Essential Fish Habitat Assessment

Salem Nuclear Generating Station Units 1 and 2
Hope Creek Generating Station
License Renewal

FEBRUARY 2011

Docket Numbers 50-272, 50-311, and 50-354

U.S. Nuclear Regulatory Commission
Rockville, Maryland

Table of Contents

Figures

Tables

Abbreviations, Acronyms, and Symbols

°C	degrees Celsius
°F	degrees Fahrenheit
ac	acre
cm	centimeter
DRBC	Delaware River Basin Commission
EEP	Estuary Enhancement Program
EFH	Essential Fish Habitat
fps	feet per second
FR	Federal Register
ft	foot
ft^3/s	cubic feet per second
gal.	gallon
gal/yr	gallons per year
ha	hectare
HCGS	Hope Creek Generating Station
hrs	hours
in.	inch
kg	kilogram
km	kilometer
lb	pound
m	meter
m/s	meters per second
m^3/day	cubic meters per day
m^3/s	cubic meters per second
m^3/yr	cubic meters per year
MAFMC	Mid-Atlantic Fishery Management Council
MBTU/hr	million British thermal units per hour
mg/L	milligrams per liter
mgd	million gallons per day
mi	mile
MSA	Magnuson-Stevens Fishery and Conservation Management Act
MSL	mean sea level
NEPA	U.S. National Environmental Policy Act of 1969
NJDEP	New Jersey Department of Environmental Protection
NJPDES	New Jersey Pollutant Discharge Elimination System
NMFS	National Marine Fisheries Service
NRC	U.S. Nuclear Regulatory Commission
ppt	parts per thousand
PSEG	PSEG Nuclear, LLC
Salem	Salem Nuclear Generating Station, Units 1 and 2
SEIS	Supplemental Environmental Impact Statement

Essential Fish Habitat Assessment for the Proposed License Renewal for the Salem Nuclear Generating Station and Hope Creek Generating Station

1.0 Introduction

In compliance with Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), the U.S. Nuclear Regulatory Commission (NRC) prepared this Essential Fish Habitat (EFH) Assessment for the proposed Federal action: NRC's decision whether or not to renew the operating licenses for Salem Nuclear Generating Station Units 1 and 2 (Salem) and Hope Creek Generating Station (HCGS), located in Salem County, New Jersey, on the eastern shore of the Delaware Estuary.

Pursuant to the MSA, NRC staff requested via letter dated December 23, 2009 (NRC, 2009), that the National Marine Fisheries Service (NMFS) provide information on EFH in the vicinity of the Salem and HCGS sites. In their response to NRC, the NMFS (2010) indicated that the estuarine portions of the Delaware River and its tributaries contain designated EFH for a number of species and directed the NRC to prepare an EFH assessment as part of the EFH consultation process.

Accordingly, this EFH Assessment describes the proposed action, identifies relevant commercially, Federally-managed species within the vicinity of the proposed action site, assesses whether the proposed action may adversely affect any designated EFH, and describes potential measures to avoid, minimize, or offset potential adverse impacts to EFH as a result of the proposed action.

2.0 Description of the Proposed Action

The proposed Federal action is NRC's decision of whether or not to renew each of the operating licenses for Salem and HCGS for an additional 20 years beyond the original 40-year term of operation.

PSEG Nuclear, LLC (PSEG), which operates Salem and HCGS, initiated the proposed Federal action by submitting applications for license renewal of Salem, for which the existing licenses, DPR-70 (Unit 1) and DPR-75 (Unit 2), expire August 13, 2016, and April 18, 2020, respectively; and HCGS, for which the existing license, NPF-57, expires April 11, 2026. If NRC issues renewed licenses for Salem and HCGS, PSEG could continue to operate until the 20-year terms of the renewed licenses expire in 2036 and 2040 for Salem, Unit 1 and Unit 2, respectively, and 2046 for HCGS. If the operating licenses are not renewed, then the facilities must be shut down on or before the expiration date of the current operating licenses: August 13, 2016, and April 18, 2020, for Salem, Unit 1 and Unit 2, respectively; and April 11, 2026, for HCGS.

Pursuant to the NRC's environmental protection regulations in Title 10, Part 51, of the *U.S. Code of Federal Regulations* (10 CFR 51), which implement the U.S. National Environmental Policy Act of 1969 (NEPA), the NRC published a draft supplemental environmental impact statement (SEIS) for Salem and Hope Creek (NRC, 2010), the notice of availability of which was published in the Federal Register on October 28, 2010 (75 FR 66398). The SEIS is a facility-specific supplement to the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437 (NRC, 1996).

No major construction, refurbishment, or replacement activities are associated with the proposed Federal action. During the proposed license renewal term, PSEG would continue to perform site maintenance activities as well as vegetation management on the transmission line rights-of-way that connect Salem and HCGS to the electric grid.

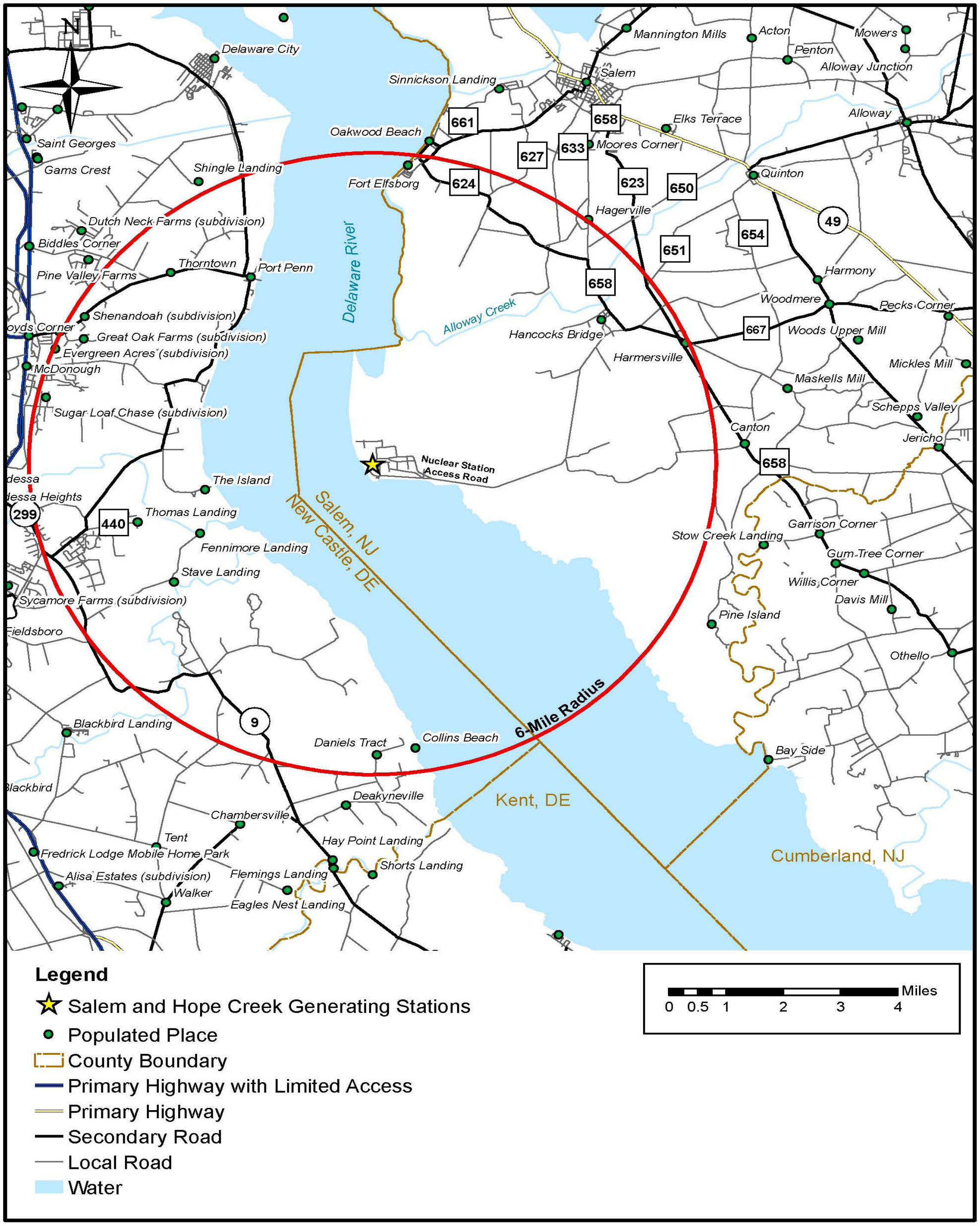
2.1 Site Location and Description

Salem and HCGS lie at the southern end of Artificial Island located on the east bank of the Delaware River in Lower Alloways Creek Township, Salem County, New Jersey, at which point the river is approximately 2.5 miles (mi; 4 kilometers [km]) wide. Artificial Island is a man-made island approximately 1,500 acres (ac; 600 hectares [ha]) in size that consists of tidal marsh and grassland. The U.S. Army Corps of Engineers created the island in the twentieth century by the deposition of hydraulic dredge spoil material atop a natural sand bar that projected into the river. The average elevation of the island is about 9 feet (ft; 3 meters [m]) above mean sea level (MSL) with a maximum elevation of approximately 18 ft (5.5 m) above MSL (AEC, 1973). The site is located approximately 17 miles (mi; 27 kilometers [km]) south of the Delaware Memorial Bridge, 35 mi (56 km) southwest of Philadelphia, Pennsylvania, and 8 mi (13 km) southwest of the City of Salem, New Jersey. Figures 1 and 2, respectively, show the location of the Salem and HCGS facilities and the areas within a 6-mi (10-km) radius and 50-mi (80-km) radius of the facility.

PSEG owns approximately 740 ac (300 ha) at the southern end of the Artificial Island, of which Salem occupies approximately 220 ac (89 ha) and HCGS occupies about 153 ac (62 ha). The remainder of Artificial Island, north of the PSEG property, is owned by the U.S. Government and the State of New Jersey; this portion of the island remains undeveloped. The land adjacent to the eastern boundary of Artificial Island consists of tidal marshlands of the former natural shoreline. The northernmost tip of Artificial Island (owned by the U. S. Government) is within the State of Delaware boundary (PSEG, 2009a; 2009b). Figures 3 and 4 are aerial photographs of the Salem and HCGS sites, respectively.

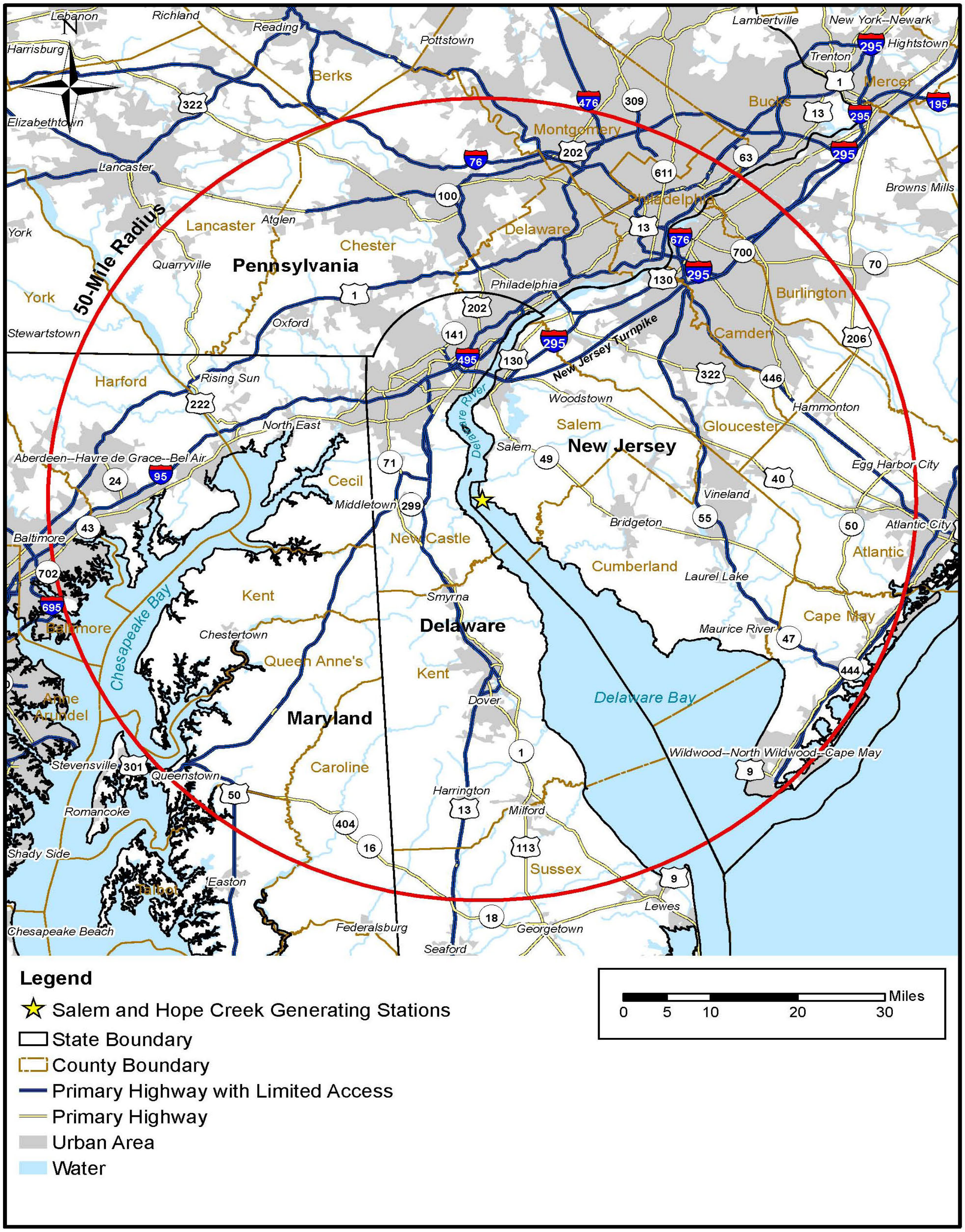
The region within 15 mi (24 km) of the site is primarily utilized for agriculture. The area also includes numerous parks, wildlife refuges, and preserves such as Mad Horse Creek Fish and Wildlife Management Area to the east; Cedar Swamp State Wildlife Management Area to the south in Delaware; Appoquinimink, Silver Run, and Augustine State Wildlife Management areas to the west in Delaware; and Supawna Meadows National Wildlife Refuge to the north. The Delaware Bay and estuary is recognized as containing wetlands of international importance and an international shorebird reserve (NJSA, 2008). The nearest permanent residences are located 3.4 mi (5.5 km) south-southwest and west-northwest of Salem and HCGS across the river in Delaware. The nearest permanent residence in New Jersey is located 3.6 mi (5.8 km) east northeast of the facilities (PSEG, 2009d). The closest densely populated center (with 25,000 residents or more) is Wilmington, Delaware, located 15 mi (24 km) north of Salem and HCGS. No heavy industry exists in the area surrounding Salem and HCGS; the nearest such industrial area is located approximately 10 mi (16 km) northwest of the site near Delaware City, Delaware (PSEG, 2009e).

