support adequate fish populations. ⁽¹⁾
<i>Passerculus sandwichensis</i>	savannah sparrow	-	T/T	Salem	Open habitats such as alfalfa fields, grasslands, meadows, fallow fields, airports, along the coast; and within salt marsh edges as well. ⁽¹⁾
<i>Podilymbus podiceps</i>	pied-billed grebe	-	E/S	Salem	Freshwater marshes associated with bogs, lakes, or slow-moving rivers. ⁽¹⁾
<i>Pooecetes gramineus</i>	vesper sparrow	-	E	Gloucester, Salem	Pastures, grasslands, cultivated fields containing crops, and other open areas. ⁽¹⁾
<i>Strix varia</i>	barred owl	-	T/T	Gloucester, Salem	Remote, contiguous, old growth wetland forests, including deciduous wetland forests; and Atlantic white cedar swamps associated with stream corridors. ⁽¹⁾

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Table 2-9. Threatened and Endangered Terrestrial and Freshwater Aquatic Species Recorded in Salem County and Counties Crossed by Transmission Lines

Scientific Name	Common Name	Status		County ^(c)	Habitat ^(d)
		Federal ^(a)	State ^{(a),(b)}		
Reptiles and Amphibians					
<i>Ambystoma tigrinum</i>	eastern tiger salamander	-	E	Gloucester, Salem	Uplands and wetlands containing breeding ponds, forests, and burrowing-appropriate soil types such as old fields, and deciduous or mixed woods. ⁽¹⁾
<i>Bufo woodhousii fowleri</i>	Fowler's toad	-	SC	Camden, Gloucester, Salem	Wooded areas, river valleys, floodplains, agricultural areas, areas with deep friable soils; burrows underground or hides under rocks, plants, or other cover when inactive; eggs and larvae develop in shallow water of marshes, rain pools, ponds, lakes, reservoirs, and flooded areas. ⁽¹⁶⁾
<i>Clemmys guttata</i>	spotted turtle	-	SC	Camden, Gloucester, Salem	Wetlands with clean, shallow, slow-moving water with muddy or mucky bottoms including aquatic and emergent vegetation, shallow ponds, wet meadows, swamps, bogs, fens, sedge meadows, wet prairies, shallow cattail marshes, sphagnum seepages, small woodland streams, and roadside ditches; during mating and nesting seasons: open fields and woodlands, and along roads. ⁽¹²⁾
<i>Clemmys insculpta</i>	wood turtle	-	E	Gloucester	Forests, meadows, or open fields near freshwater streams, creeks, or relatively remote rivers. ⁽¹⁾

Table 2-9. Threatened and Endangered Terrestrial and Freshwater Aquatic Species Recorded in Salem County and Counties Crossed by Transmission Lines

Scientific Name	Common Name	Status		County ^(c)	Habitat ^(d)
		Federal ^(a)	State ^{(a),(b)}		
<i>C. muhlenbergii</i>	bog turtle	T	E DE: E	Camden, Gloucester, Salem, New Castle	Open, wet, grassy pastures or bogs with soft, muddy bottoms. ⁽¹⁾
<i>Crotalus horridus horridus</i>	timber rattlesnake	-	E	Camden	Deciduous upland forests or pinelands habitats, often near cedar swamps and along streambanks. ⁽¹⁾
<i>Hyla andersoni</i>	pine barrens treefrog	-	E	Camden, Gloucester, Salem	Specialized acidic habitats such as Atlantic white cedar swamps and pitch pine lowlands with open canopies, dense shrub layers, and heavy ground cover. ⁽¹⁾
<i>Malaclemys terrapin terrapin</i>	northern diamondback terrapin	-	SC	Camden, Gloucester, Salem	Marshes bordering salt or brackish tidal waters, mudflats, shallow bays, coves, tidal estuaries with adjacent sandy uplands for nesting. ⁽²²⁾
<i>Pituophis melanoleucus</i>	northern pine snake	-	T	Camden, Gloucester, Salem	Dry pine-oak forest types growing on infertile sandy soils. ⁽¹⁾
<i>Terrapene carolina carolina</i>	eastern box turtle	-	SC	Camden, Gloucester, Salem	Forested habitats with sandy soils and a source of water such as a stream, pond, lake, marsh or swamp; thickets; old fields; pastures; vegetated dunes; and nesting sites - sandy, open areas. ⁽¹²⁾
Invertebrates					
<i>Alasmidonta undulata</i>	triangle floater	-	T	Gloucester	Stable substrates in waters of moderate flow in small rivers and headwater streams. ⁽²⁶⁾
<i>Callophrys irus</i>	frosted elfin	-	T	Camden	Dry clearings and open areas, savannas, power-line ROWs, roadsides. ⁽¹⁾

Affected Environment

Table 2-9. Threatened and Endangered Terrestrial and Freshwater Aquatic Species Recorded in Salem County and Counties Crossed by Transmission Lines

Scientific Name	Common Name	Status		County ^(c)	Habitat ^(d)
		Federal ^(a)	State ^{(a),(b)}		
<i>Lampsilis cariosa</i>	yellow lampmussel	-	T	Gloucester	Medium to large rivers, lakes and ponds; substrate types - sand, silt, cobble, and gravel; larval hosts - white perch and yellow perch. ⁽²²⁾
<i>Lampsilis radiata</i>	eastern lampmussel	-	T	Camden, Gloucester, Salem	Small streams, large rivers, ponds, and lakes; prefers sand or gravel substrates. ⁽²²⁾
<i>Leptodea ochracea</i>	tidewater mucket	-	T	Camden, Gloucester	Freshwater water with tidal influence on the lower coastal plain, pristine rivers. ⁽³²⁾
<i>Ligumia nasuta</i>	eastern pond mussel	-	T	Camden, Gloucester	Lakes, ponds, streams and rivers of variable depths with muddy, sandy, or gravelly substrates. ⁽³²⁾
<i>Lycaena hyllus</i>	bronze copper		E	Salem	Brackish and freshwater marshes, bogs, fens, seepages, wet sedge meadows, riparian zones, wet grasslands, and drainage ditches. ⁽¹⁾
<i>Nicrophorus americanus</i>	American burying beetle	E	E	Camden, Gloucester	Open areas, primarily coastal grassland/scrub. ⁽¹⁾
<i>Pontia protodice</i>	checkered white	-	T	Camden	Open areas, savannas, old fields, vacant lots, power-line ROWs, forest edges. ⁽¹⁾
<i>Pyrgus wyandot</i>	Appalachian grizzled skipper	-	E	Gloucester	Semi-open shale slopes with exposed crumbly rock or soil, sparse herbaceous vegetation, surrounded by scrub oak or oak-hickory woodlands; larval host plant - Canada cinquefoil (<i>Potentilla canadensis</i>); tufted grasses like broomsedge (<i>Andropogon virginicus</i>), spring beauty (<i>Claytonia</i> spp.), phlox

Table 2-9. Threatened and Endangered Terrestrial and Freshwater Aquatic Species Recorded in Salem County and Counties Crossed by Transmission Lines

Scientific Name	Common Name	Status		County ^(c)	Habitat ^(d)
		Federal ^(a)	State ^{(a),(b)}		
					(<i>Phlox subulata</i>), and birdsfoot violet (<i>Viola pedata</i>). ⁽²²⁾
Plants					
<i>Aeschynomene virginica</i>	sensitive joint vetch	T	E	Camden, Gloucester, Salem	Fresh to slightly salty (brackish) tidal marshes. ⁽²⁾
<i>Aplectrum hyemale</i>	putty root	-	E	Gloucester	Moist, deciduous upland to swampy forests. ⁽³⁾
<i>Aristida lanosa</i>	wooly three-awn grass	-	E	Camden, Salem	Dry fields, uplands, pink-oak woods, primarily in sandy soil. ⁽⁴⁾
<i>Asimina triloba</i>	pawpaw	-	E	Gloucester	Shady, open-woods areas in wet, fertile bottomlands, or upland areas on rich soils. ⁽⁵⁾
<i>Aster radula</i>	low rough aster	-	E	Camden, Gloucester, Salem	Wet meadows, open boggy woods, and along the edges; or openings in wet spruce or tamarack forests. ⁽⁶⁾
<i>Bouteloua curtipendula</i>	side oats grama grass	-	E	Gloucester	Rocky, open slopes, woodlands, and forest openings up to an elevation of approximately 7000 ft. ⁽⁵⁾
<i>Cacalia atriplicifolia</i>	pale Indian plantain	-	E	Camden, Gloucester	Dry, open woods, thickets, and rocky openings. ⁽⁶⁾
<i>Calystegia spithamea</i>	erect bindweed	-	E	Camden, Salem	Dry, open, sandy to rocky sites such as pitch pine/scrub oak barrens, sandy roadsides, riverbanks, and ROWs. ⁽⁷⁾
<i>Cardamine longii</i>	Long's bittercress	-	E	Gloucester	Shady tidal creeks, swamps, and mudflats. ⁽⁸⁾

Affected Environment

Table 2-9. Threatened and Endangered Terrestrial and Freshwater Aquatic Species Recorded in Salem County and Counties Crossed by Transmission Lines

Scientific Name	Common Name	Status		County ^(c)	Habitat ^(d)
		Federal ^(a)	State ^{(a),(b)}		
<i>Carex aquatilis</i>	water sedge	-	E	Camden	Swamps, bogs, marshes, very wet soil, ponds, lakes, marshy meadows, and other wetland-type sites. ⁽⁹⁾
<i>C. bushii</i>	Bush's sedge	-	E	Camden	Dry to mesic grasslands, and forest margins. ⁽³⁾
<i>C. cumulata</i>	clustered sedge	-	E	Camden	Damp, open rocky areas with shallow, sandy soils. ⁽⁸⁾
<i>C. limosa</i>	mud sedge	-	E	Gloucester	Fens, sphagnum bogs, wet meadows, and shorelines. ⁽³⁾
<i>C. polymorpha</i>	variable sedge	-	E	Gloucester	Dry, sandy, open areas of scrub, forests, swampy woods, and along banks and marsh edge. ⁽⁶⁾
<i>Castanea pumila</i>	chinquapin	-	E	Gloucester, Salem	High ridges and slopes within mixed hardwood forests, dry pinelands, and ROWs. ⁽⁵⁾
<i>Cercis canadensis</i>	redbud	-	E	Camden	Rich, moist wooded areas in the forest understory, streambanks, and abandoned farmlands. ⁽⁵⁾
<i>Chenopodium rubrum</i>	red goosefoot	-	E	Camden	Moist, often salty soils along the Atlantic coast. ⁽¹⁰⁾
<i>Commelina erecta</i>	slender dayflower	-	E	Camden	Along roadsides, streambanks, in gardens and prairies in sandy, or clayey soils. ⁽⁵⁾
<i>Cyperus lancastricensis</i>	Lancaster flat sedge	-	E	Camden, Gloucester	Riverbanks, floodplains, and other disturbed, sunny or partly sunny places in mesic, or dry-mesic soils. ⁽³⁾
<i>C. polystachyos</i>	coast flat sedge	-	E	Salem	Along shores, in ditches, and

Table 2-9. Threatened and Endangered Terrestrial and Freshwater Aquatic Species Recorded in Salem County and Counties Crossed by Transmission Lines