Figure 1. Location of the Salem and HCGS Sites Within a 6-Mile Radius



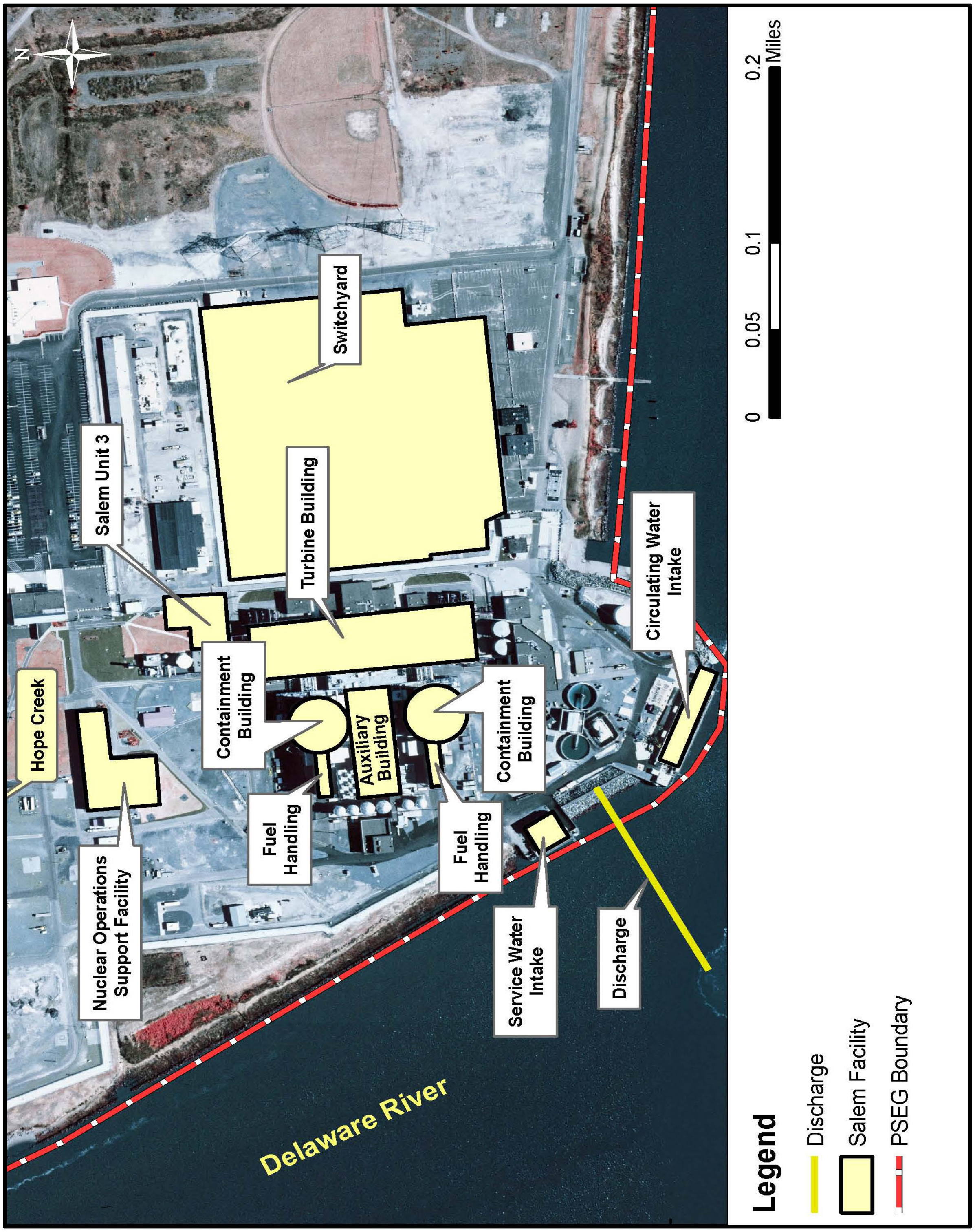
Sources: PSEG, 2009a; 2009b

Figure 2. Location of the Salem and HCGS Sites Within a 50-Mile Radius



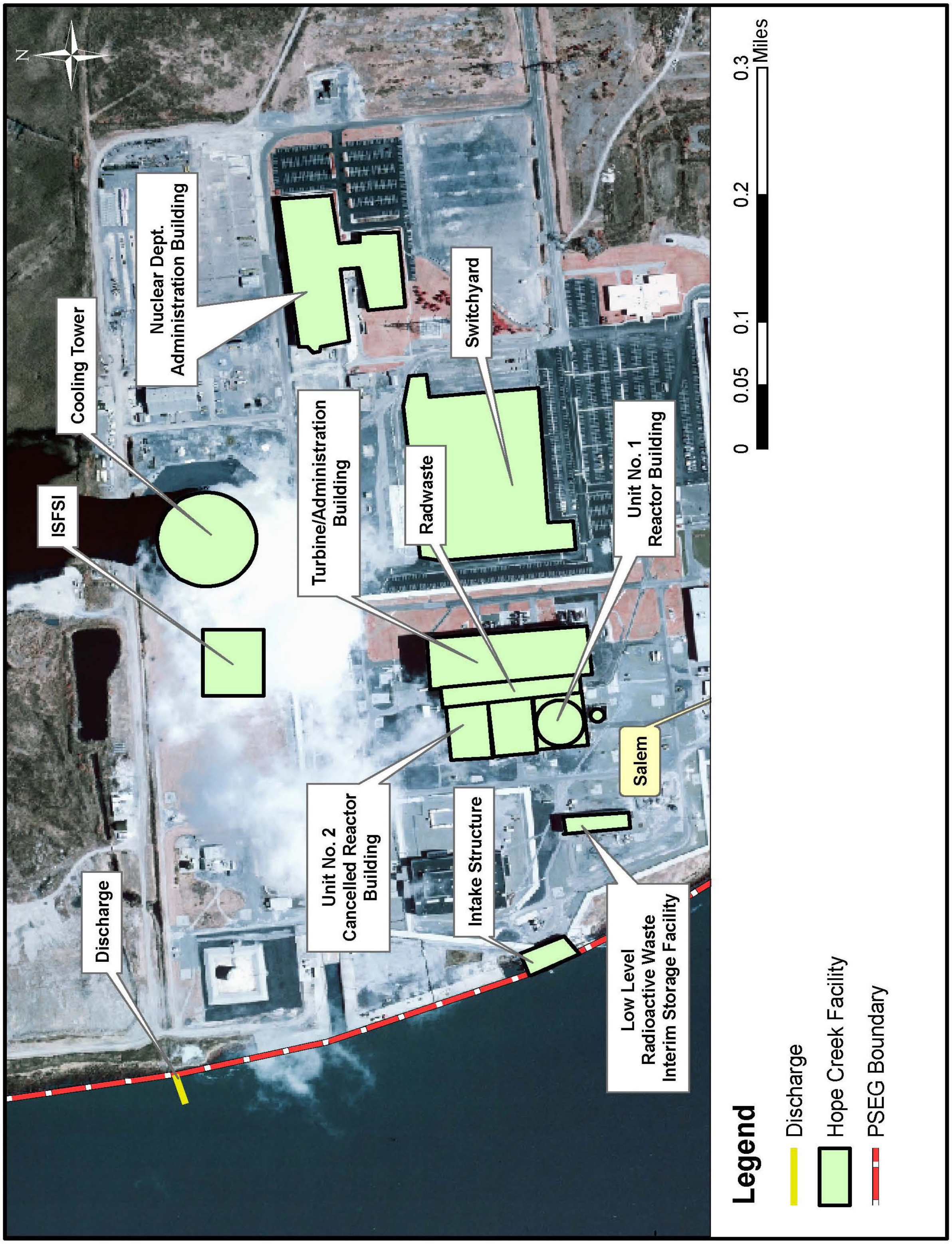
Sources: PSEG, 2009a; 2009b

Figure 3. Salem Site and Facility Layout



Source: PSEG, 2009a

Figure 4. HCGS Site and Facility Layout



Source: PSEG, 2009b

From the mouth of Delaware Bay upstream through the estuary and to the river, the aquatic environment transitions from saltwater, to tidally influenced brackish water of variable salinity, and then to tidal freshwater. Brackish and saltwater marshes occur along the margins of the estuary. The estuary's substrate provides a range of benthic habitats with characteristics dictated by salinity, tides, water velocity, and sediment type. Sediments in the estuary zone surrounding Artificial Island are primarily mud, muddy sand, and sandy mud (PSEG, 2006b).

At Artificial Island, the estuary is tidal with a net flow to the south. The U.S. Army Corps of Engineers maintains a dredged navigation channel near the center of the estuary about 6,600 ft (2,000 m) west of the shoreline at Salem and HCGS. The navigation channel is about 40 ft (12 m) deep and 1,300 ft (400 m) wide. On the New Jersey side of the channel, water depths in the open estuary at mean low water are fairly uniform at about 20 ft (6 m). Predominant tides in the area are semi-diurnal, with a period of 12.4 hours (hrs) and a mean tidal range of 5.5 ft (1.7 m). Tidal currents flow fastest in the channel and more slowly in shallower areas (NRC, 1984; Najarian Associates, 2004).

Salinity is an important determinant of biotic distribution in estuaries, and salinity near the Salem and HCGS facilities varies with river flow. NRC (1984) reported that average salinity in this area during periods of low flow ranged from 5 to 18 parts per thousand (ppt; .005 to .018 milligrams per liter [mg/L]) and during periods of higher flow ranged from 0 to 5 ppt (0 to 0.005 mg/L). Najarian Associates (2004) and PSEG (2005) characterized salinity at HCGS as ranging from 0 to 20 ppt (0 to .02 mg/L) and typically exceeding 6 ppt (0.006 mg/L) in summer during periods of low flow. Based on temperature and conductivity data collected by the USGS at Reedy Island just north of Artificial Island, Najarian Associates (2004) calculated salinity from 1991 through 2002. Their data indicate that salinity during the study period had a median of about 5 ppt (0.005 mg/L); exceeded 12 ppt (0.012 mg/L) in only two years and 13 ppt (0.013 mg/L) in only one year; and never exceeded 15 ppt (0.015 mg/L) during the entire 11-year period. Based on these observations, NRC staff assumes that salinity in the vicinity of Salem and HCGS is typically from 0 to 5 ppt (0 to 0.005 mg/L) in periods of low flow (usually, but not always, summer) and 5 to 12 ppt (0.005 to 0.012 mg/L) in periods of high flow. Within these larger patterns, salinity at any specific location also varies with the tides (NRC, 2007).

Monthly average surface water temperatures in the Delaware Estuary vary with season. Between 1977 and 1982, water temperatures ranged from a minimum temperature of 30.4 degrees Fahrenheit (°F; -0.89 degrees Celsius [°C]) in February 1982 to a maximum of 86.9 °F (32.0 °C) in August 1980. Average temperatures are between 34.5 °F (1.4 °C) in February to 80.8 °F (27.1 °C) in August. Although the estuary in this reach is generally well mixed, it can occasionally stratify, with surface temperatures 2 °F to 4 °F (1 °C to 2 °C) higher than bottom temperatures and salinity increasing as much as 2.0 ppt (0.002 mg/L) per 3.3 ft (1.0 m) of water depth. (NRC, 1984)

The estuary reach adjacent to Artificial Island is at the interface of the oligohaline and mesohaline zones, based on Cowardin et al. (1979)'s estuary classification criteria. Thus, the estuary reach bordering Salem and HCGS is oligohaline during high flow and mesohaline during low flow conditions. Based on water clarity categories of good, fair, or poor, the EPA (1998) classified the water clarity in this area of the estuary as generally fair (meaning that a wader in waist-deep water would not be able to see his feet). The EPA classified the water clarity directly upstream and downstream of this reach as poor (meaning that a diver would not be able to see his hand at arm's length).

EPA (1998) classified most estuarine waters in the Mid-Atlantic as having good water clarity and stated that lower water clarity typically is due to phytoplankton blooms and suspended sediments and detritus.

The Delaware Bay is a complex estuary, with many individual species playing different roles in the system, and often, species play several ecological roles throughout their lifecycles. Major assemblages of organisms within the estuarine community include plankton, benthic invertebrates, and fish. Detailed descriptions of these assemblages can be found in Section 2.2.5 of the NRC (2010)'s draft SEIS for Salem and HCGS.

2.2 Cooling Water System Description and Operation

The Delaware Estuary provides condenser cooling water and service water for both Salem and HCGS. However, the Salem and HCGS facilities use different types of cooling water systems.

Salem is a two-unit station with pressurized water. Each of the two units has a once-through cooling water system that withdraws brackish water from the Delaware Estuary through an intake structure located at the shoreline on the southern end of the site. Salem also withdraws water from the estuary for its service water system. (PSEG, 2009a)

HCGS is a one-unit station with a boiling water reactor. HCGS has a closed-cycle cooling water system that includes intake and discharge structures in the Delaware Estuary and a natural draft cooling tower. HCGS also withdraws water from the estuary for its service water system. (PSEG, 2009b)

Each facility's system is described in more detail in the following sections.

2.2.1 Salem Circulating and Service Water Systems

Salem has two intake systems: the circulating water system, which provides cooling water for main condenser cooling, and the service water system, which provides water for the reactor safeguard and auxiliary systems.

<u>Circulating Water System Intake</u>

The circulating water system withdraws brackish water from the Delaware Estuary via 12 cooling water pumps that connect to a 12-bay intake structure located on the shoreline at the south end of the site.

Before water is processed through the circulating water system, it must pass through several features that prevent intake of debris and biota into the cooling water pumps (PSEG, 2006b):

- <u>Removable Ice Barriers</u>. During the winter, removable ice barriers are installed in front of the intakes to prevent damage to the intake pumps from ice formed on the Delaware Estuary. These barriers consist of pressure-treated wood bars and underlying structural steel braces. The barriers are removed early in the spring and replaced in late fall.
- <u>Trash Racks</u>. After intake water passes through the ice barriers (when installed), it flows through fixed course-grid trash racks. These racks prevent large organisms and debris from entering the pumps. The racks are made from 0.5 inch (in.; 1.3 centimeters [cm]) steel bars placed on 3.5-in. (8.9-cm) centers, which create a 3-in. (7.6-cm) clearance between each bar. The

racks are inspected regularly by PSEG employees, who remove any debris caught on them with mechanical, clamshell-type trash rakes. The trash rakes include a hopper that stores and transports removed debris to a pit at the end of each intake, where it is dewatered by gravity and disposed of off-site.