Scientific Name	Common Name	Status		County ^(c)	Habitat ^(d)
		Federal ^(a)	State ^{(a),(b)}		
					swales between dunes. ⁽³⁾
<i>C. pseudovegetus</i>	marsh flat sedge	-	E	Salem	Open mesic forests, stream edges, swamps, moist sandy areas, and bottomland prairies. ⁽¹¹⁾
<i>C. retrofractus</i>	rough flat sedge	-	E	Camden, Gloucester	Sandy, disturbed areas, openings of dry upland forests and prairies. ⁽¹¹⁾
<i>Dalibarda repens</i>	robin-run-away	-	E	Gloucester	Swamps, moist woodlands, and other cool, wet areas. ⁽¹²⁾
<i>Diodia virginiana</i>	larger buttonweed	-	E	Camden	Wet meadows in wet soils, and pond margins. ⁽¹¹⁾
<i>Draba reptans</i>	Carolina Whitlow-grass	-	E	Camden, Gloucester	Rocky or sandy soils in prairies and other disturbed areas. ⁽¹³⁾
<i>Eleocharis melanocarpa</i>	black-fruit spike-rush	-	E	Salem	Fresh, oligotrophic, often drying, sandy shores, ponds, and ditches. ⁽³⁾
<i>E. equisetoides</i>	knotted spike-rush	-	E	Gloucester	Fresh lakes, ponds, marshes, streams, and cypress swamps. ⁽³⁾
<i>E. tortilis</i>	twisted spike-rush	-	E	Gloucester	Bogs, ditches, seeps, and other freshwater, acidic places. ⁽³⁾
<i>Elephantopus carolinianus</i>	Carolina elephant-foot	-	E	Gloucester, Salem	Full sun to partial shade in dry to medium, sandy soils. ⁽¹⁴⁾
<i>Eriophorum gracile</i>	slender cotton-grass	-	E	Gloucester	Peaty, acidic substrates such as bogs, meadows, and shores. ⁽³⁾
<i>E. tenellum</i>	rough cotton-grass	-	E	Camden, Gloucester	Bogs and other wet, peaty substrates. ⁽³⁾
<i>Eupatorium capillifolium</i>	dog fennel	-	E	Camden	Coastal meadows, fallow fields,

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Table 2-9. Threatened and Endangered Terrestrial and Freshwater Aquatic Species Recorded in Salem County and Counties Crossed by Transmission Lines

Scientific Name	Common Name	Status		County ^(c)	Habitat ^(d)
		Federal ^(a)	State ^{(a),(b)}		
	thoroughwort				flatwoods, marshes, and disturbed sites. ⁽¹⁵⁾
<i>E. resinosum</i>	pine barren boneset	-	E	Camden, Gloucester	Tidal marshes, wetlands, open swamps, wet ditches, sandy acidic soils of grass-sedge bogs, pocosin-savannah ecotones, beaver ponds, and shrub swamps. ⁽¹⁷⁾
<i>Euphorbia purpurea</i>	Darlington's glade spurge	-	E	Salem	Rich, cool woods along seeps, streams, or swamps. ⁽¹⁷⁾
<i>Glyceria grandis</i>	American manna grass	-	E	Camden	Grassy areas. ⁽⁶⁾
<i>Gnaphalium helleri</i>	small everlasting	-	E	Camden	Dry woods, often in sandy soil. ⁽¹³⁾
<i>Gymnopogon brevifolius</i>	short-leaf skeleton grass	-	E	Gloucester	Dryish clay-loam soils, calcareous glades, and relict prairies. ⁽²³⁾
<i>Helonias bullata</i>	swamp pink	T	E	Camden, Gloucester, Salem, New Castle	Swamps and groundwater influenced, and perennially water-saturated forested wetlands. ⁽¹⁷⁾
<i>Hemicarpha micrantha</i>	small-flower halfchaff sedge	-	E	Camden	Emergent shorelines, but rarely freshwater tidal shores. ⁽³⁾
<i>Hottonia inflata</i>	featherfoil	-	E	Salem	Quiet, shallow water of pools, streams, ditches, and occasionally in wet soil. ⁽²⁰⁾
<i>Hydrastis canadensis</i>	golden seal	-	E	Camden	Mesic, deciduous forests, often on clayey soil. ⁽³⁾
<i>Hydrocotyle ranunculoides</i>	floating marsh-pennywort	-	E	Salem	Ponds, marshes, and wet ground. ⁽¹⁹⁾
<i>Hypericum adpressum</i>	Barton's St. John's-	-	E	Salem	Pond shore. ⁽⁷⁾

Table 2-9. Threatened and Endangered Terrestrial and Freshwater Aquatic Species Recorded in Salem County and Counties Crossed by Transmission Lines

Scientific Name	Common Name	Status		County ^(c)	Habitat ^(d)
		Federal ^(a)	State ^{(a),(b)}		
	wort				
<i>Isotria meleoloides</i>	small-whorled pogonia	T	-	-	Mixed deciduous forests in second- or third-growth successional stages, coniferous forests; typically light to moderate leaf litter, open herb layer, moderate to light shrub layer, and relatively open canopy; flats or slope bases near canopy breaks. ⁽³⁾
<i>Juncus caesariensis</i>	New Jersey rush	-	E	Camden	Borders of wet woods, wet springy bogs, and swamps. ⁽³⁾
<i>J. torreyi</i>	Torrey's rush	-	E	Camden	Edge of sloughs, wet sandy shores; along slightly alkaline watercourses; swamps; sometimes on clay soils, alkaline soils, and calcareous wet meadows. ⁽³⁾
<i>Kuhnia eupatorioides</i>	false boneset	-	E	Camden	Limestone edges of bluffs, rocky wooded slopes, and rocky limestone talus. ⁽¹¹⁾
<i>Lemna perpusilla</i>	minute duckweed	-	E	Camden, Salem	Mesotrophic to eutrophic, quiet waters with relatively mild winters. ⁽³⁾
<i>Limosella subulata</i>	awl-leaf mudwort	-	E	Camden	Freshwater marshes. ⁽¹⁸⁾
<i>Linum intercursum</i>	sandplain flax	-	E	Camden, Salem	Open, dry, sandplain grasslands or moors; sand barrens; mown fields; and swaths under powerlines, usually in small colonies. ⁽²³⁾
<i>Luzula acuminata</i>	hairy wood-rush	-	E	Gloucester, Salem	Grassy areas. ⁽⁶⁾
<i>Melanthium virginicum</i>	Virginia bunchflower	-	E	Camden, Gloucester, Salem	Fens, bottomland prairies; mesic upland forests; mesic upland prairies; along streams,

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Table 2-9. Threatened and Endangered Terrestrial and Freshwater Aquatic Species Recorded in Salem County and Counties Crossed by Transmission Lines

Scientific Name	Common Name	Status		County ^(c)	Habitat ^(d)
		Federal ^(a)	State ^{(a),(b)}		
					roadsides, and railroads. ⁽¹¹⁾
<i>Micranthemum micranthemoides</i>	Nuttall's mudwort	-	E	Camden, Gloucester	Possibly extinct - last seen anywhere in 1941; freshwater tidal shores of northeast and mid-Atlantic rivers, including Hudson, Delaware, Potomac, and Anacostia. ⁽¹⁶⁾
<i>Muhlenbergia capillaries</i>	long-awn smoke grass	-	E	Gloucester	Sandy, pine openings; dry praires; and exposed ledges. ⁽⁶⁾
<i>Myriophyllum tenellum</i>	slender water-milfoil	-	E	Camden	Sandy soil, water to 5 ft deep. ⁽¹³⁾
<i>M. pinnatum</i>	cut-leaf water-milfoil	-	E	Salem	Floodplain marsh; associated with <i>Asclepias perrenis</i> , <i>Salix caroliniana</i> , and <i>Ludwigia repens</i> . ⁽¹⁶⁾
<i>Nelumbo lutea</i>	American lotus	-	E	Camden, Salem	Mostly floodplains of major rivers in ponds, lakes, pools in swamps and marshes, and backwaters of reservoirs. ⁽³⁾
<i>Nuphar microphyllum</i>	small-yellow pond-lily	-	E	Camden	Lakes, ponds, sluggish streams, ditches, sloughs, and occasionally tidal waters. ⁽³⁾
<i>Onosmodium virginianum</i>	Virginia false-gromwell	-	E	Camden, Gloucester, Salem	Sandy soil, and dry open woods. ⁽¹⁰⁾
<i>Ophioglossum vulgatum pycnostichum</i>	southern adder's tongue	-	E	Salem	Rich wooded slopes, shaded secondary woods, forested bottomlands, and floodplain woods, south of Wisconsin glaciations. ⁽³⁾
<i>Panicum aciculare</i>	bristling panic grass	-	E	Gloucester	Sandy, coastal plains that undergo rises and falls in water levels, coastal plain ponds, limestone depression ponds, and shallow cypress ponds. ⁽¹⁷⁾
<i>Penstemon laevigatus</i>	smooth beardtongue	-	E	Gloucester	Rich woods and fields. ⁽⁶⁾

Table 2-9. Threatened and Endangered Terrestrial and Freshwater Aquatic Species Recorded in Salem County and Counties Crossed by Transmission Lines

Scientific Name	Common Name	Status		County ^(c)	Habitat ^(d)
		Federal ^(a)	State ^{(a),(b)}		
<i>Plantago pusilla</i>	dwarf plantain	-	E	Camden	Dry sand prairies, hill prairies, cliffs, rocky glades, sandy fields, and areas of gravel along railroads or roadsides. ⁽²⁷⁾
<i>Platanthera flava flava</i>	southern rein orchid	-	E	Camden	Floodplain forests; white cedar, hardwood, and cypress swamps; riparian thickets; and wet meadows. ⁽³⁾
<i>Pluchea foetida</i>	stinking fleabane	-	E	Camden	Swamps, marshes, ditches, coastal savannas. ⁽²⁸⁾
<i>Polemonium reptans</i>	Greek-valerian	-	E	Salem	Moist, stream banks; and deciduous woods. ⁽⁶⁾
<i>Polygala incarnate</i>	pink milkwort	-	E	Camden, Gloucester	Fields, prairies, and meadows. ⁽⁶⁾
<i>Prunus angustifolia</i>	chickasaw plum	-	E	Camden, Gloucester, Salem	Woodland edges, forest openings, open woodlands, savannas, prairies, plains, meadows, pastures, roadsides, and fence rows. ⁽⁶⁾
<i>Pycnanthemum clinopodioides</i>	basil mountain mint	-	E	Camden	Dry south or west facing slopes on rocky soils; open oak-hickory forests, woodlands, or savannas with exposed bedrock. ⁽¹¹⁾
<i>P. torrei</i>	Torrey's mountain mint	-	E	Gloucester	Open, dry, including red cedar barrens, rocky summits, roadsides and trails, and dry upland woods. ⁽⁸⁾
<i>Quercus imbricaria</i>	shingle oak	-	E	Gloucester	Rich bottomlands, and dry to moist uplands. ⁽⁶⁾
<i>Q. lyrata</i>	overcup oak	-	E	Salem	Lowlands, bottoms, wet forests, streamside forests, and periodically inundated areas. ⁽³⁾
<i>Rhododendron atlanticum</i>	dwarf azalea	-	E	Salem	Moist, flat, pine woods, and savannas. ⁽⁶⁾
<i>Rhynchospora globularis</i>	coarse grass-like	-	E	Camden, Gloucester,	Sandy and rocky stream banks,

Affected Environment

Table 2-9. Threatened and Endangered Terrestrial and Freshwater Aquatic Species Recorded in Salem County and Counties Crossed by Transmission Lines

Scientific Name	Common Name	Status		County ^(c)	Habitat ^(d)
		Federal ^(a)	State ^{(a),(b)}		
	beaked-rush			Salem	sink-hole ponds, upland prairies, open rocky, and sandy areas. ⁽¹¹⁾
<i>R. knieskernii</i>	Knieskern's beaked-rush	T	E	Camden	Moist to wet pine barrens, borrow pits, and sand pits. ⁽³⁾
<i>Sagittaria teres</i>	slender arrowhead	-	E	Camden	Swamps of acid waters and sandy pool shores, and mostly along Atlantic Coastal Plain. ⁽³⁾
<i>Scheuchzeria palustris</i>	arrow-grass	-	E	Camden, Gloucester	Lake margins, bogs, and marshes. ⁽³⁾
<i>Schwalbea americana</i>	chaffseed	E	E	Camden	Acidic, sandy or peaty soils in open flatwoods, streamhead pocosins, pitch pine lowland forests, longleaf pine/oak sandhills, seepage bogs, palustrine pine savannahs, ecotonal areas between peaty wetlands, and xeric sandy soils. ⁽¹⁷⁾
<i>Scirpus longii</i>	Long's woolgrass	-	E	Camden	Marshes. ⁽³⁾
<i>S. maritimus</i>	saltmarsh bulrush	-	E	Camden	Water body margins, marshes, alkali, and saline wet meadows. ⁽⁶⁾
<i>Scutellaria leonardii</i>	small skullcap	-	E	Salem	Fields, meadows, and prairies. ⁽⁶⁾
<i>Spiranthes laciniata</i>	lace-lip ladies' tresses	-	E	Gloucester	Primarily on coastal plain marshes, swamps, dry to damp roadsides, meadows, ditches, fields, cemeteries, lawns; and occasionally in standing water. ⁽³⁾
<i>Stellaria pubera</i>	star chickweed	-	E	Camden	Alluvial bottomlands, and rich deciduous woods. ⁽³⁾
<i>Triadenum walteri</i>	Walter's St. John's wort	-	E	Camden	Buttonbush swamps, swamp woods, thickets, and streambanks. ⁽²¹⁾
<i>Utricularia biflora</i>	two-flower	-	E	Gloucester, Salem	Shores and shallows. ⁽¹³⁾

Table 2-9. Threatened and Endangered Terrestrial and Freshwater Aquatic Species Recorded in Salem County and Counties Crossed by Transmission Lines

Scientific Name	Common Name	Status		County ^(c)	Habitat ^(d)
		Federal ^(a)	State ^{(a),(b)}		
	bladderwort				
<i>Valerianella radiata</i>	beaked cornsalad	-	E	Gloucester	Pastures, prairies, valleys, creek beds, wet meadows, roadsides, glades, and railroads. ⁽¹¹⁾
<i>Verbena simplex</i>	narrow-leaf vervain	-	E	Camden, Gloucester	Fields, meadows, and prairies. ⁽⁶⁾
<i>Vernonia glauca</i>	broad-leaf ironweed	-	E	Gloucester, Salem	Dry fields, clearings, and upland forests. ⁽²¹⁾
<i>Vulpia ellioatea</i>	squirrel-tail six-weeks grass	-	E	Camden, Gloucester, Salem	Grass-like, or grassy habitats. ⁽⁶⁾
<i>Wolffiella floridana</i>	sword bogmat	-	E	Salem	Quiet waters in warm-temperature regions with relatively mild winters, and mesotrophic. ⁽³⁾
<i>Xyris fimbriata</i>	fringed yellow-eyed grass	-	E	Camden	Low pine savanna, bogs, seeps, peats and mucks of pond shallows, and sluggish shallow streams. ⁽³⁾

Table 2-9. Threatened and Endangered Terrestrial and Freshwater Aquatic Species Recorded in Salem County and Counties Crossed by Transmission Lines

Scientific Name	Common Name	Status		County ^(c)	Habitat ^(d)
		Federal ^(a)	State ^{(a),(b)}		
<p>⁽¹⁾ E = Endangered; T = Threatened; C = Candidate; - = Not Listed. Source of listing status: FWS 2009c, NJDEP 2008c, and DNREC 2009.</p> <p>^(b) State status shown is for the counties shown. All are for New Jersey except where a Delaware status (DE:) is shown for New Castle County. <u>New Jersey</u>: State status for birds separated by a slash (/) indicates a dual status. First status refers to the breeding population in the state, and the second status refers to the migratory or winter population in the state. S = Stable species (a species whose population is not undergoing any long-term increase/decrease within its natural cycle); U = Undetermined (a species about which there is not enough information available to determine the status). SC = Species Concern (a species showing evidence of decline, may become threatened) (NJDEP 2008c). <u>Delaware</u>: Delaware does not maintain T&E species lists by county. Upon request, Delaware provided PSEG the locations of species of greatest conservation need that occur within 0.5 mi (0.8 km) of the transmission corridor in New Castle County (DNREC 2009). State Rank S1- extremely rare in the state (typically 5 or fewer occurrences); S2- very rare within the state (6 to 20 occurrences); S3-rare to uncommon in Delaware; B - Breeding; N - Nonbreeding (DNREC 2009).</p> <p>^(c) Camden, Gloucester, and Salem Counties are in New Jersey; New Castle County is in Delaware. Source of county occurrence data: FWS 2009c, NJDEP 2008c, and DNREC 2009.</p> <p>^(d) <u>Habitat Information Sources:</u></p> <ol style="list-style-type: none"> 1 NJDEP 2004b 2 FWS 2008a. 3 eFloras.org. 2003. 4 Utah State University 2010. 5 USDA 2006. 6 University of Texas at Austin 2010. 7 New England Wild Flower Society 2003. 8 NYNHP 2010. 9 USDA 2010. 10 neartica.com 2010. 11 Missouriplants.com 2010. 12 Michigan Natural Features Inventory 2010. 13 University of Wisconsin 2010. 14 Missouri Botanical Gardens 2010. 15 Alabamaplants.com 2010. 16 NatureServe. 2009. 17 Center for Plant Conservation (CPC) 2010. Calflora 2010. 18 University of Washington Burke Museum of Natural History and Culture 2006. 19 Ohio Department of Natural Resources 1983. 20 Pennsylvania Natural Heritage Program 2007. 21 Massachusetts Division of Fisheries and Wildlife 2009. 22 Georgia Department of Natural Resources 2008. 23 USDA 1999. 24 University of Georgia 2010. 					

Table 2-9. Threatened and Endangered Terrestrial and Freshwater Aquatic Species Recorded in Salem County and Counties Crossed by Transmission Lines

Scientific Name	Common Name	Status		County ^(c)	Habitat ^(d)
		Federal ^(a)	State ^{(a),(b)}		

²⁵ South Carolina Department of Natural Resources 2010.

²⁶ Hilty 2010.

²⁷ Wernert 1998..

1 1997 under the ESA (16 USC 1531 *et seq.*). The southern population was listed as threatened
2 due to its similarity of appearance to the northern population. The southern population occurs
3 mainly in the Appalachian Mountains from southern Virginia through the Carolinas to northern
4 Georgia and eastern Tennessee. The bog turtle was Federally listed due to declines in
5 abundance caused by loss, fragmentation, and degradation of early successional wet-meadow
6 habitat, and by collection for the wildlife trade (FWS 2001). The northern population was listed
7 as endangered by the state of New Jersey in 1974 (NJDFW 2010b). In New Jersey, bog turtles
8 are mainly restricted to rural areas of the State, including Salem, Sussex, Warren, and
9 Hunterdon Counties. Nevertheless, New Jersey is home to one of the largest strongholds in the
10 bog turtle's range, and as of 2003, there were over 200 individual wetlands that supported this
11 species (NJDFW 2010c).

12 The bog turtle is one of the smallest turtles in North America. Its upper shell is 3 to 4-inches
13 (7.6 to 10.2 cm) long and light brown to black in color, and each side of its black head has a
14 distinctive patch of color that is red, orange, or yellow. Its life span is generally 20 to 30 years,
15 but may be 40 years or longer. In New Jersey, the bog turtle usually is active from April through
16 October (mating occurs mostly between May and June) and hibernates the remainder of the
17 year, often within the ground water-washed root systems of woody plants (FWS 2004, NJDFW
18 2010c). Hibernation usually occurs in more densely vegetated areas in the interfaces between
19 open areas and wooded swamps with small trees and shrubs such as alder, gray birch, red
20 maple, and tamarack. After mating, the female turtle typically digs a hole in which to deposit
21 her eggs, though in some areas, eggs are laid on top of the ground in sedge tussocks. Clutches
22 vary from one to five eggs, and hatchlings usually emerge in September, but there is evidence
23 that the eggs also can overwinter and hatch the next spring (FWS 2001).

24 The bog turtle is diurnal and semi-aquatic, and forages on land and in water for its varied diet of
25 plants (seeds, berries, duckweed), animals (insect larvae, snails, beetles), and carrion. The
26 most abundant and preferred food source found in their habitat is the common slug (FWS 2001,
27 FWS 2004, NJDFW 2004). Northern bog turtles primarily inhabit wetlands fed by groundwater
28 or associated with the headwaters of streams and dominated by emergent vegetation. These
29 habitats typically have shallow, cool water that flows slowly and vegetation that is early
30 successional, with open canopies and wet meadows of sedges (*Carex* spp.). Other herbs
31 commonly present include spike rushes (*Eleocharis* spp.) and bulrushes (*Juncus* spp. and
32 *Scirpus* spp.) (FWS 2001). Bog turtle habitats in New Jersey are typically characterized by
33 native communities of low-lying grasses, sedges, mosses, and rushes; however, many of these
34 areas are in need of restoration and management due to the encroachment of woody species
35 and invasive species such as common reed (*Phragmites australis*), cattail (*Typha* spp.), and
36 Japanese stiltgrass (*Microstegium vimineum*) (NJDFW 2010d). Later successional species may
37 discourage bog turtle occupation as they shade the basking areas in a habitat. Livestock
38 grazing maintains the early successional stage, providing favorable conditions for bog turtles
39 (NJDFW 2010b).

40 Bog turtles once existed in 18 counties in New Jersey but are now known from only 13 (FWS
41 2001). There were 168 known bog turtle populations in New Jersey in 2001, and 28 of these
42 were considered metapopulations, which are defined as two or more bog turtle colonies that are
43 connected by a complex of wetlands or other suitable habitat. These populations are extremely
44 important as they can provide pathways for the recovery of the species through dispersal, gene
45 flow, and colonization of adjacent habitats. Current conservation efforts in New Jersey include
46 developing positive relationships with private landowners, acquiring sites threatened by adjacent

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1 land uses, habitat management practices protective of the turtles, and community outreach
2 (NJDFW 2010c).

3 Swamp Pink

4 Swamp pink historically occurred between New York State and the southern Appalachian
5 Mountains of Georgia. It currently is found in Georgia, North Carolina, South Carolina,
6 Delaware, Maryland, New Jersey, New York, and Virginia, but the largest concentrations are
7 found in New Jersey (CPC 2010b). Swamp pink was federally listed as a threatened species in
8 1988 due to population declines and threats to its habitat (FWS 1991). It was also listed as
9 endangered by the State of New Jersey in 1991 and currently is also designated as endangered
10 in Delaware and six other states (Center for Plant Conservation 2010). New Jersey contains 70
11 percent of the known populations of swamp pink, most of which are on private lands. Swamp
12 pink continues to be threatened by direct loss of habitat to development, and by development
13 adjacent to populations, which can interfere with hydrology and reduce water quality (FWS
14 2010c).