- Traveling Screens. After intake water passes through the trash racks, it then travels through finer vertical traveling screens. These are modified Ristroph screens designed to remove debris and biota small enough to have passed through the trash racks while minimizing death or injury. The traveling screens are made of wire mesh with 0.25 in. x 0.5 in. (0.64 cm x 1.3 cm) openings. Water moves through these screens at approximately 0.9 feet per second (fps; 0.3 meters per second [m/s]) at mean low tide.

- Fish Return System. 10-ft (3-m) fish buckets are attached across the bottom of each traveling screen panel. As the traveling screens reach the top of each rotation, fish and other organisms slide along horizontal catch screens and are caught in the fish buckets. As the traveling screens continue to rotate, the buckets invert, a low pressure water spray washes fish off the screen, and the fish slide through a flap into a two-way fish trough. Remaining debris is then washed off the screen by a high-pressure water spray and disposed of in a separate debris trough. The contents of both the fish troughs and the debris troughs return to the estuary. The release of fish and debris is timed so that tidal flow will carry them away from the intake, reducing the likelihood of re-impingement. Thus, the troughs empty on either the north or south side of the intake structure depending on the direction of tidal flow.

Service Water System Intake

The service water system intake is located approximately 400 ft (122 m) north of the cooling water system intake within the Delaware Estuary. The service water system intake has 4 bays, each containing 3 pumps, for a total of 12 service water pumps. The average velocity throughout the service water system intake is less than 1 fps (0.3 m/s). The service water system intake structure is equipped with trash racks, traveling screens, and a fish return system to prevent the intake of debris and biota similar to those described for the circulating water system (PSEG, 1999b):

- Trash Racks. Before entering the intake bays, service water travels through mechanical trash racks composed of 0.5-in. (1.3-cm)-wide steel bars with slot openings of 3 in. (7.6 cm). The trash racks remove large debris and organisms, which are disposed of off-site.

- Traveling Screens and Fish Return System. After intake water passes through the trash racks, it then travels under a curtain wall and then through conventional vertical traveling screens to remove debris and biota small enough to have passed through the trash racks while minimizing death or injury. The traveling screens are made of wire mesh with 3/8-in.^{2} (0.95-cm^2) openings. Water moves through these screens at less than 1 fps (0.3 m/s) at mean low tide. The screens are washed with a low-pressure spray, and debris and organisms are deposited into troughs and routed back to the Delaware Estuary.

Water Discharge

Both the Salem circulating water and service water systems discharge heated water back to the Delaware Estuary through a single discharge piping system. This piping system consists of six adjacent pipes that are 7 ft (2 m) in diameter and spaced 15 ft (4.6 m) apart. As water travels through these pipes towards the estuary, the 12 pipes merge into 3 larger pipes that are 10 ft (3 m) in diameter (PSEG, 2006b). The discharge piping is buried the majority of its 500-ft (150-m) length. Water is discharged into the estuary and perpendicular to the prevailing currents at a depth of about 31 ft (9.5 m) at mean tide (PSEG, 1999b). At full power, Salem is designed to discharge approximately 3,200 million gallons per day (mgd; 12 million cubic meters per day [m^3/day]) at a velocity of about 10 fps (3 m/s) (PSEG, 1999b). Water at the discharge point is 0 to 15 °F (0 to 8.3 °C) warmer than the estuary water to which it is being discharged (PSEG, 1999b). The average temperature increase at the discharge is from 8 to 10 °F (4 to 6 °C) (PSEG, 1999b).

2.2.2 HCGS Circulating and Service Water Systems

HCGS withdraws water through only one intake structure. Once withdrawn from the estuary, water first runs through the service water system, and is then sent to the circulating water system for use as cooling tower make-up water. As with Salem, the HCGS circulating water system provides water for main condenser cooling, while the service water system provides water for reactor safeguard and auxiliary systems.

Service Water System Intake

Water is withdrawn from the Delaware Estuary via an eight-bay intake that is situated parallel to the shoreline. Only four of the eight bays are operational; the remaining four were constructed for a second HCGS reactor, which was never built. At the intake, water flows into the intake structure at a maximum velocity of 0.35 fps (0.11 m/s). As with Salem's intakes, the HCGS intake includes several features to prevent intake of debris and biota before water enters the cooling water pumps (PSEG, 2009b):

- Trash Racks. Before water enters the intake, trash racks prevent large organisms and debris from entering the intake by regularly sweeping the face of the intake structure. Mechanical rakes remove any collected debris and deposit it for off-site disposal. Water travels through the trash racks at about 0.1 fps (0.03 m/s).
- Skimmer Wall: A skimmer wall is located behind the trash racks to prevent the intake of oil slicks or ice. Water travels under the skimmer wall and into one of the four active bays at a maximum speed of 0.35 fps (0.11 m/s).
- Traveling Screens. After entering one of the four active bays, water passes through traveling screens with 1/2 in. x 1/8 in. (1.3 cm x 0.32 cm) openings in order to remove debris and biota small enough to have passed through the trash racks and skimmer wall while minimizing death or injury (NRC, 2007). Traveling screens are rotated regularly, but not continuously.
- Fish Return System. Buckets, located on the lower lip of the traveling screens, catch fish and other organisms. As the traveling screens reach the top of each rotation, fish and other organisms are caught in the fish buckets. As the traveling screens continue to rotate, the buckets invert, a low pressure water spray washes fish off the screen and into return troughs. Remaining debris is then washed off the screen by a high-pressure water spray. Fish

and debris return to the Delaware Estuary in combined troughs south of the intake structure.

After passing through the trash racks, skimmer wall, and traveling screens, water enters the service water pumps and is processed through the service water system. To prevent organic buildup and biofouling in the heat exchangers and piping of the service water system, sodium hypochlorite is continuously injected at the suction of the service water pumps.

Circulating Water System and Water Discharge

HCGS's circulating water system consists of one 512-ft (156-m) high, single counterflow, hyperbolic, natural draft cooling tower with make-up, blowdown, and basin bypass systems; four circulating water pumps; a two-pass condenser; and a closed-loop circulating water piping arrangement. Once water is processed through the service water system, it is sent to the circulating water system to cool the main condenser and for use as cooling tower make-up water; therefore, debris and biota have already been removed from the water before it enters the circulating water system. Sodium hydroxide and sodium hypochlorite are added to the circulating water system to minimize scaling and prevent biofouling in the cooling tower. Cooling tower blowdown is de-chlorinated with ammonium bisulfate before being discharged to the Delaware Estuary.
(PSEG, 2009b)

The HCGS circulating water system loses water through evaporative loss from the cooling tower and blowdown removed from the system to control the buildup of suspended solids. Heated water from cooling tower blowdown is discharged to the estuary through an underwater conduit located 1,500 ft (460 m) upstream of the HCGS intake. The HCGS discharge pipe extends 10 ft (3.0 m) offshore and is situated at mean tide level. (PSEG, 2009b)

2.3 Surface Water Use and Facility NJPDES Permits' Limitations

The Delaware River Basin Commission (DRBC) and the State of New Jersey regulate surface water use for Salem and HCGS. The DRBC authorizes Salem to withdraw surface water from the Delaware Estuary under a contract that was originally signed in 1977 (DRBC, 1977) and was approved for a 25-year term in 2001 (DRBC, 2001). The DRBC authorizes HCGS to withdraw surface water from the Delaware Estuary under a contract that was originally signed in 1975 that was then revised in 1985 following PSEG's decision to build only one unit (DRBC, 1984a). The State of New Jersey regulates water use and effluent discharges under the New Jersey Pollutant Discharge Elimination System (NJPDES) Permit Nos.NJ005622 (for Salem) and NJ0025411 (for HCGS).

Salem

Salem's NJPDES permit limits the total withdrawal of Delaware River water to 3,024 mgd (11.4 million m^3/d), with a monthly maximum of 90,720 million gallons (gal.; 343 million cubic meters [m^3]) (NJDEP, 2001). DRBC's contract with Salem authorizes the facility to withdrawal water not to exceed 97,000 million gal. (367 million m^3) in a single 30-day period (DRBC, 1977; DRBC, 2001). PSEG reports withdrawal volumes to the New Jersey Department of Environmental Protection (NJDEP) through monthly Discharge Monitoring Reports.

From June 1 through September 30, Salem may discharge water at a maximum temperature of 115 °F (46.1 °C) (PSEG, 1999b). Year-round, Salem's NJPDES permit limits the change in temperature such that discharged water may not exceed a 27.5 °F (15.3 °C) change in temperature from the ambient estuary water temperature (PSEG, 1999b).

Table 1 summarizes specific discharge locations, their associated reporting requirements, and discharge limits under Salem's NJPDES.

Table 1. NJPDES Permit Requirements for Salem Nuclear Generating Station

Discharge	Description	Required Reporting	Permit Limits
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
DSNs 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 storm water from north portion.	Effluent flow	None
		pH	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 storm water from south portion.	Effluent flow	None
		pH	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

Discharge	Description	Required Reporting	Permit Limits
DSN Outfall FACA	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 FACB	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

MBTU/hr = million British thermal units per hour
mg/L = milligrams per liter
Source: NJDEP, 2001

HCGS

Though PSEG is required to measure and report withdrawal volumes to the NJDEP, HCGS's NJPDES permit does not specify limits on the total withdrawal volume of Delaware Estuary water (NJDEP, 2003). HCGS's actual withdrawal of water averages to about 66.8 mgd (253,000 m^3/day), of which 6.7 mgd (25,000 m^3/day) are returned as screen backwash, and 13 mgd (49,000 m^3/day) are evaporated. The remainder (approximately 46 mgd [174,000 m^3/day]) is discharged back to the estuary (PSEG, 2009b). DRBC's contract with HCGS authorizes the facility to withdraw 16.998 billion gal. per year (gal/yr; 64.3 million cubic meters per year [m^3/yr]), including up to 4.086 billion gal. (17.44 million m^3) of consumptive use (DRBC, 1984a; DRBC, 1984b). To compensate for evaporative losses in the system, the DRBC authorization requires releases from storage reservoirs, or reductions in withdrawal, during periods of low-flow conditions at Trenton, New Jersey (DRBC, 2001). To accomplish this, PSEG is one of several utilities that owns and operates the Merrill Creek Reservoir in Washington, New Jersey, which is used to release water during low-flow conditions as required by the DRBC authorization (PSEG, 2009b).

HCGS's NJPDES permit limits heat dissipation from discharged water to an area no larger than 2500 ft (762 m) upstream or downstream and 1500 ft (457 m) offshore from the discharge point. Outside of the designated area, water temperature changes attributable to the plant cannot exceed the estuary's ambient water temperature by more than 4 °F (2.2 °C) from September through May or by 1.5 °F (0.8 °C) in June, July, and August (Najarian Associates, 2004). In addition, the maximum water temperature attributable to the plant outside of the designated area cannot exceed 86 °F (30 °C) (Najarian Associates, 2004).

Table 2 summarizes specific discharge locations, their associated reporting requirements, and discharge limits under HCGS's NJPDES.

Table 2. 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	36.2oC daily maximum
		Intake temperature	None
		Total organic carbon (effluent gross, effluent net, and intake)	None
		Heat content (June to August)	534 MBTU/hr daily maximum
		Heat content (September to May)	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 /100 ml monthly geometric
			400 /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

Source: NJDEP, 2005

2.4 Habitat Restoration

PSEG is involved in a number of restoration activities within the Delaware Estuary as a requirement of their 1994, 2001, and 2006 NJPDES permits. PSEG implemented an Estuary Enhancement Program (EEP) in 1994 as a requirement of Salem's NJPDES permit and in order to address entrainment and impingement losses at Salem's cooling water intake. Since its implementation, the EEP has preserved and/or restored more than 20,000 ac (8,000 ha) of wetland and adjoining upland buffers to date (PSEG, 2009a).

In particular, the program restored 4,400 ac (1,800 ha) of formerly diked salt hay farms to reestablish conditions suitable for the growth of low marsh vegetation such as saltmarsh cord grass (*Spartina alterniflora*) and provide for tidal exchange with the estuary. These restored wetlands increase the production of fish and shellfish by increasing primary production in the detritus-based food web of the Delaware Estuary. Both primary and secondary consumers benefit from this increase in production, including EFH species.

The EEP also included the installation of 13 fish ladders at impoundments in New Jersey and Delaware (PSEG, 2009c). PSEG constructed the fish ladders in New Jersey at Sunset Lake, Stewart Lake (two ladders), Newton Lake, and Cooper River Lake; and in Delaware at Noxontown Pond, Silver Lake (Dover), Silver Lake (Milford), McGinnis Pond, Coursey Pond, McColley Pond, Garrisons Lake, and Moore's Lake. The fish ladders eliminate blockages to spawning areas for anadromous fish species. Because most anadromous fish exhibit spawning site fidelity, PSEG undertook a stocking program that transplanted gavid adults into the newly accessible impoundments to induce future spawning runs (PSEG, 2009b).

Along with active restoration activities, PSEG has provided funding through the EEP for many other programs in the area, including some managed by NJDEP and the Delaware Department of Natural Resources and Environmental Control. These funded programs include: restoration of three areas in Delaware dominated by common reed (*Phragmites australis*), a State-managed artificial reef programs, revitalization of 150 ac (61 ha) of State-managed oyster habitat, and restoration of 964 ac (390 ha) of degraded wetlands at the Augustine Creek impoundment (PSEG, 2009a).

In 2006, PSEG evaluated and quantified the increased secondary production associated with its EEP and compared the results with secondary production lost due to entrainment and impingement at the facility. The assessment was a requirement of Salem's 2001 NJPDES permit, and PSEG provided the results in Section 7 of Salem's 2006 NJPDES permit renewal application (PSEG, 2006b). The assessment included estimates of increased production associated with the restoration of three salt hay farms and 12 fish ladder sites. The assessment did not include production associated with the restoration of marshes dominated by common reed, upland buffer areas, and artificial reefs.

PSEG (2006b) used an Aggregated Food Chain Model to estimate the annual production in pounds wet weight per year of secondary consumers attributable to the restoration of the salt hay farm sites. This model used data for the biomass of above-ground vegetation collected during the annual monitoring from 2002 through 2004 to estimate primary production. PSEG converted the calculated primary productivity to production of secondary consumers through three trophic transfers: vegetation to detrital complex (dissolved and particulate organic matter, bacteria, fungi, protozoa, nematodes, rotifers, copepods, and other microscopic organisms) to primary consumers (zooplankton and macroinvertebrates) to secondary consumers (age-0 fish). PSEG also used two independent methods—an ecosystem model and a fish abundance model—to corroborate the Aggregated Food Chain Model estimates.