15 Swamp pink is a member of the lily family and has smooth evergreen leaves that are shiny
16 when young and can turn purplish when older. The flower stem is 1 to 3 ft (30 to 91 cm) tall and
17 has small leaves along it. Swamp pink flowers in April and May. The flowers are clustered (30
18 to 50 flowers) at the top of the stalk and are pink with blue anthers (FWS 2010c). Fruits are
19 trilobed and heart shaped, with many ovules. Seeds are linear shaped with fatty appendages
20 that are presumably eaten by potential distributors, or aid with flotation for water-based
21 dispersal (Center for Plant Conservation 2010, FWS 1991). Seeds are released by June (FWS
22 2010c, Center for Plant Conservation 2010). Swamp pink is not very successful at dispersing
23 through seeds, however, and rhizomes are the main source of new plants. During the winter,
24 the leaves of the plant lie flat on the ground, often covered by leaf litter, and the next year's
25 flower is visible as a bud in the center of the leaf rosette (FWS 1991). Swamp pink exhibits a
26 highly clumped distribution where it is found, possibly due to the short distance over which its
27 seeds are dispersed because of their weight or to the prevalence of non-sexual propagation.
28 Populations could also be considered colonies due to the rhizomatous connections, possibly
29 allowing physiological cooperation within a colony. Populations can vary from a few individuals
30 to several thousand plants (FWS 1991).

31 Swamp pink is a wetland plant that is thought to be limited to shady areas. It needs soil that is
32 saturated but not persistently flooded. It usually grows on hummocks in wetlands, which keep
33 the roots moist but not submerged. Specific habitats include Atlantic white-cedar swamps,
34 swampy forested wetlands that border small streams, meadows, and spring seepage areas. It
35 is most commonly found with other wetland plants such as Atlantic white cedar (*Chamaecypa*
36 *tisthyoides*), red maple (*Acer rubrum*), sweet pepperbush (*Clethra alnifolia*), sweetbay magnolia
37 (*Magnolia virginiana*), sphagnum moss (*Sphagnum* spp.), cinnamon fern (*Osmunda*
38 *cinnamomea*), skunk cabbage (*Symplocarpus foetidus*), pitch pine (*Pinus rigida*), American
39 larch (*Larix laricina*), black spruce (*Picea mariana*), and laurel (*Kalmia* spp.). The overstory
40 plants can also provide some protection from grazing by deer (FWS 2010c, Center for Plant
41 Conservation 2010).

42 As of 1991, when a recovery plan for swamp pink was completed, New Jersey supported over
43 half the known populations of the species, with 139 records and 71 confirmed occurrences. It
44 was considered locally abundant in Camden County, with most of the occurrences on the
45 coastal plain in pinelands fringe areas in the Delaware River drainage. Fifteen sites were
46 confirmed in Delaware, also in the coastal plain province in the counties of New Castle, Kent,

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1 and Sussex (FWS 1991). A five year review was completed in 2008 to assess progress on the
2 recovery plan. Due to field investigations, there are now 227 known occurrences of swamp
3 pink; however, several prior populations are now considered historic and many of the new and
4 previously existing populations are now ranked poorly and many are in decline. New Jersey
5 completed several preserve designs or conservation plans to conserve 21 existing populations
6 between 1991 and 2001. In addition, 11 agreements with landowners have been reached
7 between FWS and individuals in New Jersey, though these agreements do not provide
8 permanent protection (FWS 2008b).

9 As of 2008, Salem County had 20 confirmed occurrences of swamp pink, Gloucester County
10 had 13, and Camden County had 28. There is one recognized occurrence of swamp pink in
11 New Castle County, Delaware. Delaware does not have any regulations specifically for
12 threatened or endangered plant species (FWS 2008b).

13 **2.2.8 Socioeconomic Factors**

14 This section describes current socioeconomic factors that have the potential to be directly or
15 indirectly affected by changes in operations at Salem and at HCGS. Salem and HCGS and the
16 communities that support them can be described as dynamic socioeconomic systems. The
17 communities provide the people, goods, and services required to operate Salem and HCGS.
18 Salem and HCGS operations, in turn, create the demand and pay for the people, goods, and
19 services in the form of wages, salaries, and benefits for jobs and dollar expenditures for goods
20 and services. The measure of the communities' ability to support the demands of Salem and of
21 HCGS depends on their ability to respond to changing environmental, social, economic, and
22 demographic conditions.

23 The socioeconomic region of influence (ROI) for Salem is defined as the areas in which Salem
24 employees and their families reside, spend their income, and use their benefits, thereby
25 affecting the economic conditions of the region. The Salem and HCGS ROI consists of a four-
26 county region where approximately 85 percent of Salem and 82 percent of HCGS employees
27 reside: Salem, Gloucester, and Cumberland Counties in New Jersey and New Castle County in
28 Delaware. The ROI for HCGS is defined as the areas in which HCGS employees and their
29 families reside. The HCGS ROI consists of the same four county region, where 82 percent of
30 HCGS employees reside. Salem and HCGS staff include shared corporate and matrixed
31 employees, 79 percent of whom reside in the four county region. The following sections
32 describe the housing, public services, offsite land use, visual aesthetics and noise, population
33 demography, and the economy in the ROI for Salem and HCGS.

34 Salem employs a permanent workforce of approximately 644 employees and the HCGS
35 permanent workforce includes approximately 521 employees (PSEG 2010c). Salem and HCGS
36 share an additional 340 PSEG corporate and 109 matrixed employees. Approximately 85
37 percent of the Salem workforce, 82 percent of the HCGS workforce, and 79 percent of the
38 PSEG corporate and matrixed employees live in Salem, Gloucester, and Cumberland Counties,
39 New Jersey, and New Castle County, Delaware (Table 2-10). The remaining 15 percent of the
40 Salem workforce are divided among 14 counties in New Jersey, Pennsylvania, and Maryland,
41 as well as one county in Georgia, with numbers ranging from 1 to 42 employees per county.
42 The remaining 18 percent of the HCGS workforce are divided among 16 counties in New
43 Jersey, Pennsylvania, and Maryland, as well as one county in each of three states (Delaware,
44 New York, and Washington), with numbers ranging from 1 to 38 employees per county. The
45 remaining 21 percent of the corporate and matrixed employees reside in 13 counties in New
46 Jersey, Pennsylvania, and Maryland, as well as one county in Delaware, one county in North

1 Carolina, and the District of Columbia. Given the residential locations of Salem and HCGS
 2 employees, the most significant impacts of plant operations are likely to occur in Salem,
 3 Gloucester, and Cumberland Counties in New Jersey and New Castle County in Delaware.
 4 Therefore, the socioeconomic impact analysis in this draft SEIS focuses on the impacts of
 5 Salem and HCGS on these four counties.

6 **Table 2-10. Salem and HCGS Employee Residence by County**

County	Number of Salem Employees	Number of HCGS Employees	Number of Corporate and Matrixed Employees	Total Number of Employees	Percent of Total Workforce
Salem , NJ	253	198	189	640	39.7
Gloucester, NJ	100	74	68	242	15.0
Cumberland, NJ	73	51	35	159	9.8
New Castle, DE	123	106	64	293	18.2
Other	95	92	93	280	17.3
Total	644	521	449	1,614	100

Source: PSEG 2010c.

7
 8 Refueling outages at Salem and HCGS generally occur at 18-month intervals for both stations.
 9 During refueling outages, site employment increases by as many as 600 workers at each station
 10 for approximately 23 days at Salem and as many as 600 workers for approximately 23 days at
 11 HCGS (PSEG 2009a, PSEG 2009b). Most of these workers are assumed to be located in the
 12 same geographic areas as the permanent Salem and HCGS Staff.

13 **2.2.8.1 Housing**

14 Table 2-11 lists the total number of occupied and vacant housing units, vacancy rates, and
 15 median value in the four-county ROI. According to the 2000 census, there were nearly 373,600
 16 housing units in the ROI, of which approximately 353,000 were occupied. The median value of
 17 owner-occupied units ranged from \$91,200 in Cumberland County to \$136,000 in New Castle
 18 County. The vacancy rate was highest in Salem County (7.1 percent) and Cumberland County
 19 (7.0 percent) and lower in New Castle County (5.3 percent) and Gloucester County (4.6
 20 percent).

21 By 2008, the total number of housing units within the four-county ROI had grown by
 22 approximately 28,000 units to 401,673 housing units, while the total number of occupied units
 23 grew by 17,832 units to 370,922. The median house value increased approximately \$101,600
 24 between the 2000 census and the three-year estimation period (2006 through 2008). As a
 25 result, the vacancy rate increased from 6 percent to 8 percent of total housing units.

26

1 **Table 2-11. Housing in Cumberland, Gloucester, and Salem Counties, New Jersey, and**
 2 **New Castle County, Delaware**

	Cumberland	Gloucester	Salem	New Castle	Region of Influence
2000					
Total Housing Units	52,863	95,054	26,158	199,521	373,596
Occupied Housing Units	49,143	90,717	24,295	188,935	353,090
Vacant units	3,720	4,337	1,863	10,586	20,506
Vacancy rate (percent)	7	4.6	7.1	5.3	5.5
Median value (dollars)	91,200	120,100	105,200	136,000	113,125
2008^(a)					
Total Housing Units	55,261	106,641	27,463	212,308	401,673
Occupied Housing Units	50,648	100,743	24,939	194,592	370,922
Vacant units	4,613	5,898	2,524	17,716	30,751
Vacancy rate (percent)	8.3	5.5	9.2	8.3	7.7
Median value (dollars)	171,600	238,200	197,100	252,000	214,725

^(a) Housing values for the 2008 estimates are based on 2006-2008 American Community Survey 3-Year Estimates, U.S. Census Bureau.
 Sources: USCB 2000a; USCB 2009.

3

4 **2.2.8.2 Public Services**

5 This section presents a discussion of public services including water, education, and
 6 transportation.

7 Water Supply

8 Approximately 85 percent of Salem employees, 82 percent of HCGS employees, and 79
 9 percent of shared PSEG corporate and matrixed employees reside in Salem, Gloucester, and
 10 Cumberland Counties, New Jersey, and New Castle County, Delaware (PSEG 2010c).
 11 Information for the major municipal water suppliers in the three New Jersey counties, including
 12 firm capacity and peak demand, is presented in Table 2-12. Population served and water
 13 source for each system is also provided. The primary source of potable water in Cumberland
 14 County is groundwater withdrawn from the Cohansey-Maurice watershed. In Gloucester
 15 County, the water is primarily groundwater obtained from the Lower Delaware watershed. The
 16 major suppliers in Salem County obtain their drinking water supply from surface water or
 17 groundwater from the Delaware Bay watershed.

18 Information for the major municipal water suppliers in New Castle County, Delaware, is provided
 19 in Table 2-13, including maximum capacity and average daily production as well as population
 20 served and water source for each system. The majority of the potable water supply is surface
 21 water withdrawn from the Brandywine-Christina watershed.