In their assessment results, PSEG (2006b) reported the secondary consumer production attributable to the salt hay marsh restoration sites to be 11.2 million pounds (lbs) wet weight/yr (5.09 million kilograms [kg] wet weight/yr). In their comparison of secondary consumer production attributable to restoration activities and lost production due to impingement and entrainment, PSEG (2006b) estimated that the increase in production attributable to restoration activities was 2.3 times the annual production lost from impingement and entrainment. PSEG (2006b) noted that the model used was likely to have underestimated total secondary production attributable to the salt marsh hay restoration because it did not include primary production associated with below-ground plant parts (roots and rhizomes), benthic algae, or other primary producers such as photosynthetic bacteria. Therefore, actual secondary production gains attributable to restoration activities are likely higher than 2.3 times the secondary production lost to impingement and entrainment.

PSEG also estimated annual production gains from the installation of fish ladders. However, because none of the EFH species considered for in-depth analysis are found in freshwater, and the fish ladders were installed upstream of Salem and HCGS, the results of these calculations are not applicable to this EFH assessment.

3.0 EFH Species Near the Site

3.1 EFH Species Identified for Preliminary Analysis

According to the *National Estuarine Inventory Data Atlas* (NOAA, 1985), Salem and HCGS lie within the Delaware Bay's mixing zone. The waters and substrate necessary for spawning, breeding, feeding, or growth to maturity are considered EFH (16 U.S.C. 1802(10)), and the reach of the Delaware Estuary adjacent to Salem and HCGS contains designated EFH for several fish species and life stages. NRC staff considered designated EFH that could occur in the vicinity of Salem and HCGS based on geographic coordinates and eliminated EFH for some species and life stages with EFH requirements outside of the normal conditions recorded locally.

In their Guide *to Essential Fish Habitat Designations in the Northeastern United States*, the NOAA (2010c) identifies EFH by 10 minute (') squares of latitude and longitude as well as by major estuary, bay, or river for estuarine waters outside of the 10 ' square grid. The waters of the Delaware Estuary adjacent to Salem and HCGS are within the "Delaware Bay, New Jersey/Delaware" EFH Designation. The sixteen fish species with designated EFH in the Delaware Bay appear in Table 3.

Table 3. Species of Fish with Designated EFH in the Delaware Bay

Common Name	Scientific Name	Eggs	Larvae	Juveniles	Adults	Spawning Adults
American plaice	*Hippoglossoides platessoides*	-	-	M,S	S	-
Atlantic butterfish	*Peprilus triacanthus*	-	S	M,S	S	-
Atlantic sea herring	*Clupea harengus*	-	-	M,S	S	-
black sea bass	*Centropristus stiata*	-	-	M,S	S	-
bluefish	*Pomatomus saltatrix*	-	-	M,S	M,S	-

Common Name	Scientific Name	Eggs	Larvae	Juveniles	Adults	Spawning Adults
clearnose skate	*Leucoraja eglantaria*	-	-	X	X	-
cobia	*Rachycentron canadum*	X	X	X	X	-
king mackerel	*Scomberomorus cavalla*	X	X	X	X	-
little skate	*Leucoraja erinacea*	-	-	X	X	-
red hake	*Urophycis chuss*	-	-	-	S	-
scup	*Stenotomus chrysops*	-	-	M,S	S	-
Spanish mackerel	*Scomberomorus maculatus*	X	X	X	X	-
summer flounder	*Paralicthys dentatus*	-	-	M,S	M,S	-
windowpane	*Scopthalmus aquosus*	M,S	M,S	M,S	M,S	M,S
winter flounder	*Pleuronectes americanus*	M,S	M,S	M,S	M,S	M,S
winter skate	*Leucoraja ocellata*	-	-	X	X	-

Sources: NOAA, 2010b; NOAA, 2010d

X = designated EFH present for species and life stage

S = designated EFH for this species and life stage includes the seawater salinity zone of the bay or estuary (salinity ≥ 25.0%)

M = designated EFH for this species and life stage includes the mixing water/brackish salinity zone of the bay or estuary (salinity ranges from 0.5 to 25.0%)

\- = no designated EFH present for species and life stage

The NRC staff compared salinity in the vicinity of Salem and HCGS (described in Section 2.1 and listed in Table 4) with EFH salinity requirements for each of the species and life stages that appear in Table 3 in order to further refine the EFH species with the potential to be adversely affected by the proposed action. The salinity requirements of several of the fish species and life stages are higher than the conditions that have been reported in the vicinity of Salem and HCGS (see Table 5). For those species whose EFH salinity requirements do not match the local conditions, the NRC staff did not further consider these species in this EFH assessment. The remaining species and life stages whose salinity requirements match local conditions appear in Table 6. Accordingly, the three remaining species— Atlantic butterfish (*Peprilus triacanthus*); windowpane flounder, or windowpane (*Scopthalmus aquosus*); and winter flounder (*Pleuronectes americanus*)—are described in detail in Section 3.2.

Table 4. Habitat Salinity in the Delaware Estuary Adjacent to Salem and HCGS

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

Source: Najarian Associates, 2004

Table 5. Salinity Requirements of Identified EFH Species

Species, Life Stage	EFH Salinity Requirement (ppt)	Site Salinity Matches with EFH Requirements? (Yes/No)
American plaice		
juveniles	32	No
adults	20-34	No
Atlantic butterfish		
juveniles	3-37	Yes
Atlantic herring		
juveniles	26-32	No
adults	>28	No
black sea bass		
juveniles	>18	No
bluefish		
juveniles	23-36	No
adults	>25ppt	No
clearnose skate		
juveniles and adults	>20	No
cobia		
all life stages	>25	No
king mackerel		
all life stages	>30	No
little skate		
juveniles and adults	20-36	No
red hake		
adults	33-34	No
scup		
juveniles and adults	>15	No
Spanish mackerel		
all life stages	>30	No
summer flounder		
juveniles	10-30	No
adults	high salinity portions of estuaries	No
windowpane		
eggs and larvae	unspecified	Yes
juveniles, adults, and spawning adults	5.5-36	Yes (low flow only)
winter flounder		
eggs	10-30	Yes (low flow only)

Species, Life Stage	EFH Salinity Requirement (ppt)	Site Salinity Matches with EFH Requirements? (Yes/No)
larvae	4-30	Yes
juveniles	10-30	Yes (low flow only)
adults	15-33	No
spawning adults	5.5-36	Yes (low flow only)
winter skate		
juveniles and adults	>20	No

Sources: Change et al., 1999; NMFS, 2010f; Packer et al., 1999; 2003a; 2003b; 2003c; Pereira et al., 1999

Table 6. Species of Fish Retained for In-Depth EFH Analysis

Common Name	Scientific Name	Eggs	Larvae	Juveniles	Adults	Spawning Adults
Atlantic butterfish	*Peprilus triacanthus*	-	-	X	-	-
windowpane	*Scopthalmus aquosus*	X	X	X	X	X
winter flounder	*Pleuronectes americanus*	X	X	X	-	X

Source: NOAA, 2010d
X = designated EFH present; - = no designated EFH present

3.2 EFH Species Identified for In-Depth Analysis

3.2.1 Atlantic Butterfish (*Peprilus triacanthus*)

<u>Species Description</u>

The Atlantic butterfish is a pelagic schooling fish that is ecologically important as a forage fish for many larger fishes, marine mammals, and birds. It inhabits the Atlantic coast from Newfoundland to Florida, but it is most abundant from the Gulf of Maine to Cape Hatteras (Overhotlz, 2006; Cross et al., 1999). Butterfish migrate seasonally; in the summer, they migrate inshore into bays, estuaries, and coastal waters of southern New England and the Gulf of Maine, and in winter, they migrate to the edge of the continental shelf in the Mid-Atlantic Bight (Cross et al., 1999). The species generally stays within 200 mi (322 km) of the shore.

Butterfish reach sexual maturity between ages 1 and 2, and rarely live more than 3 years (Overholtz, 2006). Adults are 5.9 to 9.1 in. (15 to 23 cm) long on average and can reach a weight of up to 1.1 lbs (0.5 kg). Females are broadcast spawners and spawn in large bays and estuaries from June through August. Females generally release eggs at night in the upper part of the water column in water of 59°F (15°C) or more. Eggs are pelagic and buoyant (Cross et al., 1999). Butterfish eggs and larvae are found in water with depths ranging from the shore to 6,000 ft (1,828 m) and temperatures between 48°F and 66°F (9°C and 19°C). Juvenile and adult butterfish are found in waters from 33 to 1,200 ft (10 to 366 m) deep and at temperatures ranging from 37°F to 82°F (3°C to 28°C) (Cross et al., 1999). In summer, butterfish can be found over the entire continental shelf, including sheltered bays and estuaries, to a depth of 656 ft (200 m) over substrates of sand, rock, or mud (Cross et al., 1999). Butterfish prey mainly on urochordates and mollusks, with minor food sources including squid, crustaceans such as amphipods and shrimp, annelid worms, and small fishes (Bigelow and Schroeder, 2002; Cross et al., 1999). In turn, butterfish are preyed upon by many species, including haddock (*Melanogrammus aeglefinus*), silver hake (*Merluccius bilinearis*), goosefish (Lophius americanus), bluefish (*Pomatomus saltatrix*), swordfish (*Xiphias gladuis*), sharks, and long-finned squid (*Loligo pealei*) (Cross et al., 1999).

<u>Status of the Fishery</u>

The Atlantic butterfish has been commercially fished since the late 1800s (Cross et al., 1999). By the mid-1900s, fishing fleets from Japan, Poland, the USSR, and other countries began to target the butterfish and caused a drastic increase in landings (Cross et al., 1999; Overholtz, 2006). Landings peaked in 1973 at 75.6 million lbs (34,300 mt) (Overholtz, 2006). U.S. commercial landings averaged 7.1 million lbs (3,200 mt) between 1965 and 2002, but have steadily decreased since 1985 (Overholtz, 2006). In 2009, NOAA reported a cumulative landing of 0.95 million lbs (430 mt), and as of November 27, 2010, the reported landings for 2010 were 1.2 million lbs (550 mt) (NOAA, 2009; 2010bl). Butterfish are also caught as bycatch in other fisheries. Bycatch landings averaged 9.3 million lbs (4200 mt) per year between 1996 and 2002 (Overholtz, 2006).

The Mid-Atlantic Fishery Management Council (MAFMC) manages the Atlantic butterfish under a Management Plan that includes the Atlantic mackerel, squid, and butterfish. The butterfish fishery is capped by an annual coast-wide quota. A directed fishery for butterfish is open from January through August; however, most butterfish are harvested as bycatch in squid fisheries (NOAA, 2010a). Currently, MAFMC is unsure whether the fishery is overfished but is working on a rebuilding plan for butterfish (NMFS, 2010d).

<u>Designated EFH in the Vicinity of Salem and HCGS</u>

The NRC staff has determined that EFH for Atlantic butterfish juveniles may exist in the vicinity of Salem and HCGS. The NMFS has designated juvenile butterfish EFH in the mixing water/brackish salinity zone and the seawater salinity zone of the Delaware Bay (NMFS, 2010a). Environmental requirements for juvenile butterfish EFH habitat appear in Table 7.

Table 7. Butterfish EFH Descriptions by Life Stage

Life Stage	Habitat Type	Temperature in °F (°C)	Depth in ft (m)	Salinity in ppt	Seasonal Occurrence in Estuaries
Juveniles	Pelagic waters; Bottom habitats with sandy or muddy substrate	37.4-82.4 (3-28)	33-1,200 (10-365)	3-37	spring through fall

Sources: NMFS, 2010a; 2010f

3.2.2 Windowpane (*Scopthalmus aquosus*)

<u>Species Description</u>

Windowpane inhabit estuaries, coastal waters, and oceans over the continental shelf along the Atlantic coast from the Gulf of Saint Lawrence to Florida. The species is most abundant in bays and estuaries south of Cape Cod in shallow waters, over sand, sand and silt, or mud substrates (Chang et al., 1999).

Windowpane reach sexual maturity between 3 and 4 years of age and grow to a length of up to 18 in. (46 cm) (Chang et al., 1999). Females spawn from April to December, and in the Mid-Atlantic region, spawning peaks in May and September (Chang et al., 1999; Morse and Able, 1995). Females release pelagic, buoyant eggs that hatch in approximately 8 days. Larvae begin life as plankton, but quickly settle to the bottom and become demersal. In spring-spawned fish, larvae settle in estuaries and over the continental shelf and then inhabit the polyhaline portions of the estuary throughout the summer. In fall-spawned fish, larvae settle mostly on the shelf. Juveniles migrate from estuaries to coastal waters during autumn, and they overwinter offshore in deeper waters. Adults remain offshore throughout the year and are highly abundant off southern New Jersey. Adult windowpane tolerate a wide range of temperatures and salinities—from 23 °F to 80.2 °F (0 °C to 26.8 °C) and 5.5 ppt to 36 ppt—and are abundant in the mixing and saline zones of the Delaware Bay (Chang et al., 1999).

Juvenile and adult windowpane have similar food sources, including small crustaceans and fish larvae of hakes and tomcod (*Microgadus tomcod*), and in turn are preyed upon by a number of species including spiny dogfish (*Squalus acanthias*), thorny skate (*Amblyraja radiata*), goosefish, Atlantic cod (*Cadus morhua*), black sea bass (*Centropristis striata*), weakfish (*Cynoscion regalis*), and summer flounder (*Paralichyths dentatus*) (Chang et al., 1999).

<u>Status of the Fishery</u>

The windowpane is broken down into two stocks: the Gulf of Maine/Georges Bank stock and the Southern New England/Mid-Atlantic stock. Windowpane have never been widely directly targeted as a commercial species, but have been harvested in mixed-species fisheries since the 1900s. In the 1950s, windowpane landings were estimated to be as high as 2.04 million lbs (924 mt) per year (Hendrickson, 2006). Landings ranged from 1.1 to 2.0 million lbs (500 to 900 mt) per year between 1975 and 1981, increased to a record high of 4.6 million lbs (2,100 mt) in 1985, and have since steadily declined (Hendrickson, 2006). The windowpane stock structure has never been formally quantified, and additionally, windowpane bycatch and discards from other fisheries are unknown and may account for a significant portion of annual windowpane catch. The NEFMC manages the windowpane stock under its Multispecies Groundfish Fishery Management Plan. Currently, the New England/Mid-Atlantic stock is considered to be overfished (Change et al., 1999).

<u>Designated EFH in the Vicinity of Salem and HCGS</u>

The NRC staff has determined that EFH for all life stages of windowpane may exist in the vicinity of Salem and HCGS. The NMFS has designated EFH in the mixing water/brackish salinity zone and the seawater salinity zone of the Delaware Bay (NMFS, 2010b). Environmental requirements for windowpane EFH habitat by life stage appear in Table 8.