22

1
2**Table 2-12. Major Public Water Supply Systems in Cumberland, Gloucester, and Salem Counties, New Jersey**

Water System	Population Served	Primary Water Source	Peak Daily Demand ^(a) (mgd)	Total Capacity (mgd)
Cumberland County				
City of Bridgeton	22,770	GW	4.05	3.35
City of Millville	27,500	GW	5.71	7.83
City of Vineland	33,000	GW	15.26	16.49
Gloucester County				
Borough of Clayton	7,155	GW	1.09	1.22
Deptford Township	26,000	SW (Purchased)	4.79	8.80
Borough of Glassboro	19,238	GW	4.29	6.31
Mantua Township	11,713	SW (Purchased)	2.19	2.74
Monroe Township	26,145	GW	6.22	7.15
Borough of Paulsboro	6,200	GW	1.25	1.80
Borough of Pitman	9,445	GW	0.96	1.59
Washington Township	48,000	GW	8.25	12.92
West Deptford Township	20,000	GW	4.26	7.03
Borough of Westville	6,000	GW	0.70	1.73
City of Woodbury	11,000	SW (Purchased)	1.76	4.32
Salem County				
Pennsville Township	13,500	GW	1.63	1.87
City of Salem	6,199	SW	1.66	4.27

Mgd = million gallons per day; GW = groundwater; SW = surface water.
(a) Current peak yearly demand plus committed peak yearly demand.
Sources: EPA 2010e (population served and primary water source); NJDEP 2009d (peak annual demand and available capacity).

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1
2

Table 2-13. Major Public Water Supply Systems in New Castle County, Delaware

Water System	Population Served	Primary Water Source	Average Daily Production (mgd)	Maximum Capacity (mgd)
City of Middletown	16,000	GW	NA	NA
City of New Castle	6,000	GW	0.5	1.3
City of Newark	36,130	SW	4	6
City of Wilmington	140,000	SW	29	61

GW = groundwater; SW = surface water; NA = not available.
Sources: EPA 2010c (population served and primary water source); PSEG 2009a, PSEG 2009b (reported production and maximum capacity).

3

4 Education

5 Salem and HCGS are located in Lower Alloways Creek School District, which had an enrollment
6 of approximately 223 students in pre-Kindergarten through 8th grade for the 2008-2009 school
7 year. Salem County has 15 public school districts, with a total enrollment of 12,012 students.
8 Cumberland County has a total of 15 school districts with 26,739 students enrolled in public
9 schools in the county in 2008-2009. Gloucester County has 28 public school districts with a
10 total 2008-2009 enrollment of 49,782 students (New Jersey Department of Education [NJDOE]
11 2010). There are five public school districts in New Castle County, Delaware; total enrollment in
12 the 2009-2010 school year is 66,679 students (Delaware Department of Education [DDE] 2010).

13 Transportation

14 Figures 2.1-1 and 2.1-2 show the Salem and HCGS location and highways within a 50-mile
15 radius and a 6-mile radius of the facilities. At the larger regional scale, the major highways
16 serving Salem and HCGS are Interstate 295 and the New Jersey Turnpike, located
17 approximately 15 miles north of the facilities. Interstate 295 crosses the Delaware River via the
18 Delaware Memorial Bridge, providing access to Delaware and, via Interstate 95, to
19 Pennsylvania.

20 Local road access to Salem and HCGS is from the northeast via Alloway Creek Neck Road, a
21 two-lane road which leads directly to the facility access road. Alloway Creek Neck Road
22 intersects County Route (CR) 658 approximately 4 miles northeast of Salem and HCGS. CR
23 658 leads northward to the City of Salem, where it intersects New Jersey State Route 49, which
24 is the major north-south route through western Salem County and connects local traffic to the
25 Delaware Memorial Bridge to the north. Approximately 1 mile east of its intersection with
26 Alloway Creek Neck Road, CR 658 intersects with CR 623 (a north-south road) and CR 667 (an
27 east-west road). Employees who live to the north, northeast, and northwest of Salem and

1 HCGS, as well as those from Delaware and Pennsylvania, could travel south on State Route 49,
 2 connecting to CR 658 and from there to Alloway Creek Neck Road to reach the facilities.
 3 Employees from the south could travel north on CR 623, connecting to Alloway Creek Neck
 4 Road via CR 658. Employees living farther south or to the southeast could use State Route 49,
 5 connecting to Alloway Creek Neck Road via CR 667, and CR 658 or CR 623 (PSEG 2009a,
 6 PSEG 2009b).

7 Traffic volumes in Salem County are highest on roadways in the northern and eastern parts of
 8 the county, where all of the annual average daily traffic counts greater than 10,000 were
 9 measured. The highest annual average daily traffic count in the county is 27,301 on Interstate
 10 295 in the northeastern corner of the county. In western Salem County, in the vicinity of Salem
 11 and HCGS, annual average daily traffic counts range from 236 to 1052, while within the City of
 12 Salem they range from 4218 to 9003. At the traffic count location closest to Salem and HCGS,
 13 located on CR 623, the annual average daily traffic count is 895 (New Jersey Department of
 14 Transportation [NJDOT] 2009). Level of service data, which describe operational conditions on
 15 a roadway and their perception by motorists, are not collected by New Jersey (PSEG 2009a,
 16 PSEG 2009b).

17 **2.2.8.3 Offsite Land Use**

18 This section describes offsite land use in the four-county region of influence (ROI), including
 19 Salem, Gloucester, and Cumberland Counties, New Jersey, and New Castle County, Delaware,
 20 which is where the majority of Salem and HCGS employees reside. Salem and HCGS are
 21 located in western Salem County adjacent to the Delaware River, which is the border between
 22 New Jersey and Delaware.

23 Salem County, New Jersey

24 Salem County is rural in nature, consisting of more than 338 square miles of land with an
 25 estimated 66,141 residents, a 2.9 percent increase since 2000 (USCB 2009). Only 13 percent of
 26 the land area in the county is considered urban (in residential, commercial, or industrial use),
 27 with development concentrated in western Salem County along the Delaware River. The
 28 remaining 87 percent of the county is dedicated farmland under active cultivation (42 percent) or
 29 undeveloped natural areas, primarily tidal and freshwater wetlands (30 percent) and forests (12
 30 percent) (Morris Land Conservancy 2008). There are 199 farms for a total of 26,191 acres, or
 31 12 percent of the county, which have been preserved in Salem County under the New Jersey
 32 Farmland Preservation Program (State Agricultural Development Committee [SADC] 2009).

33 Two municipalities within Salem County, Lower Alloways Creek Township and the City of
 34 Salem, receive annual real estate tax payments from Salem and from HCGS. Over half of the
 35 land area in Lower Alloways Creek Township is wetlands (65 percent), 15 percent is used for
 36 agriculture, and 8 percent is urban. The City of Salem is largely urban (49 percent), with 24
 37 percent of its area wetlands and 12 percent in agricultural use (Morris Land Conservancy 2006).

38 Land use within Salem County is guided by the *Smart Growth Plan* (Rukenstein & Associates
 39 2004), which has the goal of concentrating development within a corridor along the Delaware
 40 River and I-295/New Jersey Turnpike in the northwestern part of the county and encouraging
 41 agriculture and the preservation of open space in the central and eastern parts of the county.
 42 Land development is regulated by the municipalities within Salem County through the use of
 43 zoning and other ordinances.

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1 Lower Alloways Creek Township has a master plan to guide development, which includes a
2 land use plan (Lower Alloways Creek Township 1992). The plan encourages development in
3 those areas of the township most capable of providing necessary services, continuation of
4 agricultural use, and restriction on development in the conservation district (primarily wetlands).
5 The land use plan includes an industrial district adjacent to Artificial Island. The master plan
6 was updated in the *2005 Master Plan Reexamination Report* (Alaimo Group 2005), which
7 looked at key issues and reaffirmed the importance of preserving farmland, open space, and
8 environmental resources.

9 Cumberland County, New Jersey

10 Cumberland County, which is located to the south and east of Salem County, occupies about
11 489 square miles of land along Delaware Bay at the south end of New Jersey. In 2008, the
12 county had an estimated population of 156,830 residents, which is a 7.1 percent increase since
13 2000 (USCB 2009). Over 60 percent of the land area in the county is forest (32 percent) or
14 wetlands (30 percent). Approximately 19 percent is occupied by agriculture, mostly
15 concentrated in the northwestern part of the county near Salem County. Only 12 percent of
16 Cumberland County is considered urban (Delaware Valley Regional Planning Commission
17 [DVRPC] 2009). Under the New Jersey Farmland Preservation Program, 117 farms, including a
18 total of 14,569 acres of farmland, have been preserved in Cumberland County (SADC 2009).

19 Cumberland County has assembled a series of planning initiatives that together provide a
20 strategic plan for the future of the county (Ortho-Rodgers 2002). A recently completed
21 *Farmland Preservation Plan* for the county seeks to maintain its productive farmland in active
22 use. The *Western/Southern Cumberland Region Strategic Plan* (issued as a draft in 2005)
23 identifies 32 existing community centers in the county for concentration of future residential and
24 commercial growth, and the county Master Plan, prepared in 1967, is in the process of being
25 updated. The municipalities within Cumberland County regulate land development through
26 zoning and other ordinances (DVRPC 2009).

27 Gloucester County, New Jersey

28 Gloucester County is located northeast of Salem County. Gloucester County has approximately
29 325 square miles of land and in 2008 had an estimated population of 287,860 residents, which
30 represents a 12.6 percent increase since 2000 (USCB 2009). It is the fastest growing county in
31 New Jersey and has the fastest growing municipality (Woolwich Township) on the East Coast
32 (Gloucester County 2010). Major land uses in the county are urban (26 percent) and agriculture
33 (26 percent), with 30 percent of the county land area vacant and 10 percent wetlands
34 (Gloucester County 2009). There are 113 farms with a total of 9,527 acres (4 percent of the
35 county land area) that have been preserved in Gloucester County under the New Jersey
36 Farmland Preservation Program (SADC 2009).

37 The County *Development Management Plan* and its various elements provide guidance for land
38 use planning in Gloucester County. It encourages a growth pattern that will concentrate
39 development rather than disperse it, enhancing existing urban areas and preserving natural
40 resources. The Gloucester County *Northeast Region Strategic Plan* goals include taking
41 advantage of infill opportunities to avoid sprawl into undeveloped areas and creating compact
42 development that allows preservation of farms and open spaces. Land development is
43 regulated by the municipalities within Gloucester County through zoning and other ordinances
44 (Gloucester County Planning Division [GCPD] 2005).

45

1 New Castle County, Delaware

2 New Castle County, the northernmost county in the state of Delaware, is located east of Salem
3 County across the Delaware River. The county encompasses slightly more than 426 square
4 miles and has an estimated resident population of 529,641, which is a 5.9 percent increase from
5 2000 to 2008. It is the most populous of the three counties in Delaware (USCB 2009). The
6 three major land uses in New Castle County are agriculture (29 percent), residential (28
7 percent), and forests (15 percent) (New Castle County 2007). In 2007, the county had a total of
8 347 farms (less than 14 percent of all farms in the state) located on approximately 67,000 acres
9 of land. This reflects a decrease of 6 percent in land used for farming compared to 2000 (USDA
10 2007).

11 The New Castle County *Comprehensive Development Plan* addresses county policies with
12 regard to zoning, density, and open space preservation. It seeks to concentrate new growth as
13 well as redevelopment in established communities in order to preserve limited resources. This
14 is accomplished through use of a future land use map. The plan proposes policies to
15 encourage development in the northern part of the county with growth in the southern portion
16 more centralized and compact (New Castle County 2007).

17 **2.2.8.4 Visual Aesthetics and Noise**

18 Salem and HCGS are bordered by the Delaware River to the west and south and by a large
19 expanse of wildlife management areas on the north, east and southeast. The access road runs
20 east to west along the shoreline of Artificial Island then continues east through the wetlands.
21 The immediate area is flat in relief, consisting of open water and large expanses of tidal and
22 freshwater marsh. Across the bay, in Delaware, the shoreline consists of state parks and
23 wildlife areas with low profile marshy habitats and very few structures to interrupt the view.
24 Beyond the parks and wetland areas are farmlands and then small to medium sized towns, in
25 both Delaware and New Jersey.

26 The main vertical components of the Salem and HCGS building complex are the HCGS natural
27 draft cooling tower (514-ft [157-m] tall), the most prominent feature on Artificial Island, and the
28 three domed reactor containment buildings (190 to 200-ft [57.9 to 60.9-m] tall). The structures
29 are most visible from the Delaware River. Portions of the Salem and HCGS building complex
30 can be seen from many miles away, in particular the cooling tower and the plume it produces.
31 The complex can easily be seen from the marsh areas and the river itself, while in the more
32 populated areas it is often blocked by trees or houses, and can only be seen from certain
33 angles. The structures within the Salem and HCGS building complex are for the most part
34 made of concrete and metal, with exposed non-concrete buildings and equipment painted light,
35 generally neutral colors such as brown and blue (AEC 1973, PSEG 1983). The overhead
36 transmission lines leading away to the north, northeast and east can also be seen from many
37 directions as they cross over the low profile expanses of the marshes. Farther inland, portions
38 of the transmission lines are visible especially as they pass over roads and highways.

39 Sources of noise at Salem and HCGS include the cooling tower, transformers, turbines, circuit
40 breakers, transmission lines and intermittent industrial noise from activities at the facilities.
41 Noise studies were conducted prior to the operation of the Salem generating units. The
42 transformers were each estimated to produce between 82 and 85 adjusted decibels (dBA) at 6 ft
43 away and the turbines were each estimated to produce 95 dBA at 3 ft away. The combined
44 noise from all sources was estimated at 36 dBA at the site boundary. The noise from the plant
45 at the nearest residence, approximately 3.5 miles mi from the Salem and HCGS facilities, was

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1 estimated to be approximately 27dBA. The U. S. Department of Housing and Urban
2 Development (HUD) criterion guidelines for non-aircraft noise define 45 dBA as the maximum
3 noise level for the "clearly acceptable" range. Therefore, noise from the Salem generating units
4 was considered acceptable to nearby receptors (AEC 1974). Additional pre-operational studies
5 were conducted for HCGS. An ambient noise survey, within a radius of 5 mi, established that
6 most of the existing sound levels were within New Jersey's limits for industrial operations, as
7 measured at residential property boundaries. The exceptions were sound levels measured at
8 five locations in unpopulated areas near the facility, presumably reflecting construction activities
9 at HCGS and vehicular traffic on the facility access road. Additional noise sources from aircraft
10 could also have contributed to these high readings (PSEG 1983).

11 Given the industrial nature of these two stations, noise emissions are generally nothing more
12 than an intermittent minor nuisance. However, noise levels may sometimes exceed the 55 dBA
13 level that the U.S. Environmental Protection Agency (EPA) uses as a threshold level to protect
14 against excess noise during outdoor activities (EPA 1974). However, according to the EPA this
15 threshold does "not constitute a standard, specification, or regulation," but was intended to
16 provide a basis for state and local governments establishing noise standards. To date, no noise
17 complaints associated with operations at Salem and HCGS have been reported from
18 neighboring communities.

19 2.2.8.5 Demography

20 According to the 2000 Census, approximately 501,820 people lived within a 20-mi (32-km)
21 radius of Salem and HCGS, which equates to a population density of 450 persons per square
22 mile (mi²). This density translates to a Category 4 (greater than or equal to 120 persons per mi²
23 within 20 miles) using the generic environmental impact statement (GEIS) measure of
24 sparseness. Approximately 5,201,842 people live within 50 mi (80 km) of Salem and HCGS, for
25 a density of 771 persons per mi² (PSEG 2009a, PSEG 2009b). Applying the GEIS proximity
26 measures, this density is classified as Category 4 (greater than or equal to 190 persons per mi²
27 within 50 miles [80 km]). Therefore, according to the sparseness and proximity matrix presented
28 in the GEIS, a Category 4 value for sparseness and for proximity indicate that Salem and HCGS
29 are located in a high population area.

30 Table 2-14 shows population projections and growth rates from 1970 to 2035 in Cumberland,
31 Gloucester, and Salem Counties, New Jersey, and New Castle County, Delaware. All of the
32 four counties experienced continuous growth during the period 1970 to 2000, except for Salem
33 County, which saw a 1.5 percent decline in population between 1990 and 2000. Gloucester
34 County experienced the greatest rate of growth during this period. Beyond 2000, county
35 populations are expected to continue to grow in the next decades, with Gloucester County
36 projected to experience the highest rate of growth.

1 **Table 2-14. Population and Percent Growth in Cumberland, Gloucester, and Salem**
 2 **Counties, New Jersey, and New Castle County, Delaware from 1970 to 2000 and**
 3 **Projected for 2010 to 2035₀**

Year	Cumberland County		Gloucester County		Salem County		New Castle County	
	Population	Percent Growth ^(a)	Population	Percent Growth ^(a)	Population	Percent Growth ^(a)	Population	Percent Growth ^(a)
1970	121,374	—	172,681	—	60,346	—	385,856	—
1980	132,866	9.5	199,917	15.8	64,676	7.2	398,115	3.2
1990	138,053	3.9	230,082	15.1	65,294	1.0	441,946	11.0
2000	146,438	6.1	254,673	10.7	64,285	-1.5	500,265	13.2
2008	155,388	6.1	284,886	11.9	65,952	2.6	526,414	5.2
2010	157,745	7.7	289,920	13.8	66,342	3.2	535,572	7.1
2020 ^(b)	164,617	4.4	307,688	6.1	69,433	4.7	564,944	5.5
2030 ^(b)	176,784	7.4	338,672	10.1	74,576	7.4	586,387	3.8
2040 ^(c)	185,421	4.9	360,845	6.5	78,351	5.1	613,116	4.6
2050 ^(c)	194,941	5.1	385,221	6.8	82,468	5.3	638,524	4.1

— = Not applicable.

(a) Percent growth rate is calculated over the previous decade.

(b) The 2020 and 2030 population projections for Cumberland, Gloucester, and Salem Counties are for 2018 and 2028, respectively.

(b)(c) Calculated.

Sources: Population data for 1970 through 1990 (USCB 1995a, USCB 1995b); population data for 2000 (USCB 2000d); New Jersey counties estimated population for 2009 (USCB 2010); New Castle County projected population for 2010 to 2040 (Delaware Population Consortium [DPC] 2009); New Jersey counties projected population for 2018 and 2028 (Center for Urban Policy Research [CUPR] 2009).

4 The 2000 demographic profile of the four-county ROI is included in Table 2-15. Persons self-
 5 designated as minority individuals comprise approximately 30 percent of the total population.
 6 This minority population is composed largely of Black or African American residents.

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Table 2-15. Demographic Profile of the Population in the Salem and HCGS Region of Influence in 2000

	Cumberland, NJ	Gloucester, NJ	Salem, NJ	New Castle, DE	Region of Influence
Total Population	146,438	254,673	64,285	500,265	965,661
Race (percent of total population, Not-Hispanic or Latino)					
White	72.158.4	88.085.7	82.879.6	74.670.7	78.673.4
Black or African American	23.719.2	9.18.9	15.014.4	21.019.9	17.716.5
American Indian and Alaska Native	0.79	0.2	0.3	1.70.2	0.3
Asian	1.10.9	1.5	0.6	2.72.6	2.01.9
Native Hawaiian and Other Pacific Islander	0.03	0.02	0.02	0.03	0.03
Some other race	0.1	0.090.1	0.090.1	0.1	0.12
Two or more races	2.01.63	1.1	1.12	1.23	1.23
Ethnicity					
Hispanic or Latino	27,823	6,583	2,498	26,293	63,197
Percent of total population	19.0	2.6	3.9	5.3	6.5
Minority Populations (including Hispanic or Latino ethnicity)					
Total minority population	60,928	36,411	13,114	146,505	256,958
Percent minority	41.6	14.3	20.4	29.3	26.6

Source: USCB 2000d.

Comment [C9]: Should this percentage added to the "Percent minority" in the last row equal 100%?

Comment [JJR10]: Yes. These percentages have been revised to exclude Hispanic or Latino ethnicity from race totals to avoid double counting (see Census 2000, Summary File 1 [SF 1], Table P4, Race, Combinations of Two races, and Not Hispanic or Latino). Minority population is determined by subtracting White, Not-Hispanic or Latino populations from the total population.

Comment [C11]: No. The White population is the Majority. Minority populations should not equal 100%

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According to the U.S. Census Bureau's 2006-2008 American Community Survey 3-Year Estimates, minority populations were estimated to have increased by approximately 61,000 persons and comprised 31.8 percent of the four-county ROI population (see Table 2-16). Most of this increase was due to an estimated influx of Hispanic or Latinos (over 25,000 persons), an increase in population of over 39.8 percent from 2000. The next largest increases in minority populations were Black or African American and Asian populations with increases of approximately 23,000 and 9,700 persons or 14.4 and 53 percent, respectively, from 2000.

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Table 2-16. Demographic Profile of the Population in the Salem and HCGS Region of Influence, 2006-2008 Three-Year Estimate

	<u>Cumberland, NJ</u>	<u>Gloucester, NJ</u>	<u>Salem, NJ</u>	<u>New Castle, DE</u>	<u>Region of Influence</u>
Total Population	155,388	284,886	65,952	526,414	1,032,640
Race (percent of total population, Not-Hispanic or Latino)					
<u>White</u>	53.6	82.8	77.8	65.3	69.2
<u>Black or African American</u>	19.2	9.5	14.8	22.0	17.7
<u>American Indian and Alaska Native</u>	0.8	0.1	0.3	0.2	0.2
<u>Asian</u>	1.1	2.3	0.6	3.7	2.7
<u>Native Hawaiian and Other Pacific Islander</u>	0.01	0.03	0.00	0.02	0.02
<u>Some other race</u>	0.2	0.1	0.3	0.2	0.2
<u>Two or more races</u>	1.6	1.6	0.9	1.4	1.4
Ethnicity					
<u>Hispanic or Latino</u>	36,530	10,409	3,489	37,929	88,357
<u>Percent of total population</u>	23.5	3.7	5.3	7.2	8.6
Minority Populations (including Hispanic or Latino ethnicity)					
<u>Total minority population</u>	72,112	48,927	14,653	182,540	318,232
<u>Percent minority</u>	46.4	17.2	22.2	34.7	30.8

Source: U.S. Census Bureau, 2006-2008 American Community Survey (USCB 2010).

3

4 Transient Population

5 Within 50 mi (80 km) of Salem and HCGS, colleges and recreational opportunities attract daily
6 and seasonal visitors who create demand for temporary housing and services. In 2000 in the
7 four-county ROI, 0.5 percent of all housing units were considered temporary housing for
8 seasonal, recreational, or occasional use. Table 2-176 provides information on seasonal
9 housing for the counties located within the Salem and HCGS ROI (USCB 2000b). In 2008,
10 there were 49,498 students attending colleges and universities located within 50 mi (80 km) of
11 Salem and HCGS (National Center for Educational Statistics [NCES] 2009).

1 | **Table 2-176. Seasonal Housing in the Salem and HCGS Region of Influence in 2000**

County ^a	Number of Housing Units	Vacant Housing Units for Seasonal, Recreational or Occasional Use	Percent
Cumberland	52,863	826	1.6
Gloucester	95,054	274	0.3
Salem	26,158	131	0.5
New Castle	199,521	707	0.4
Region of Influence	373,596	1,938	0.5

Source: USCB 2000c.