Table 8. Windowpane EFH Descriptions by Life Stage

Life Stage	Habitat Type	Temperature in °F (°C)	Depth in ft (m)	Salinity in ppt	Seasonal Occurrence in Estuaries
Eggs	Surface waters	<68 (<20)	<230 (<70)	not specified	February to November with peaks in May and October

Life Stage	Habitat Type	Temperature in °F (°C)	Depth in ft (m)	Salinity in ppt	Seasonal Occurrence in Estuaries
Larvae	Pelagic waters	<68 (<20)	<230 (<70)	not specified	February to November with peaks in May and October
Juveniles	Bottom habitats with mud or fine-grained sand substrate	<75 (<25)	3.3-330 (1-100)	5.5-36	year-round
Adults	Bottom habitats with mud or fine-grained sand substrate	<80.2 (<26.8)	3.3-246 (1-75)	5.5-36	year-round
Spawning Adults	Bottom habitats with mud or fine-grained sand substrate	<69.8 (<21)	3.3-246 (1-75)	5.5-36	February through December with a peak in May
Sources: NEFMC, 1998a; NMFS, 2010b; 2010f					

3.2.3 Winter Flounder (*Pleuronectes americanus*)

Species Description

There are three major populations of winter flounder in the Atlantic, which are each managed as individual stocks: the Gulf of Maine, southern New England and the Middle Atlantic, and Georges Bank (Pereira et al., 1999). In the Mid-Atlantic, winter flounder are most common between the Gulf of Saint Lawrence and Chesapeake Bay (Grimes et al., 1989). Adult winter flounder migrate inshore to bays and estuaries in the fall and early winter to spawn and may remain inshore year-round in areas where temperatures are 59 °F (15 °C) or lower and enough food is available (Pereira et al., 1999).

Adult winter flounder are a small-mouthed, right-eyed flounder that grow to 23 in. (58 cm) in total length and live up to 15 years (Pereira et al., 1999). Studies vary widely on the age of maturity of winter flounder. Generally, sexual maturity is dependent on size rather than age, and southern individuals reach spawning size more rapidly than northern fish. Pereira et al. (1999) summarized a number of studies, which place the age of maturity at between 1.9 and 7 years and between 10.1 to 11.4 in. (25.6 to 29.0 cm) for males and 9.8 to 11.7 in. (24.9 to 29.7 cm) for females. In the Delaware Bay region, winter flounder spawn in coastal waters in February and March. Females spawn at depths of 7 to 260 ft (2 to 79 m) over sandy substrates in inshore coves and inlets at salinities of 31 to 32.5 ppt (Buckley, 1989; Pereira et al., 1999). Eggs are demersal, stick to the substrate, and are most often found at salinities between 10 and 30 ppt (Buckley, 1989). Larvae initially are planktonic but become increasingly benthic as they develop (Pereira et al., 1999). Juveniles and adults are completely benthic, with juveniles preferring a sandy or silty substrate in estuarine areas (Buckley, 1989). Juveniles move seaward as they grow, remaining in estuaries for the first year (Buckley, 1989; Grimes et al., 1989). Water temperature appears to dictate adult movements; south of Cape Cod, winter flounder spend the colder months in inshore and estuarine waters and move farther offshore in the warmer months (Buckley, 1989). Adult winter flounder tolerate salinities of 5 to 35 ppt and prefer waters temperatures of 32 °F to 77 °F (0 °C to 25 °C).

Winter flounder larvae feed on small invertebrates, invertebrate eggs, and phytoplankton (Buckley, 1989; Pereira et al., 1999). Adults feed on benthic invertebrates such as polychaetes, cnidarians, mollusks, and hydrozoans. Adults and juveniles are an important food source for predatory fish such as the striped bass (*Morone saxatilis*), bluefish, goosefish, spiny dogfish, and other flounders, and birds such as the great cormorant (*Phalacrocorax carbo*), great blue heron (*Ardea herodias*), and osprey (*Pandion haliaetus*) (Buckley, 1989).

Status of the Fishery

Winter flounder are highly abundant in estuarine and coastal waters and, therefore, are one of the most important species for commercial and recreational fisheries on the Atlantic coast (Buckley, 1989). Winter flounder are generally commercially harvested using otter trawl, but the species is also a popular recreational fish. Winter flounder in the vicinity of Salem and HCGS are part of the Southern New England/Mid-Atlantic Bight Stock. This stock peaked in the mid-1960s with 26 million lbs (12,000 mt) in landings in 1966, declined through the 1970s, peaked again through the 1980s with 24 million lbs (11,000 mt) in landings in 1981, and has since continued to decline (Hendrickson et al., 2006). Commercial landings reached a record low in 2005 at 2.98 million lbs (1,350 mt), but have increased slightly since, with landings at 3.58 million lbs (1,622 mt) in 2007 (NEFSC, 2008).

Because the winter flounder migrates between offshore Federal waters and inshore state waters, the New England Fishery Management Council (NEFMC) manages the winter flounder in Federal waters under the Northeast Multispecies Fishery Management Plan, and the ASMFC manages the winter flounder in state waters under the Fishery Management Plan for Inshore Stocks of Winter Flounder. As of 2009, the ASMFC reported that the Southern New England/Mid-Atlantic Bight winter flounder stock is overfished and at only 9 percent of its target spawning stock biomass (ASMFC, 2009).

Designated EFH within the Vicinity of Salem and HCGS

The NRC staff has determined that EFH for winter flounder eggs, larvae, juveniles, and spawning adults may exist in the vicinity of Salem and HCGS. The NMFS has designated EFH in the mixing water/brackish salinity zone and the seawater salinity zone of the Delaware Bay (NMFS, 2010c). Environmental requirements for winter flounder EFH habitat by life stage appear in Table 9.

Table 9. Winter Flounder EFH Descriptions by Life Stage

Life Stage	Habitat Type	Temperature in °F (°C)	Depth in ft (m)	Salinity in ppt	Seasonal Occurrence in Estuaries
Eggs	Bottom habitat with sand, muddy sand, mud, or gravel substrate	<50 (<10)	<16 (<5)	10-30	February to June with a peak in April
Larvae	Pelagic and bottom waters	<59 (<15)	<20 (<6)	4-30	March to July with a peak in April and May
Juveniles	Bottom habitats with mud or fine-grained sand substrate	<82.4 (<28)	0.3-160 (0.1-50)	5-33	year-round
Adults	Bottom habitats with mud, sand, or gravel substrate	<77 (<25)	3.3-330 (1-100)	15-33	year-round
Spawning Adults	Bottom habitat with sand, muddy sand, mud, or gravel substrate	<59 (<15)	<20 (<6)	5.5-36	February through June

Life Stage	Habitat Type	Temperature in °F (°C)	Depth in ft (m)	Salinity in ppt	Seasonal Occurrence in Estuaries
Sources: NEFMC, 1998b; NMFS, 2010c; 2010f					

4.0 Potential Adverse Effects to EFH

The provisions of the MSA define an "adverse effect" to EFH as the following (50 CFR 600.810):

> *Adverse effect* means any impact that reduces quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

For purposes of conducting NEPA reviews, the NRC staff published the Generic *Environmental Impact Statement for License Renewal of Nuclear Plants* or "GEIS" (NRC, 1996), which identifies 13 impacts to aquatic resources as either "Category 1" or "Category 2." Category 1 issues are generic in that they are similar at all nuclear plants and have one impact level (SMALL, MODERATE, or LARGE) for all nuclear plants, and mitigation measures for Category 1 issues are not likely to be sufficiently beneficial to warrant implementation. Category 2 issues vary from site to site and must be evaluated on a site-specific basis. Table 10 lists the aquatic resource issues as identified in the GEIS.

Table 10. Aquatic Resource Issues Identified in the GEIS

Issues	Category	Impact Level
For All Plants(1)		
Accumulation of contaminants in sediments or biota	1	SMALL
Entrainment of phytoplankton and zooplankton	1	SMALL
Cold shock	1	SMALL
Thermal plume barrier to migrating fish	1	SMALL
Distribution of aquatic organisms	1	SMALL
Premature emergence of aquatic insects	1	SMALL
Gas supersaturation (gas bubble disease)	1	SMALL
Low dissolved oxygen in the discharge	1	SMALL
Losses from parasitism, predation, and disease among organisms exposed to sublethal stresses	1	SMALL
Stimulation of nuisance organisms	1	SMALL
For Plants with Cooling-Tower-Based Heat Dissipation Systems(2)		

Issues	Category	Impact Level
Entrainment of fish and shellfish in early life stages	1	SMALL
Impingement of fish and shellfish	1	SMALL
Heat shock	1	SMALL
For Plants with Once-Through Heat Dissipation Systems[(3)]		
Impingement of fish and shellfish	2	SMALL, MODERATE, or LARGE
Entrainment of fish and shellfish in early life stages	2	SMALL, MODERATE, or LARGE
Heat shock	2	SMALL, MODERATE, or LARGE

[(1)]Applicable to Salem and HCGS
[(2)]Applicable to HCGS only
[(1)]Applicable to Salem only
Source: NRC, 1996

The GEIS classifies all impacts levels for aquatic resources are "SMALL" except impingement, entrainment, and heat shock. "SMALL" is defined as "having environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource" (10 CFR 51, App. B, Table B-1). The NRC staff believes that the impacts concluded to be "SMALL" will also be small for EFH. Therefore, this EFH assessment will focus on the potential adverse effects of impingement, entrainment, and heat shock on EFH. **Impingement** occurs when aquatic organisms are pinned against intake screens or other parts of the cooling water system intake structure. **Entrainment** occurs when aquatic organisms (usually eggs, larvae, and other small organisms) are drawn into the cooling water system and are subjected the thermal, physical, and chemical stress. **Heat shock** is acute thermal stress caused by exposure to a sudden elevation of water temperature that adversely affects the metabolism and behavior of fish and other aquatic organisms. In addition to heat shock, increased water temperatures at the discharge can also reduce the available habitat for fish species if the discharged water is higher than the environmental preferences of a particular species. This issue will be discussed together with heat shock.

In addition to impingement, entrainment, and heat shock, the NRC staff will assess the impacts to EFH species' food (forage species) in the form of displacement or loss of forage species and loss of forage species habitat as well as cumulative impacts to EFH species or their habitat resulting from the past, present, and reasonably foreseeable future projects in the vicinity of Salem and HCGS.

In summary, the NRC staff has identified the following potential adverse effects to EFH as a result of the proposed license renewal of Salem and HCGS:

- Impingement,
- Entrainment,
- Thermal effects (heat shock and loss of habitat), and
- Loss of forage species.

In the following sections, each of these issues is addressed for each of the three species identified for in-depth analysis in Section 3.2. Cumulative effects are discussed separately in Section 5.0.

4.1 Atlantic Butterfish

As discussed in Section 3.2.1, the NMFS has designated EFH for juvenile butterfish within the vicinity of Salem and HCGS. The potential effects to this species' EFH as a result of the proposed action are considered in the following sections.

4.1.1 Impingement

The NRC staff obtained data on butterfish impingement from PSEG's Annual Biological Monitoring Reports for the period 1995 through 2008. The reports summarize the results of PSEG's ongoing ecological monitoring program, which is a requirement of Salem's NJPDES permit.

PSEG collects impingement samples three times per week between January and December of each year. For each sample day, 10 samples are collected every 2.5 hrs in order to include two full tidal cycles (PSEG, 2009c). Butterfish impingement during the 1995 to 2008 period appears in Table 11. The impingement densities include both juveniles and adults because PSEG does not differentiate during their monitoring collections. Therefore, the average densities of impinged juvenile butterfish are expected to be lower than the rates listed in Table 11. Total annual impingement numbers (actual or estimated) for butterfish are not available.

Table 11. Atlantic Butterfish Impingement Sampling at Salem, 1995-2008

Year	Mean Density[(1)] ($n/10^6\ m^3$)	% Dead or Injured
1995	0.15	0
1996	2.13	0
1997	1.13	0
1998	1.68	17
1999	0.15	50
2000	1.27	14
2001	0.31	0
2002	0.34	0
2003	0.46	0
2004	-	-
2005	-	-
2006	1.82	9
2007	-	-
2008	0.13	50

[(1)] Average density expressed as number of fish (n) per million (10^6) cubic meters (m^3) of water withdrawn through the intake screens.

Year	Mean Density(1) (n/10^6 m^3)	% Dead or Injured
A "-" indicates that no butterfish were collected during the given year.		
Sources: PSEG, 1996; 1997; 1998; 1999a; 2000; 2001; 2002; 2003; 2004; 2005; 2006a; 2007; 2008; 2009c		

Butterfish impingement densities at Salem are rather small in comparison to other impinged fish species. As part of their biological monitoring program, PSEG studies 13 Representative Species in detail. Representative Species comprise "Representative Important Species" per the 1977 316(b) Rule and target species to be consistent with the published Phase II Rule. The average impingement densities of these Representative Species appear in Table 12 for the monitoring period 1995 through 2008. Butterfish, with an average density of 0.87 fish per million cubic meters of water from 1995 through 2008, are impinged at a significantly lower rate than all 12 Representative Species.

Table 12. Representative Species Average Impingement Densities at Salem, 1995-2008

Common Name	Scientific Name	Average Density(1) (n/10^6 m^3)
Atlantic croaker	*Micropogonias undulatus*	917.94
blue crab	*Callinectes sapidus*	842.50
white perch	*Morone americana*	783.12
weakfish	*Cynoscion regalis*	565.97
bay anchovy	*Anchoa mitchilli*	132.01
striped bass	*Morone saxatilis*	61.40
blueback herring	*Alosa aestivalis*	58.56
Atlantic silverside	*Menidia menidia*	46.84
spot	*Leiostomus xanthurus*	14.88
alewife	*Alosa pseudoharengus*	11.35
American shad	*Also sapidissima*	8.02
(1)Average density expressed as number of fish (n) per million (10^6) cubic meters (m^3) of water withdrawn through the intake screens.		
Sources: PSEG, 1996; 1997; 1998; 1999a; 2000; 2001; 2002; 2003; 2004; 2005; 2006a; 2007; 2008; 2009c		

PSEG has not conducted impingement sampling at HCGS, but the NRC expects that HCGS would impinge butterfish at a significantly lower rate than Salem. HCGS has a closed-cycle cooling system, which takes in less water (66.8 mgd [253,000 m^3/d] on average) than Salem (3,024 mgd [11.4 million m^3/d]). Additionally, HCGS's slower intake velocity (0.35 fps [0.11 m/s]) compared to Salem's (0.9 fps [0.3 m/s] at Salem) increases the likelihood that smaller and/or slower fish would be able to escape from the intake area prior to being impinged.

Because PSEG's EEP is a requirement of Salem's NJPDES permit, activities associated with the EEP (discussed in Section 2.4) serve to mitigate impingement and entrainment losses at Salem and HCGS. However, because EEP activities are focused on wetland and marsh areas, only losses to those fish species that inhabit wetlands and marshes would be recovered. Butterfish generally do not inhabit these types of habitats, and, therefore, EEP activities are not likely to mitigate butterfish impingement losses.