2

3 | Migrant Farm Workers

4 Migrant farm workers are individuals whose employment requires travel to harvest agricultural
 5 crops. These workers may or may not have a permanent residence. Some migrant workers
 6 may follow the harvesting of crops, particularly fruit, throughout the northeastern U.S. rural
 7 areas. Others may be permanent residents near Salem and HCGS who travel from farm to
 8 farm harvesting crops.

9 Migrant workers may be members of minority or low-income populations. Because they travel
 10 and can spend a significant amount of time in an area without being actual residents, migrant
 11 workers may be unavailable for counting by census takers. If uncounted, these workers would
 12 be "underrepresented" in USCB minority and low income population counts.

13 The 2007 Census of Agriculture collected information on migrant farm and temporary labor.
 14 Table 2-187 provides information on migrant farm workers and temporary (less than 150 days)
 15 farm labor within 50 mi (80 km) of Salem and HCGS. According to the 2007 Census of
 16 Agriculture, 15,764 farm workers were hired to work for less than 150 days and were employed
 17 on 1,747 farms within 50 mi (80 km) of Salem and HCGS. The county with the largest number
 18 of temporary farm workers (4,979 persons on 118 farms) was Atlantic County, New Jersey
 19 (USDA 2007). Salem County had 804 temporary farm workers on 121 farms; Cumberland
 20 County had 1857 temporary workers on 141 farms, and Gloucester County had 1228 on 110
 21 farms (USDA 2007). New Castle County reported 320 temporary workers on 52 farms.

22 Farm operators were asked whether any hired workers were migrant workers, defined as a farm
 23 worker whose employment required travel that prevented the migrant worker from returning to
 24 their permanent place of residence the same day. A total of 453 farms in the region (within a
 25 50-mi [80 km] radius of Salem and HCGS) reported hiring migrant workers. Chester County,
 26 Pennsylvania, reported the most farms (101) with hired migrant workers. Within the four-county
 27 ROI, a total of 164 farms were reported with hired migrant farm workers including Cumberland
 28 County with 65 farms, followed by Gloucester County with 56 and Salem County with 33. New
 29 Castle County reported a total of 10 farms with hired migrant workers (USDA 2007).

Table 2-187. Migrant Farm Worker and Temporary Farm Labor within 50 mi of Salem and HCGS

County ^(a)	Farm workers working less than 150 days	Farms hiring workers for less than 150 days	Farms reporting migrant farm labor	Farms with hired farm labor
Delaware:				
Kent	728	106	22	169
New Castle	320	52	10	81
County Subtotal	1048	158	32	250
Maryland:				
Caroline	478	121	13	153
Cecil	546	87	5	128
Hartford	266	101	12	155
Kent	245	78	8	111
Queen Anne's	317	89	13	126
County Subtotal	1852	476	51	673
New Jersey:				
Atlantic	4979	118	74	163
Camden	470	43	17	52
Cape May	173	38	8	46
Cumberland	1857	141	65	192
Gloucester	1228	110	56	163
Salem	804	121	33	172
County Subtotal	9511	571	253	788
Pennsylvania:				
Chester	2687	403	101	580
Delaware	106	19	2	25
Montgomery	560	115	14	155
Philadelphia	-	5	-	5
County Subtotal	3353	542	117	765
County Total	15,764	1747	453	2746

^(a) Includes counties with approximately more than half their area within a 50-mi radius of Salem and HCGS.

Source: USDA 2007.

Affected Environment

1 **2.2.8.6 Economy**

2 This section contains a discussion of the economy, including employment and income,
3 unemployment, and taxes.

4 Employment and Income

5 Between 2000 and 2007, the civilian labor force in Salem County decreased 4.4 percent to
6 18,193. During the same time period, the civilian labor force in Gloucester County and
7 Cumberland County grew 18.5 percent and 5.8 percent, respectively, to the 2007 levels of
8 92,154 and 48,468. In New Castle County, Delaware, the civilian labor force increased slightly
9 (0.9 percent) to 284,647 between 2000 and 2007 (USCB 2010a).

10 In 2008, trade, transportation, and utilities represented the largest sector of employment in the
11 three New Jersey counties followed by education and health services in Salem and Gloucester
12 Counties and manufacturing in Cumberland County (New Jersey Department of Labor and
13 Workforce Development [NJDLWD] 2010a, NJDLWD 2010b, NJDLWD 2010c). The trade,
14 transportation, and utilities sector employed the most people in New Castle County, Delaware,
15 in 2008 followed closely by the professional and business services sector (Delaware
16 Department of Labor [DDL] 2009). A list of some of the major employers in Salem County is
17 provided in Table 2-198. The largest employer in the county in 2006 was PSEG with over 1300
18 employees.

19 **Table 2-198. Major Employers in Salem County in 2007**

Firm	Number of Employees
PSEG	1300+ ^(a)
E.I. duPont	1250
Mannington Mills	826
Memorial Hospital of Salem County	600
Atlantic City Electric	426
R.E. Pierson Construction	400+
Anchor Glass	361
McLane NJ	352
Elmer Hospital	350
Wal-Mart	256
Berkowitz Glass	225
Siegfried (USA)	155

Source: Salem County 2007.

^(a) PSEG (2010c) reports that Salem and HCGS employ approximately 1165 employees and share an additional 340 PSEG corporate and 109 matrixed employees, for a total of 1614 employees.

20
21 Income information for the four-county ROI is presented in Table 2-2049. Median household
22 incomes in Gloucester and New Castle Counties were each above their respective state median
23 household income averages, while Salem and Cumberland Counties had median household
24 incomes below the State of New Jersey average. Per capita incomes in Salem, Gloucester, and
25 Cumberland Counties were each below the State of New Jersey average, while the New Castle
26 County per capita income was above the State of Delaware average. In Salem and

1 Cumberland Counties, 9.9 and 15.1 percent of the population, respectively, was living below the
 2 official poverty level, which is greater than the percentage for the State of New Jersey as a
 3 whole (8.7 percent). Only 7.5 percent of the Gloucester County population was living below the
 4 poverty level. In Delaware, 9.9 percent of the New Castle County population was living below
 5 the poverty, while the State average was 10.4 percent. In addition, Cumberland County has the
 6 highest percentage of families living below the poverty level in the ROI.

7 **Table 2-4920. Income Information for the Salem and HCGS Region of Influence, 2008**

	Salem County	Gloucester County	Cumberland County	New Jersey	New Castle County	Delaware
Median Household Income (dollars)	61,204	72,316	49,944	69,674	62,628	57,270
Per capita income (dollars)	27,785	30,893	21,316	34,899	31,400	29,124
Persons below poverty level (percent)	9.9	7.5	15.1	8.7	9.9	10.4
<u>Families below poverty level (percent)</u>	<u>5.9</u>	<u>5.7</u>	<u>12.6</u>	<u>6.3</u>	<u>6.1</u>	<u>7.1</u>

Source: USCB 2008USCB2010.

8

9 Unemployment

10 In 2008, the annual unemployment average in Salem, Gloucester, and Cumberland Counties
 11 was 7.5, 6.4, and 9.6 percent, respectively, all of which were higher than the unemployment
 12 average of 6.0 percent for New Jersey. Conversely, the annual unemployment average of 5.6
 13 for New Castle County was lower than the Delaware average of 6.0 percent (USCB
 14 2008USCB2010).

15 Taxes

16 The owners of Salem and HCGS pay annual property taxes to Lower Alloways Creek Township.
 17 From 2003 through 2009, PSEG and Exelon paid between \$1,191,870 and \$1,511,301 annually
 18 in property taxes to Lower Alloways Creek Township (Table 2-219). During the same time
 19 period, these tax payments represented between 54.2 and 59.3 percent of the township's total
 20 annual property tax revenue. Each year, Lower Alloways Creek Township forwards this tax
 21 money to Salem County, which provides most services to township residents. The property
 22 taxes paid annually for Salem and HCGS during 2003 through 2009 represent approximately
 23 2.5 to 3.5 percent of Salem County's total annual property tax revenues ~~during that time period.~~
 24 As a result of the payment of property taxes for Salem and HCGS to Lower Alloways Creek
 25 Township, residents of the township do not pay local municipal property taxes on residences,
 26 local school taxes, or municipal open space taxes; they pay only Salem County taxes and
 27 county open space taxes (PSEG 2009a, PSEG 2009b).

28 In addition, PSEG and Exelon pay annual property taxes to the City of Salem for the Energy and
 29 Environmental Resource Center, located in Salem. From 2003 through 2009, between
 30 \$177,360 and \$387,353 in annual property taxes for the Center were paid to the city (Table 2-
 31 224).

Table 2-219. Salem and HCGS Property Tax Paid and Percentage of Lower Alloways Creek Township and Salem County Tax Revenues, 2003 to 2009

Year	Property Tax Paid by PSEG and/or Exelon (dollars)			Lower Alloways Creek Township PSEG and/or Exelon Property Tax as Percentage of Total Property Tax Revenue (percent)			Salem County PSEG and/or Exelon Property Tax as Percentage of Total Property Tax Revenue (percent)				
	Salem	HCGS	Total	Total Property Tax Revenue in Township (dollars)	Salem	HCGS	Total	Total Property Tax Revenue in County (dollars)	Salem	HCGS	Total
2003	748,537	464,677	1,213,214	2,099,185	35.7	22.1	57.8	34,697,781	2.2	1.3	3.5
2004	764,379	474,512	1,238,891	2,251,474	34.0	21.1	55.0	36,320,365	2.1	1.3	3.4
2005	783,644	485,624	1,269,268	2,325,378	33.7	20.9	54.6	40,562,971	1.9	1.2	3.1
2006	734,841	457,029	1,191,870	2,195,746	33.5	20.8	54.3	43,382,037	1.7	1.1	2.7
2007	772,543	480,476	1,253,019	2,310,262	33.4	20.8	54.2	46,667,551	1.7	1.0	2.7
2008	745,081	463,397	1,208,478	2,038,467	36.6	22.7	59.3	49,058,072	1.5	0.9	2.5
2009	931,785	579,516	1,511,301	2,644,636	35.2	21.9	57.1	51,636,999	1.8	1.1	2.9

Source: PSEG 2009a, PSEG 2009b, PSEG 2010d.

1 **Table 2-224. Energy and Environmental Resource Center Property Tax Paid and**
 2 **Percentage of City of Salem Tax Revenues, 2003 to 2009**

Year	Property Tax Paid by PSEG and/or Exelon (dollars)	Total Property Tax Revenue in City of Salem (dollars)	PSEG and/or Exelon Property Tax as Percentage of Total Property Tax Revenue in City of Salem (percent)
2003	177,360	5,092,527	3.5
2004	211,755	6,049,675	3.5
2005	220,822	6,294,613	3.5
2006	228,492	6,485,947	3.5
2007	318,910	7,389,319	4.3
2008	184,445	8,423,203	2.2
2009	387,353	8,313,289	4.7

Source: PSEG 2009a, PSEG 2009b, PSEG 2010d.

3
 4 This represented between 2.2 and 4.7 percent of the city's total annual property tax revenue.
 5 Ownership of the Energy and Environmental Resource Center was transferred to PSEG Power
 6 in the fourth quarter of 2008; therefore, Exelon is no longer minority owner of the Center.

7 In 1999, the State of New Jersey deregulated its utility industry (EIA 2008). Any changes to the
 8 tax assessment for Salem or HCGS would already have occurred and are reflected in the tax
 9 payment information provided in Table 2-210. Potential future changes to Salem and HCGS
 10 property tax rates due to deregulation would be independent of license renewal.