Though no total annual impingement numbers (actual or estimated) for butterfish are available and the EEP's mitigative activities are not likely to replace lost butterfish, the NRC staff concludes that the low butterfish impingement densities in PSEG's ongoing impingement monitoring samples indicate that Salem and HCGS will not result in a substantial adverse effect to juvenile butterfish during the remainder of the facilities' operating licenses or during the proposed license renewal term.

4.1.2 Entrainment

PSEG conducts ongoing entrainment sampling as part of their biological monitoring program. PSEG collects impingement samples from the intake bay at the mid-point of the water column 3 times per week over a 24-hour period in January through March and August through December. From April through July, samples are collected over four sample days per week due to the increased egg and larvae densities at this time of year. PSEG has not collected butterfish eggs, larvae, or juveniles in any of its entrainment samples from 1995 through 2008. (PSEG, 2009c)

Because PSEG has not collected any butterfish in entrainment sampling, the NRC staff concludes that entrainment will not adversely affect juvenile butterfish during the remainder of the facilities' operating licenses or during the proposed license renewal term.

4.1.3 Thermal Effects

Heat shock, which is acute thermal stress caused by a sudden elevation in water temperature, can result in injury or mortality to fish. In the SEIS for Salem and HCGS (NRC, 2010), the NRC staff concluded that impacts to all species of fish and shellfish from heat shock at Salem and HCGS would be small because both Salem and HCGS have NJPDES permits that place thermal limits on the maximum discharge temperature and maximum change in ambient estuary temperature caused by facility discharge. Additionally, the high exit velocity of discharge water produces rapid dilution, which limits high temperatures to relatively small areas of the initial mixing zones for both Salem and HCGS. Aquatic species, including juvenile butterfish, may largely avoid these areas due to high velocities and turbulence.

The NRC staff does not expect Salem and HCGS's thermal discharges to reduce available habitat to juvenile butterfish. Juvenile butterfish EFH temperature requirements range from 37.4 °F to 82.4 °F (3 °C to 28 °C) (NMFS, 2010a). Average ambient surface water temperatures in the Delaware Estuary in the vicinity of Salem and HCGS vary between 34.5 °F (1.4 °C) in February to 80.8 °F (27.1 °C) in August (NRC, 1984), which would only naturally exclude this reach of the Delaware Estuary as juvenile butterfish EFH during the coldest winter months when the surface water temperatures dip below 37.4 °F (3 °C). In the summer months, Salem may discharge water with a maximum change in temperature of 27.5 °F (15.3 °C) and a maximum absolute temperature of 115 °F (46.1 °C) per the facility's NJPDES permit (PSEG, 1999b). Per HCGS's NJPDES permit, HCGS may discharge water not to exceed 86 °F (30 °C) outside of its heat dissipation zone, which extends 2500 ft (762 m) upstream or downstream and 1500 ft (457 m) offshore from the discharge point (Najarian Associates, 2004). Within the heat dissipation zone, the NRC staff assumes that temperatures exceed 86 °F (30 °C) in the summer months. Though both Salem and HCGS discharge water that exceeds the maximum temperature for juvenile butterfish EFH, juvenile butterfish are generally found in bottom habitats at depths of 33 to 1,200 ft (10 to 365 m). Therefore, because the buoyant thermal plume at the discharge points would rise toward the surface of the estuary, the NRC staff conclude that the increased temperatures at Salem and HCGS is not likely to adversely affect juvenile butterfish during the remainder of the facilities' operating licenses or during the proposed license renewal term.

4.1.4 Loss of Forage Species

Butterfish prey mainly on urochordates and mollusks, with minor food sources including squid, crustaceans such as amphipods and shrimp, annelid worms, and small fishes (Bigelow and Schroeder, 2002; Cross et al., 1999). Because impingement and entrainment data is unavailable to calculate losses of butterfish prey species, the NRC staff considered the volume of water that flows through Salem and HCGS compared with the average flow of water into the Delaware Estuary.

As described in Section 2.3, Salem's NJPDES permit allows the facility to withdraw 3,024 mgd (11.4 million m^3/d) with a monthly maximum of 90,720 million gal (343 million m^3). HCGS's NJPDES permit does not specify water withdrawal limits, but HCGS withdraws an average of 66.8 mgd (253,000 m^3/d). PSEG's 316(a) Demonstration as part of their 1999 NJPDES permit renewal application (PSEG, 1999a) notes that the average inflow of freshwater to the Delaware Estuary is 20,243 cubic feet per second (ft^3/s; 573.2 cubic meters per second [m^3/s]). Therefore, Salem and HCGS are withdrawing a combined 4,782 ft^3/s (135 m^3/s), or about 23.6 percent of the freshwater inflow to the Delaware Estuary. If zero survivorship for small invertebrates entrained in the plants' intakes is assumed, then Salem and HCGS are adversely affecting juvenile butterfish EFH by reducing the quantity of prey species available.

However, as described in Section 2.4, PSEG estimated that secondary production attributable to EEP activities was 2.3 times higher than the annual secondary production lost from impingement and entrainment, which suggests that when considered together, the positive impacts of PSEG's restoration activities and the adverse impacts of Salem and HCGS's water intakes are producing a net positive impact to primary production (i.e. forage species). Therefore, the NRC staff anticipates that loss of forage species from entrainment at Salem and HCGS will not have a net adverse effect to juvenile butterfish during the remainder of the facilities' operating licenses or during the proposed license renewal term.

4.2 Windowpane

As discussed in Section 3.2.2, the NMFS has designated EFH for windowpane eggs, larvae, juveniles, adults, and spawning adults within the vicinity of Salem and HCGS. The potential effects to this species' EFH as a result of the proposed action are considered in the following sections.

4.2.1 Impingement

The NRC staff obtained data on windowpane impingement from PSEG's Annual Biological Monitoring Reports for the period 1995 through 2008. As described in

Section 4.1.1, PSEG collects impingement samples three times per week between January and December of each year. For each sample day, 10 samples are collected every 2.5 hrs in order to include two full tidal cycles (PSEG, 2009c).

Data on windowpane impingement during the 1995 to 2008 period appears in Table 14. The impingement densities include both juveniles and adults because PSEG does not differentiate during their monitoring collections. Total annual impingement numbers (actual or estimated) for windowpane are not available.

Table 14. Windowpane Impingement Sampling at Salem, 1995-2008

Year	Total Collected	Mean Density ($n/10^6\ m^3$)	% Dead or Injured
1995	29	6.46	0
1996	0	-	-
1997	40	3.10	0
1998	1	0.08	100
1999	10	0.75	20
2000	1	0.06	0
2001	19	0.98	5
2002	40	2.27	0
2003	56	3.19	0
2004	36	2.51	0
2005	14	0.96	0
2006	200	10.71	0
2007	2	0.01	0
2008	2	0.13	0

Sources: PSEG, 1996; 1997; 1998; 1999a; 2000; 2001; 2002; 2003; 2004; 2005; 2006a; 2007; 2008; 2009c

Windowpane impingement densities at Salem have fluctuated greatly between sampling years, but impingement densities have remained rather small in comparison to Representative Species impingement densities (Table 12). Windowpane have only been impinged at a higher rate in one year (2006 at 10.71 fish per million cubic meters of water) than the Representative Species with the lowest average impingement density (American shad at 8.06 fish per million cubic meters of water), and on average over the sampling period, windowpane are impinged at a lower rate than all Representative Species.

As discussed in Section 4.1.1, PSEG does not conduct impingement sampling at HCGS, but the NRC expects that HCGS would impinge windowpane at a significantly lower rate than Salem.

Because PSEG's EEP is a requirement of Salem's NJPDES permit, activities associated with the EEP (discussed in Section 2.4) serve to mitigate impingement and entrainment losses at Salem and HCGS. However, because EEP activities are focused on wetland and marsh areas, only losses to those fish species that inhabit wetlands and marshes would be recovered. All life stages of the windowpane inhabit or use estuary habitats, but the species does not specifically rely upon estuarine marshes for any life stage. In a study on spatial variation of fish assemblages in the Delaware Bay, Able et al. (2001) found windowpane to be transient inhabitants of one of five sampled Delaware Bay marshes. Therefore, EEP activities are likely to replace some windowpane impingement losses, but the EEP would not be directly attributed to locally increasing the windowpane population.

Because data from Salem's biological monitoring reports indicate that windowpane are impinged at a low rate and the EEP is likely to replace some windowpane losses, the NRC staff does not expect the low densities of windowpane impingement to adversely affect windowpane during the remainder of the facilities' operating licenses or during the proposed license renewal term.

4.2.2 Entrainment

PSEG conducts ongoing entrainment sampling (described in Section 4.1.2) as part of their biological monitoring program. Data on windowpane entrainment during the 1995 to 2008 period appear in Table 15. Total annual entrainment numbers (actual or estimated) for windowpane are not available.

Table 15. Windowpane Entrainment Sampling at Salem, 1995-2008

Year	Larvae Collected	Mean Density ($n/10^6\ m^3$)	Juveniles Collected	Mean Density ($n/10^6\ m^3$)
1995	0	0.01	1	0.01
1996	0	-	0	-
1997	0	-	0	-
1998	0	-	0	-
1999	0	-	0	-
2000	0	-	0	-
2001	0	-	0	-
2002	1	<0.01	0	-
2003	5	0.01	0	-
2004	0	-	0	-
2005	0	-	0	-
2006	1	<0.01	0	-
2007	0	-	0	-
2008	0	-	0	-

Sources: PSEG, 1996; 1997; 1998; 1999a; 2000; 2001; 2002; 2003; 2004; 2005; 2006a; 2007; 2008; 2009c

PSEG has not estimated annual entrainment losses specifically for the windowpane. However, given that windowpane rarely appeared in entrainment samples at Salem from 1995 to 2008, the NRC staff conclude that entrainment in unlikely to adversely affect windowpane during the remainder of the facilities' operating licenses or during the proposed license renewal term.

4.2.3 Thermal Effects

The adverse effects of heat shock on the windowpane are the same as those described for the butterfish in Section 4.1.3. The NRC staff does not expect heat shock to adversely affect the windowpane at any life stage.

The NRC staff does not expect Salem and HCGS's thermal discharges to reduce available habitat to windowpane at any life stage. Windowpane EFH temperature requirements appear in Table 8. Based on average ambient surface water temperatures in the Delaware Estuary in the vicinity of Salem and HCGS, eggs, larvae, juveniles, and spawning adults are expected to naturally avoid the immediate vicinity of Salem and HCGS in the summer months. Non-spawning adults would potentially remain in the immediate area in the summer months because their temperature limit (80.2 °F [26.8 °C]) is similar to the average ambient surface water temperature of 80.8 °F (27.1 °C) in August. Similar to the butterfish (discussed in Section 4.1.3), the windowpane is more likely to occur in bottom habitats. Because the area of the thermal plume from each facility's discharge is small, and the temperature change is greatest near the surface due to the buoyancy of the plume, the NRC staff conclude that the increased temperatures at Salem and HCGS is not likely to adversely affect windowpane during the remainder of the facilities' operating licenses or during the proposed license renewal term.

4.2.4 Loss of Forage Species

Juvenile and adult windowpane eat small crustaceans and fish larvae of hakes and cod (Gadidae). Similar to the butterfish's prey species, impingement and entrainment data is unavailable to calculate losses of windowpane prey species. However, the NRC staff considers the discussion in Section 4.1.4 on loss of butterfish forage species to be applicable to windowpane. The NRC staff concludes that Salem and HCGS are adversely affecting juvenile and adult windowpane EFH by reducing the quantity of prey species available, but that the increased primary production as a result of EEP activities (discussed in Section 2.4) will not result in a net adverse effect to windowpane during the remainder of the facilities' operating licenses or during the proposed license renewal term.

4.3 Winter Flounder

As discussed in Section 3.2.2, the NMFS has designated EFH for winter flounder eggs, larvae, juveniles, adults, and spawning adults within the vicinity of Salem and HCGS. The potential effects to this species' EFH as a result of the proposed action are considered in the following sections.

4.3.1 Impingement

The NRC staff obtained data on winter flounder impingement from PSEG's Annual Biological Monitoring Reports for the period 1995 through 2008. As described in Section 4.1.1, PSEG collects impingement samples three times per week between January and December of each year. For each sample day, 10 samples are collected every 2.5 hrs in order to include two full tidal cycles (PSEG, 2009c).

Data on winter flounder impingement during the 1995 to 2008 period appear in Table 14. The impingement densities include both juveniles and adults because PSEG does not differentiate during their monitoring collections. Total annual impingement numbers (actual or estimated) for winter flounder are not available.

Table 16. Winter Flounder Impingement Sampling at Salem, 1995-2008

Year	Total Collected	Mean Density ($n/10^6$ m^3)	% Dead or Injured
1995	12	4.03	0
1996	17	4.78	0
1997	5	0.50	0
1998	15	1.07	0
1999	193	14.50	2
2000	14	0.85	7
2001	18	0.93	0
2002	1	0.06	0
2003	23	1.31	13
2004	2	0.14	0
2005	17	1.17	0
2006	33	1.77	6
2007	0	-	-
2008	0	-	-

Sources: PSEG, 1996; 1997; 1998; 1999a; 2000; 2001; 2002; 2003; 2004; 2005; 2006a; 2007; 2008; 2009c

Winter flounder impingement densities at Salem are rather small in comparison to average impingement densities of the Representative Species (Table 12). Winter flounder impingement densities spiked in one year (1999) at 14.50 individuals per million cubic meters of water, which is higher than both the alewife's and American shad's average impingement densities. However, all other years, PSEG has reported winter flounder to be impinged at rates significantly lower than all Representative Species.

As discussed in Section 4.1.1, PSEG does not conduct impingement sampling at HCGS, but the NRC expects that HCGS would impinge winter flounder at a significantly lower rate than Salem.

Because PSEG's EEP is a requirement of Salem's NJPDES permit, activities associated with the EEP (discussed in Section 2.4) serve to mitigate impingement and entrainment losses at Salem and HCGS. However, because EEP activities are focused on wetland and marsh areas, only losses to those fish species that inhabit wetlands and marshes would be recovered. Able et al. (2001) found winter flounder to be residents in four out of five sampled Delaware Bay marshes. Therefore, the increased production associated with EEP activities is likely to provide additional winter flounder habitat and to replace a significant portion of winter flounder impingement losses at Salem and HCGS.

When considered with the increased production associated with Salem's EEP, which is likely to provide additional winter flounder habitat and to replace a significant portion of impingement losses, the NRC staff does not expect the low densities of winter flounder impingement to adversely affect the winter flounder during the remainder of the facilities' operating licenses or during the proposed license renewal term.

4.3.2 Entrainment

PSEG conducts ongoing entrainment sampling (described in Section 4.1.2) as part of their biological monitoring program. Data on winter flounder entrainment during the 1995 to 2008 period appear in Table 16. Total annual entrainment numbers (actual or estimated) for winter flounder are not available.

Table 15. Winter Flounder Entrainment Sampling at Salem, 1995-2008

Year	Larvae Collected	Mean Density ($n/10^6\ m^3$)	Juveniles Collected	Mean Density ($n/10^6\ m^3$)
1995	0	-	0	-
1996	0	-	0	-
1997	0	-	0	-
1998	0	-	0	-
1999	2	0.01	1	<0.01
2000	0	-	1	<0.01
2001	0	-	1	<0.01
2002	1	<0.01	0	-
2003	5	0.01	0	-
2004	0	-	0	-
2005	0	-	1	<0.01
2006	3	<0.01	7	0.01
2007	1	<0.01	2	<0.01
2008	0	-	0	-

Sources: PSEG, 1996; 1997; 1998; 1999a; 2000; 2001; 2002; 2003; 2004; 2005; 2006a; 2007; 2008; 2009c

PSEG has not estimated annual entrainment losses specifically for the winter flounder. However, given that windowpane rarely appeared in entrainment samples at Salem from 1995 to 2008, the NRC staff conclude that entrainment in unlikely to adversely affect winter flounder during the remainder of the facilities' operating licenses or during the proposed license renewal term.

4.3.3 Thermal Effects

The adverse effects of heat shock on the winter flounder are the same as those described for the butterfish in Section 4.1.3. The NRC staff does not expect heat shock to adversely affect the winter flounder at any life stage.

The NRC staff does not expect Salem and HCGS's thermal discharges to reduce available habitat to winter flounder at any life stage. Winter EFH temperature requirements appear in Table 9. Based on average ambient surface water temperatures in the Delaware Estuary in the vicinity of Salem and HCGS, eggs, larvae, and spawning adults are expected to naturally avoid the immediate vicinity of Salem and HCGS in warmer months. Juveniles and adults would potentially remain in the immediate area in the summer months, but adults would likely disperse in the hottest months because their temperature limit (77 °F [25 °C]) is lower than the average ambient surface water temperature of 80.8 °F (27.1 °C) in August. Similar to the butterfish and windowpane (discussed in Sections 4.1.3 and 4.2.3, respectively), the winter flounder is more likely to occur in bottom habitats. Because the area of the thermal plume from each facility's discharge is small, and the temperature change is greatest near the surface due to the buoyancy of the plume, the NRC staff concludes that the increased temperatures at Salem and HCGS is not likely to adversely affect the winter flounder during the remainder of the facilities' operating licenses or during the proposed license renewal term.

4.3.4 Loss of Forage Species

Winter flounder larvae feed on small invertebrates, invertebrate eggs, and phytoplankton and adults feed on benthic invertebrates such as polychaetes, cnidarians, mollusks, and hydrozoans. Impingement and entrainment data is unavailable to calculate losses of winter flounder prey species. However, the NRC staff considers the discussion in Section 4.1.4 on loss of butterfish forage species to be applicable to winter flounder and conclude that Salem and HCGS are adversely affecting juvenile and adult winter flounder EFH by reducing the quantity of prey species available, but that the increased primary production as a result of EEP activities (discussed in Section 2.4) will not result in a net adverse effect to winter flounder during the remainder of the facilities' operating licenses or during the proposed license renewal term.

5.0 Cumulative Effects to EFH

Construction and Operation of an Additional Nuclear Facility on Artificial Island

On May 25, 2010, PSEG submitted to NRC an application for an Early Site Permit for the possible construction and operation of a new two-unit nuclear facility on Artificial Island (PSEG, 2010). If approved, construction of this facility would begin in 2016. The new facility would have a closed-cycle cooling system such as the cooling system at HCGS. Therefore, impacts from the new facility would be similar to HCGS. The new facility would likely impinge a small number of EFH species annually; would not contribute any noticeable thermal effects to EFH species; and would entrain some EFH species' prey species. Because PSEG (2006b) estimated that the increase in production attributable to EEP restoration activities was 2.3 times the annual production lost from impingement and entrainment at Salem, the EEP would likely make up for some fish losses resulting from the new facility. The facility would also be subject to NJDEP's NJPDES permitting, which would set limitations on water intake and effluent and heated discharge to be protective of aquatic life.

Other Water-Withdrawing and Discharging Facilities in the Delaware Estuary

Water-withdrawing and discharging facilities can adversely affect aquatic habitats entraining and impinging aquatic organisms, impairing fish passage, altering local hydrological regimes, degrading water quality, releasing contaminants, and causing siltation/sedimentation (Johnson et al., 2008). No large industrial facilities lie downstream of Artificial Island on either side of the estuary south to the mouth of Delaware Bay. An oil refinery lies upstream of Artificial Island in Delaware approximately 8 mi (13 km) to the north, and many industrial facilities are upstream from there (PSEG, 2009a). Many of these facilities are permitted to withdraw water from the river and to discharge effluents to the river. In addition, water is withdrawn from the non-tidal, freshwater reaches of the river to supply municipal water throughout New Jersey, Pennsylvania, and New York. In the tidal portion of the river, water is used for power plant cooling systems as well as industrial operations. DRBC-approved water users in this reach include 22 industrial facilities and 14 power plants in Delaware, New Jersey, and Pennsylvania (DRBC, 2005). To put these facilities' water withdrawals in perspective, Salem uses by far the largest volume of water in the tidal portion of the river with a withdrawal volume that exceeds the combined total withdrawal for all other industrial, power, and public water supply purposes (DRBC, 2005). Given this fact, the combined adverse impacts from impingement of EFH species at other water-withdrawing facilities are likely to be similar to the adverse impact from impingement at Salem with some variance based on water velocity at the intake and local habitat conditions.

<u>Fishing Pressure</u>

The status of the butterfish, windowpane, and winter flounder fisheries is discussed in Sections 3.2.1, 3.2.2, and 3.2.3, respectively. All three species' stocks have been in decline for the past few decades. The butterfish and windowpane are often taken as bycatch, which makes landing estimates difficult to accurately quantify. Each species' fishery is managed by the MAFMC and/or the NEFMC; however, the continued decline in landings suggests that fishing pressure is likely to continue to impact the three species.

<u>Habitat Loss and Restoration</u>

Alterations to terrestrial, wetland, shoreline, and aquatic habitats have occurred in the Delaware Estuary since colonial times, and development, agriculture, and other upland habitat alterations within the watershed have affected water quality. The creation of dams and the filling or isolation of wetlands to support industrial and agricultural activities has dramatically changed patterns of nutrient and sediment loading to the estuary. Such activities also have reduced productive marsh habitats and limited access of anadromous fish to upstream spawning habitats. In addition, historic dredging and deposition activities have altered estuarine environments and affected flow patterns, and future activities, such as dredging to deepen the shipping channel through the estuary, may continue to influence estuarine habitats. Development along the shores of the estuary in some places also has resulted in the loss of shoreline habitat.

Although habitat loss in the vicinity of the Delaware Estuary continues to occur currently and is likely in the future, habitat restoration activities have had a beneficial effect on the estuary and are expected to continue as a requirement of the Salem NJPDES permit during the license renewal term (see Section 4.1.1 for a description of Salem's EEP). In addition, NRC expects wetland permitting regulations to limit future losses of wetland habitat from development in the watershed. Thus, the net cumulative impacts on EFH within the estuary are likely to be minimal in the future, and restoration activities are expected to provide ongoing habitat improvements.

6.0 EFH Conservation Measures

6.1 Salem

The NRC staff identified a number of conservation measures and best management practices at Salem that would reduce the potential adverse effects to EFH. These measures include:

- closed-cycle cooling,
- derating the facility,

- operating under reduced intake flows, and
- scheduling plant outages during historic peak impingement periods.

However, the NRC does not have the authority to mandate these measures. Jurisdiction for such changes lies with the NJDEP, which has the authority to impose or modify requirements, such as the cooling system design, under the NJPDES permitting process.

6.2 HCGS

Closed-cycle cooling systems, such as the one already operating at HCGS, are the most reasonable way to mitigate the number of aquatic organisms entrained and impinged in the facility's cooling system. The NRC staff identified continuous operation of the traveling screens as a method that may reduce the mortality of those organisms that are impinged at HCGS.

7.0 Conclusions

Conclusions regarding Salem and HCGS's adverse effects on EFH are addressed in the following sections by species. All conclusions are made for the combined period of continued operation under Salem and HCGS's current operating licenses (6 and 10 years for Salem, Units 1 and 2, respectively, and 16 years for HCGS) and the proposed 20-year relicensing period.

7.1 Atlantic Butterfish

The NRC staff concludes that Salem and HCGS will have **a minimal adverse effect** on juvenile butterfish EFH. The NRC staff concludes that Salem and HCGS will continue to impinge a small number of juvenile butterfish each year. PSEG's EEP focuses on estuary wetlands and marshes, and the NRC staff, therefore, does not expect the EEP to reduce the adverse effect to butterfish because it is primarily a pelagic species and is not found in Delaware Bay wetlands and marshes.

7.2 Windowpane

The NRC staff concludes that Salem and HCGS will have **a minimal adverse effect** on juvenile and adult windowpane EFH. The NRC staff concludes that Salem and HCGS will continue to impinge a small number of juvenile and adult windowpane each year. However, the NRC staff expects the increased secondary production associated with EEP activities to replace a portion of the windowpane lost to impingement because the EEP focuses on Delaware Bay marshes and wetlands and Able et al. (2001) reported the windowpane to occur in Delaware Bay marsh and wetland areas with moderate frequency.

The NRC staff concludes that Salem and HCGS will have **no adverse effect** on windowpane eggs and larvae. The NRC staff concludes that Salem and HCGS will not entrain windowpane eggs because PSEG's ecological monitoring reports from 1995 through 2008 did not record the entrainment of any windowpane eggs, and the NRC staff expects this to remain true of future years. The NRC staff concludes that Salem and HCGS will continue to entrain a negligible number of windowpane larvae each year, but expect the increased secondary production associated with the EEP activities to replace these minimal losses.

7.3 Winter Flounder

The NRC staff concludes that Salem and HCGS will have **no adverse effect** on winter flounder EFH. The NRC staff concludes that Salem and HCGS will continue to impinge a small number of juvenile and adult winter flounder each year and entrain a negligible number of windowpane larvae and juveniles during the period of continued operation and proposed license renewal. However, the NRC staff expects the increased secondary production associated with Salem's EEP activities to replace the majority of winter flounder lost to impingement because the EEP focuses on Delaware Bay marshes and wetlands and Able et al. (2001) reported the winter flounder to occur in Delaware Bay marshes and wetlands with high frequency.

8.0 References

16 U.S.C. 1802. *United States Code*. Title 10, *Conservation*, Chapter 38, *Fishery Conservation and Management*, Part 1802, "Definitions."

50 CFR 600. *Code of Federal Regulations*, Title 50, *Wildlife and Fisheries*, Part 60, "Magnuson-Stevens Act Provisions."

75 FR 66398. U.S. Nuclear Regulatory Commission. "Notice of Availability of the Draft Supplement 45 to the Generic Environmental Impact Statement for License Renewal of Nuclear Plants, and Public Meetings for the License Renewal of Hope Creek Generating Station and Salem Nuclear Generating Station, Units 1 and 2." *Federal Register*: Volume 75, No. 208, pp. 66398-66399. October 28, 2010.

Able, K.W., D.M. Nemerson, R. Bush, and P. Light. 2001. Spatial Variation in Delaware Bay (U.S.A) Marsh Creek Fish Assemblages. *Estuaries*, Vol. 24, No. 3, pp. 441-452. June 2001. Available URL: http://www.springerlink.com/content/n1442v82316640kn/fulltext.pdf (accessed January 5, 2011).

AEC (Atomic Energy Commission). 1973. Final Environmental Statement Related to the Salem Nuclear Generating Station Units 1 and 2, Public Service Electric and Gas Company. Docket Nos. 50-272 and 50-311, Washington, D.C., April 1973.

ASMFC (Atlantic States Marine Fisheries Commission). 2009. "Overview of Stock Status: Winter Flounder, *Pseudopleuronectes americanus*." August 4, 2009. Available URL: http://www.asmfc.org/speciesDocuments/winterFlounder/stockStatus.pdf (accessed December 10, 2010).

Bigelow, H.B., and W.C. Schroeder. 2002. "Butterfish, *Porontus triacanthus* (Peck) 1800: in *Fishes of the Gulf of Maine*. Fishery Bulletin of the Fish and Wildlife Service, No. 74, Vol. 53. Revision 1.1. Originally published in 1953. Available URL: http://www.gma.org/fogm/Poronotus_triacanthus.htm (accessed December 14, 2010).

Buckley, J. 1989. *Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (North Atlantic) – Winter Flounder*. U.S. Fish and Wildlife Service Biological Report, 82(11.87), U.S. Army Corps of Engineers, TR EL 82 4. Available URL: http://www.nwrc.usgs.gov/wdb/pub/species_profiles/82_11-087.pdf (accessed September 7, 2010).

Chang, S. P.L. Berrien, D.L. Johnson, and W.W. Morse. 1999. *Essential Fish Habitat Source Document: Windowpane*, Scophthalmus aquosus*, Life History and Habitat Characteristics*. NOAA Technical Memorandum NMFS-NE-137. September 1999. Available URL: http://www.nefsc.noaa.gov/nefsc/publications/tm/tm137/tm137.pdf (accessed December 7, 2010).

Cowardin, L. M., V. Carter, F. C. Golet, E. T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U. S. Department of the Interior, U.S. Fish and Wildlife Service. Available URL: http://www.npwrc.usgs.gov/resource/wetlands/classwet/index.htm (accessed December 6, 2010).

Cross, J.N., C.A. Zetlin, P.L. Berrien, D.L. Johnson, and C. McBride. 1999. *Essential Fish Habitat Source Document: Butterfish*, Peprilus triacanthus*, Life History and Habitat Characteristics*. NOAA Technical Memorandum NMFS-NE-145. September 1999. Available URL: http://www.nefsc.noaa.gov/nefsc/publications/tm/tm145/tm145.pdf (accessed December 7, 2010).

DRBC (Delaware River Basin Commission). 1977. Contract No. 76-EP-482 Covering to Provide the Supply of Cooling Water from the Delaware River, Required for Operation of Salem Units 1 and 2 at Salem Nuclear Generating Station between the Delaware River Basin Commission and Public Service Electric and Gas Company. January 13, 1977.

DRBC (Delaware River Basin Commission). 1984a. Notice of Commission Action: Revision of the Hope Creek Generating Station Project Previously Included in the Comprehensive Plan. Docket No. D-73-193 CP (Revised). May 1, 1984.

DRBC (Delaware River Basin Commission). 1984b. Water Contract Between the DRBC and PSEG Concerning the Water Supply at Hope Creek Generating Station, West Trenton, NJ. December 1984.

DRBC (Delaware River Basin Commission). 2001. Letter from M.F. Vaskis, Associate General, Environmental Counsel, to H. Keiser et al., Public Service Electric and Gas Company. Subject: Approval to Revise Delaware Basin Compact. Docket No. D-68-20 (Revision 2). September 26, 2001.