11 The continued availability of Salem and HCGS and the associated tax base is an important
 12 feature in the ability of Salem County communities to continue to invest in infrastructure and to
 13 draw industry and new residents.

14 **2.2.9 Historic and Archaeological Resources**

15 This section presents a brief summary of the region's cultural background and a description of
 16 known historic and archaeological resources at the Salem/Hope Creek site and its immediate
 17 vicinity. The information presented was collected from area repositories, the New Jersey State
 18 Historic Preservation Office (SHPO), the New Jersey State Museum (NJSM) and the applicant's
 19 environmental report (PSEG 2009a, PSEG 2009b).

20

Affected Environment

1 2.2.9.1 Cultural Background

2 The prehistory of New Jersey includes four major temporal divisions based on technological
3 advancements, the stylistic evolution of the lithic tool kit, and changes in subsistence strategies
4 related to a changing environment and resource base. These divisions are:

- 5 • The Paleo-Indian period (circa 12,000-10,000 years before present [BP]).
- 6 • The Archaic period (circa 10,000-3,000 years BP).
- 7 • The Woodland period (circa 3,000 BP-1600 AD).
- 8 • The Contact period (circa 1600-1700 AD).

9 These periods are typically broken into shorter time intervals reflecting specific adaptations and
10 stylistic trends and are briefly discussed below.

11 Paleo-Indian Period

12 The Paleo-Indian period began after the Wisconsin glacier retreated from the region
13 approximately 12,000 years ago, and represents the earliest known occupation in New Jersey.
14 The Paleo-Indian peoples were hunter-gatherers whose subsistence strategy may have been
15 dependent upon hunting large game animals over a wide region of tundra-like vegetation that
16 gradually developed into open grasslands with scattered coniferous forests (Kraft 1982). The
17 settlement pattern during this period likely consisted of small, temporary camps (Kraft 1981).

18 Few Paleo-Indian sites have been excavated in the Mid-Atlantic region. Within New Jersey,
19 Paleo-Indian sites, such as the Plenge site excavated in the Musconetcong Valley in
20 northwestern part of the state, have largely been identified in valley and ridge zones (Marshall
21 1982).

22 Archaic Period

23 The Archaic period is marked by changes in subsistence and settlement patterns. While hunting
24 and gathering were still the primary subsistence activities, the emphasis seems to have shifted
25 toward hunting the smaller animals inhabiting the deciduous forests that developed during this
26 time. Based on archaeological evidence, the settlement pattern that helps define the Archaic
27 period consisted of larger, more permanent habitation sites. In addition to game animals, the
28 quantities of plant resources, as well as fish and shellfish remains that have been identified at
29 these sites indicate the Archaic peoples were more efficiently exploiting the natural environment
30 (Kraft 1981).

31 An example of a typical Archaic Period site in southern New Jersey is the Indian Head Site,
32 located about 35 miles Northeast of the Salem/Hope Creek Site. The Indian Head Site is a large
33 multicomponent site with evidence of both Middle and Late Archaic period occupations.

34 Woodland Period

35 The Woodland period marks the introduction of ceramic manufacture, as clay vessels replaced
36 the earlier carved-soapstone vessels. Hunting and gathering subsistence activities persisted,
37 however, the period is notable for the development of horticulture. As horticulture became of

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1 increasing importance to the subsistence economy of the Woodland peoples, settlement
2 patterns were affected. Habitation sites increased in size and permanence, as a larger
3 population size could be sustained due to the more efficient exploitation of the natural
4 environment for subsistence (Kraft 1982).

5 Examples of Woodland period occupations in Southern New Jersey are well documented in the
6 many Riggins Complex sites recorded in the Cohansey Creek and Maurice River Drainages.

7 Contact Period

8 European exploration of the Mid-Atlantic region began in the 16th century, and by the early 17th
9 century maps of the area were being produced (aclink.org). The Dutch ship *Furtoyn* explored
10 the Mullica River in 1614. The Dutch and Swedish were the first to colonize the area, though
11 they were eventually forced to give control of lands to the British in the later part of the 17th
12 century. These settlements mark the beginning of the Contact Period, a time of ever-increasing
13 contact between the Native Americans of the region and the Europeans.

14 The native groups of the southern New Jersey region were part of the widespread Algonquin
15 cultural and linguistic tradition (Kraft 1982). Following initial contact, a pattern of
16 Indian/European trade developed and the Native Americans began to acquire European-made
17 tools, ornaments, and other goods. This pattern is reflected in the archaeological record, as the
18 artifact assemblages from Contact Period sites contain both Native American and European
19 cultural material.

20 At the time of contact, the Lenni Lenape inhabited the Salem/Hope Creek area. The Lenni
21 Lenape, who eventually became known as the Delaware tribe, also occupied lands throughout
22 New Jersey as well as in present-day Pennsylvania and New York (Eaton 1899). The group
23 occupying southern New Jersey spoke the Southern Unami dialects of the Algonquin language
24 (Kraft 2001).

25 Historic Period

26 The first European settlement in the vicinity of the Salem/Hope Creek site occurred in 1638,
27 when a Swedish fort was established along the Delaware River in the present day town of
28 Elsinborough (Barber-1844CSS, 2010). This settlement was short lived, as the location was
29 plagued with mosquitoes and was eventually deemed untenable. Later attempts to settle the
30 area, by Swedish, Finnish, and Dutch groups also met with limited success. In 1675, the
31 Englishman John Fenwick and his group of colonists landed along the Delaware north of the
32 original Swedish settlement at Elsinborough (Brown 2007). They established "Fenwicks Colony"
33 and the town of Salem. In 1790 the population of Salem County was 10,437. By 1880 the
34 county's population had more than doubled in size, reaching 24,579. Today, approximately
35 65,000 people inhabit Salem County (USCB 2010).

36 During the 18th and 19th century the predominant industries in Salem County included
37 commercial fishing, shipping of agricultural products, ship building businesses, glass
38 manufacturing and farming (Discover Salem County [DSC] 2010). In the latter part of the 19th
39 century the DuPont Company established a gunpowder manufacturing plant in Salem County.
40 At its peak, in the early part of the 20th century, the plant employed nearly 25,000 workers. The
41 DuPont facilities continued operation into the late 1970's. In addition to generation of electric
42 power at the Salem and Hope Creek generating stations, furniture and glass manufacturing

Affected Environment

1 have been the predominate industries in Salem County in the latter part of the 20th and the
2 early part of the 21st centuries (Gallo 2010).²

3 **2.2.9.2 Historic and Archaeological Resources at the Salem/Hope Creek Site**

4 Previously Identified Resources

5 The NJSM houses the State's archaeological site files and the New Jersey SHPO houses
6 information on historic resources such as buildings and houses, including available information
7 concerning the National or State Register eligibility status of these resources. The NRC cultural
8 resource team visited the NJSM and collected site files on archaeological sites and information
9 on historic resources located within or nearby the Salem/Hope Creek property. Online sources
10 were used to identify National Register of Historic Places (NRHP) listed properties in Salem
11 County, New Jersey and New Castle County, Delaware (NRHP 2010).

Comment [C12]: Not listed in References section.

12 A review of the NJSM files to identify archaeological resources indicated that no archaeological
13 or historic sites have been recorded on Artificial Island. The nearest recorded prehistoric
14 archaeological site, 35CU99, is located approximately 3.5 miles southeast of the plant site, in
15 Cumberland County. 35CU99 is an Archaic Period archeological site containing stone tools and
16 evidence of stone tool making activity. The closest NRHP listed site is the Joseph Ware House,
17 which is located 6 miles to the Northeast, in Hancock's Bridge. To date, 6 properties within a 10-
18 mile radius of the Salem/Hope Creek site in Salem County, New Jersey have been listed on the
19 NRHP. A total of 17 NRHP listed sites in New Castle County, Delaware fall within a 10-mile
20 radius of Salem/Hope Creek.

21 Potential Archaeological Resources

22 The Salem and Hope Creek generating stations are located on a manmade island in the
23 Delaware River. This would suggest a very low potential for the discovery of previously
24 undocumented prehistoric archaeological sites on the plant property. However, given the age of
25 the artificial island upon which the generating stations were constructed, it is possible that
26 previously undocumented historic-period resources may be present. Further research would be
27 required to determine historic period land use patterns on the island during the 20th century.

28 **2.3 Related Federal Project Activities**

29 The NRC Staff reviewed the possibility that activities of other Federal agencies might impact the
30 renewal of the operating licenses for Salem and HCGS. Any such activity could result in
31 cumulative environmental impacts and the possible need for a Federal agency to become a
32 cooperating agency in the preparation of the Salem and HCGS SEIS.

33 The NRC Staff has determined that there are no Federal projects that would make it desirable
34 for another Federal agency to become a cooperating agency in the preparation of the SEIS.
35 Federal facilities and parks and wildlife areas within 50 mi of Salem and HCGS are listed below.

- 36 • Coast Guard Training Center, Cape May (New Jersey)
- 37 • Dover Air Force Base (Delaware)
- 38 • Aberdeen Test Center (Maryland)

² Personal communication with B. Gallo, Editor of Today's Sunbeam, Salem County, New Jersey. March 9, 2010.

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- 1 • United States Defense Government Supply Center, Philadelphia (Pennsylvania)
- 2 • Federal Correctional Institution, Fairton (New Jersey)
- 3 • Federal Detention Center, Philadelphia (Pennsylvania)
- 4 • New Jersey Coastal Heritage Trail
- 5 • Great Egg Harbor National Scenic and Recreational River (New Jersey)
- 6 • New Jersey Pinelands National Reserve
- 7 • Captain John Smith Chesapeake National Historic Trail (Delaware, Maryland)
- 8 • Chesapeake Bay Gateways Network (Delaware, Maryland)
- 9 • Hopewell Furnace – National Historic Site (Pennsylvania)
- 10 • Cape May National Wildlife Refuge (New Jersey)
- 11 • Supawna Meadows National Wildlife Refuge (New Jersey)
- 12 • Eastern Neck National Wildlife Refuge (Maryland)
- 13 • Bombay Hook National Wildlife Refuge (Delaware)
- 14 • Prime Hook National Wildlife Refuge (Delaware)
- 15 • Independence National Historical Park (Pennsylvania)

16 The USACE is involved in a project that could affect resources in the vicinity of Salem and
17 HCGS. The USACE plans on deepening the Delaware River main navigation channel from
18 Philadelphia to the Atlantic Ocean to a depth of 45 ft. This channel passes close to Artificial
19 Island and the Salem and HCGS effluent discharge area. Studies determined that potential
20 minor changes in hydrology, including salinity, would be possible. Temporary increases in
21 turbidity would be expected during construction (USACE 2009).

22 Although it is not a Federal project, the potential construction of a fourth unit at the Salem and
23 HCGS site would require action by a Federal agency. PSEG intends to submit an early site
24 permit application to the NRC regarding possible construction of a new nuclear power plant unit
25 at the Salem and HCGS site on Artificial Island (PSEG 2010).

26 The NRC is required under Section 102(2)(c) of the National Environmental Policy Act of 1969,
27 as amended (NEPA) to consult with and obtain the comments of any Federal agency that has
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29 NRC consulted with the NMFS and the FWS. Federal agency consultation correspondence and
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Comment [C13]: 16 USC 1801 et seq is cited
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Comment [C15]: Should this be an "NOAA" reference, according to the URL link?

Comment [C16]: These NOAA Tech Memo references are listed two different ways in the references section. These are listed by NOAA; page 2-131 lists them by author for the clearnose skate and little skate.

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