DRBC (Delaware River Basin Commission). 2005. "Year 2005 Water Withdrawal and Consumptive Use by Large Users on the Tidal Delaware River." Available URL: http://www.state.nj.us/drbc/wateruse/largeusers_05.htm (accessed December 15, 2010).

EPA (U.S. Environmental Protection Agency). 1998. *Condition of the Mid-Atlantic Estuaries*, EPA 600-R-98-147. November 1998. Available URL: http://www.epa.gov/emap/html/pubs/docs/groupdocs/estuary/assess/cond_mae.pdf (accessed November 18, 2010).

Grimes, B.H., M.T. Huish, J.H. Kerby, and D.P Moran. 1989. *Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid Atlantic) – Summer and Winter Flounder*. U.S. Fish and Wildlife Service Biological Report, 82(11.112), U.S. Army Corps of Engineers, TR EL 82 4. Available URL: http://www.nwrc.usgs.gov/wdb/pub/species_profiles/82_11-112.pdf (accessed September 7, 2010).

Hendrickson, L. 2006. "Status of Fishery Resources off the Northeastern U.S.: Windowpane Flounder (*Scophthalmus aquosus*)." December 2006. Available URL: http://www.nefsc.noaa.gov/sos/spsyn/fldrs/window/ (accessed December 10, 2010).

Hendrickson, L., P. Nitschke, and M. Terceiro. 2006. "Status of Fishery Resources off the Northeastern U.S.: Winter Flounder (*Pseudopleuronectes americanus*)." December 2006. Available URL: http://www.nefsc.noaa.gov/sos/spsyn/fldrs/winter/ (accessed December 8, 2010).

Johnson, M.R., C. Boelke, L.A. Chiarella, P.D. Colosi, K. Greene, K. Lellis-Dibble, H. Ludemann, M. Ludwig, S. McDermott, J. Ortiz, D. Rusanowsky, M. Scott, and J. Smith. 2008. *Impacts to Marine Fisheries Habitat from Nonfishing Activities in the Northeastern*

United States. NOAA Technical Memorandum NMFS-NE-209. February 2008. Available URL: http://www.nefsc.noaa.gov/publications/tm/tm209/tm209.pdf (accessed December 15, 2010).

Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996. Public Law 104-267.

Morse, W.W. and K.W. Able. 1995. *Distribution and Life History of Windowpane, Scophthalmus aquosus, Off the Northeastern United States*. Fishery Bulletin, Vol. 93, No. 4, pp. 675 693. Available URL: http://fishbull.noaa.gov/934/morse.pdf (accessed September 7, 2010).

Najarian Associates. 2004. *Hydrological Modeling Analysis for the Hope Creek Generating Station Extended Power Uprate Project*. Final Report. Submitted to PSEG, Environmental Health and Safety, Newark, NJ.

National Environmental Policy Act of 1969. 42 U.S.C. 4321, et seq.

NEFMC (New England Fisheries Management Council). 1998a. "Essential Fish Habitat Description: Windowpane Flounder (*Scophthalmus aquosus*)." October 7, 1998. Available URL: http://www.nero.noaa.gov/hcd/windowpane.pdf (accessed December 7, 2010).

NEFMC (New England Fisheries Management Council). 1998b. "Essential Fish Habitat Description: Winter flounder (*Pleuronectes americanus*)." Available URL: http://www.nero.noaa.gov/hcd/winter.pdf (accessed February 10, 2010).

NEFSC (Northeast Fisheries Science Center). 2008. *Assessment of 19 Northeast Groundfish Stocks through 2007: Report of the 3rd Groundfish Assessment Review Meeting (GARM III)*. August 2008. Available URL: http://www.nefsc.noaa.gov/nefsc/publications/crd/crd0815/ (accessed December 10, 2010).

NJDEP (New Jersey Department of Environmental Protection). 2001. Final Surface Water Renewal Permit Action for Industrial Wastewater, Salem Generating Station, NJPDES Permit No. NJ0005622. June 2001. Provided in Appendix B of Applicant's Environmental Report (PSEG, 2009a).

NJDEP (New Jersey Department of Environmental Protection). 2003. Final Consolidated Renewal Permit Action for Industrial Wastewater and Stormwater, Hope Creek Generating Station, NJPDES Permit No. MJ0025411, January 2003. Provided in Appendix B of Applicant's Environmental Report (PSEG, 2009b).

NJSA (New Jersey State Atlas). 2008. "New Jersey Land Change Viewer: Interactive Maps." Available URL: http://njstateatlas.com/luc/ (accessed February 8, 2010).

NMFS (National Marine Fisheries Service). 2010a. "Essential Fish Habitat (EFH) for Butterfish." Available URL: http://www.nero.noaa.gov/hcd/butterfish.htm (accessed December 7, 2010).

NMFS (National Marine Fisheries Service). 2010b. "Essential Fish Habitat (EFH) Description: Windowpane Flounder (*Scophthalmus aquosus*)." Available URL: http://www.nero.noaa.gov/hcd/windowpane.pdf (accessed December 7, 2010).

NMFS (National Marine Fisheries Service). 2010c. "Essential Fish Habitat (EFH) Description: Winter Flounder (*Pleuronectes americanus*)." Available URL: http://www.nero.noaa.gov/hcd/winter.pdf (accessed December 7, 2010).

NMFS (National Marine Fisheries Service). 2010d. "Fishery Management Plans: Atlantic Mackerel, Squid, and Butterfish." November 23, 2010. Available URL: http://www.nero.noaa.gov/sfd/sfdsmb.html (accessed December 9, 2010).

NMFS (National Marine Fisheries Service). 2010e. Letter from S.W. Gorski, Field Office Supervisor, to B. Pham, Branch Chief, NRC. Subject: Salem and Hope Creek Nuclear Generating Station License Renewal Review, Salem County, New Jersey. February 23, 2010. ADAMS No. ML101970072.

NMFS (National Marine Fisheries Service). 2010f. "Summary of Essential Fish Habitat (EFH) and General Habitat Parameters for Federally Managed Species." Available URL: http://www.nero.noaa.gov/hcd/efhtables.pdf (accessed December 6, 2010).

NOAA (National Oceanic and Atmospheric Administration). 1985. *National Estuarine Inventory Data Atlas, Volume 1: Physical and Hydrological Characteristics*. November 1985. Available URL: http://www.nero.noaa.gov/hcd/National%20Estuarine%20Inventory%20-%20NE%20Region1.pdf (accessed December 8, 2010).

NOAA (National Oceanic and Atmospheric Administration). 2009. "NOAA Fisheries Weekly Quota Management Report for Butterfish, Week Ending December 26, 2009." Available URL: http://www.nero.noaa.gov/ro/fso/reports/reports_frame.htm (accessed December 9, 2010).

NOAA (National Oceanic and Atmospheric Administration). 2010a. "Butterfish Coastwide Weekly Landings Report." Available URL: http://www.nero.noaa.gov/ro/fso/reports/reports_frame.htm (accessed December 9, 2010).

NOAA (National Oceanic and Atmospheric Administration). 2010b. "Essential Fish Habitat Designations for New England Skate Complex." Available URL: http://www.nero.noaa.gov/hcd/skateefhmaps.htm (accessed December 6, 2010).

NOAA (National Oceanic and Atmospheric Administration). 2010c. *Guide to Essential Fish Habitat Designations in the Northeastern Unites States*. Available URL: http://www.nero.noaa.gov/hcd/webintro.html (accessed December 9, 2010).

NOAA (National Oceanic and Atmospheric Administration). 2010d. "Summary of Essential Fish Habitat (EFH) Designations for Delaware Bay, New Jersey/Delaware." Available URL: http://www.nero.noaa.gov/hcd/nj2.html (accessed December 7, 2010).

NRC (U.S. Nuclear Regulatory Commission (NRC). 1984. *Final Environmental Statement Related to the Operation of Hope Creek Generating Station*. NUREG-1074, Washington D.C. Docket Number 50-354. December 1984.

NRC (U.S. Nuclear Regulatory Commission). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437, Volumes 1 and 2, Washington, D.C. May 1996. ADAMS Nos. ML040690705 and ML040690738.

NRC (U.S. Nuclear Regulatory Commission). 2007. *Essential Fish Habitat for an Extended Power Uprate at Hope Creek Generating Station*. June 2007. Docket No. 50-354. ADAMS No. ML071520463.

NRC (U.S Nuclear Regulatory Commission). 2009. Letter from B. Pham, Branch Chief, to P. Kurkul, Regional Administrator, National Marine Fisheries Service. Subject: Request for List of Protected Species Within the Area Under Evaluation for the Salem and Hope Creek Nuclear Generating Stations License Renewal Application Review. December 23, 2009. ADAMS No. ML093500057.

NRC (U.S. Nuclear Regulatory Commission). 2010. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Regarding Hope Creek Generating Station and Salem Nuclear Generating Station, Units 1 and 2*. Draft Report for Comment. NUREG-1437, Supplement 45, Office of Nuclear Reactor Regulation, Washington, D.C. October 2010. ADAMS Nos. ML102940169 and ML102940267.

Overholtz, W. "Status of Fishery Resources Off the Northeastern U.S.: Butterfish (*Peprilus triacanthus*)." December 2006. Available URL: http://www.nefsc.noaa.gov/sos/spsyn/op/butter/#tab241 (accessed December 9, 2010).

Packer, D.B, S.J. Griesbach, P.L. Berrien, C.A. Zetlin, D.L. Johnson, and W.W. Morse. 1999. *Essential Fish Habitat Source Document: Summer Flounder,* Paralichthys dentatus*, Life History and Habitat Characteristics*. NOAA Technical Memorandum NMFS-NE-151. September 1999. Available URL: http://www.nefsc.noaa.gov/nefsc/publications/tm/tm151/tm151.pdf (accessed December 7, 2010).

Packer, D.B, C.A. Zetlin, and J.J. Vitaliano. 2003a. *Essential Fish Habitat Source Document: Clearnose Skate,* Raja eglanteria*, Life History and Habitat Characteristics*. NOAA Technical Memorandum NMFS-NE-174. March 2003. Available URL: http://www.nefsc.noaa.gov/nefsc/publications/tm/tm174/tm174.pdf (accessed December 7, 2010).

Packer, D.B, C.A. Zetlin, and J.J. Vitaliano. 2003b. *Essential Fish Habitat Source Document: Little Skate,* Leucoraja erinacea*, Life History and Habitat Characteristics*. NOAA Technical Memorandum NMFS-NE-175. March 2003. Available URL: http://www.nefsc.noaa.gov/nefsc/publications/tm/tm175/tm175.pdf (accessed December 7, 2010).

Packer, D.B, C.A. Zetlin, and J.J. Vitaliano. 2003c. *Essential Fish Habitat Source Document: Winter Skate,* Leucoraja ocellata*, Life History and Habitat Characteristics*. NOAA Technical Memorandum NMFS-NE-179. March 2003. Available URL: http://www.nefsc.noaa.gov/nefsc/publications/tm/tm179/tm179.pdf (accessed December 7, 2010).

Pereira, J.J., R. Goldberg, J.J. Ziskowski, P.L. Berrien, W.W. Morse, and D.L. Johnson. 1999. *Essential Fish Habitat Source Document: Winter Flounder*, Pseudopleuronectes americanus*, Life History and Habitat Characteristics*. NOAA Technical Memorandum NMFS-NE-138. September 1999. Available URL: http://www.nefsc.noaa.gov/nefsc/publications/tm/tm138/tm138.pdf (accessed December 7, 2010).

PSEG (PSEG Nuclear, LLC). 1996. Public Service Enterprise Group Biological Monitoring Program 1995 Annual Report.

PSEG (PSEG Nuclear, LLC). 1997. Public Service Enterprise Group Biological Monitoring Program 1996 Annual Report.

PSEG (PSEG Nuclear, LLC). 1998. Public Service Enterprise Group Biological Monitoring Program 1997 Annual Report.

PSEG (PSEG Nuclear, LLC). 1999a. Public Service Enterprise Group Biological Monitoring Program 1998 Annual Report.

PSEG (PSEG Nuclear, LLC). 1999b. Salem NJPDES Permit Renewal Application, NJPDES Permit No. NJ0005622, Public Service Enterprise Group, Newark, NJ. Appendix B: Description of Station and Station Operating Conditions. March 4, 1999.

PSEG (PSEG Nuclear, LLC). 2000. Public Service Enterprise Group Biological Monitoring Program 1999 Annual Report.

PSEG (PSEG Nuclear, LLC). 2001. Public Service Enterprise Group Biological Monitoring Program 2000 Annual Report.

PSEG (PSEG Nuclear, LLC). 2002. Public Service Enterprise Group Biological Monitoring Program 2001 Annual Report.

PSEG (PSEG Nuclear, LLC). 2003. Public Service Enterprise Group Biological Monitoring Program 2002 Annual Report.

PSEG (PSEG Nuclear, LLC). 2004. Public Service Enterprise Group Biological Monitoring Program 2003 Annual Report.

PSEG (PSEG Nuclear, LLC). 2005. Public Service Enterprise Group Biological Monitoring Program 2004 Annual Report.

PSEG (PSEG Nuclear, LLC).2006a.Public Service Enterprise Group Biological Monitoring Program 2005 Annual Report.

PSEG (PSEG Nuclear, LLC). 2006b. Salem Generating Station NJPDES Permit No. NJ0005622 Application for Renewal. Public Service Enterprise Group, Newark, NJ. January 31, 2006.

PSEG (PSEG Nuclear, LLC). 2007. Public Service Enterprise Group Biological Monitoring Program 2006 Annual Report.

PSEG (PSEG Nuclear, LLC). 2008. Public Service Enterprise Group Biological Monitoring Program 2007 Annual Report.

PSEG (PSEG Nuclear, LLC). 2009a. Salem Nuclear Generating Station, Units 1 and 2, License Renewal Application, Appendix E - Applicant's Environmental Report – Operating License Renewal Stage. Lower Alloways Creek Township, New Jersey. August 2009. ADAMS Nos. ML092400532, ML092400531, ML092430231.

PSEG (PSEG Nuclear, LLC). 2009b. Hope Creek Generating Station, License Renewal Application, Appendix E - Applicant's Environmental Report – Operating License Renewal Stage. Lower Alloways Creek Township, New Jersey. August, 2009. ADAMS No. ML092430389.

PSEG (PSEG Nuclear, LLC). 2009c. Public Service Enterprise Group Biological Monitoring Program 2008 Annual Report. *in* Salem/Hope Creek Environmental Audit—Post-Audit Information, Ecology, pp.232-537. ADAMS No. ML101440178.

PSEG (PSEG Nuclear, LLC). 2009d. Salem and Hope Creek Generating Stations 2008 Annual Radiological Environmental Operating Report. ADAMS Accession No. ML091200612.

PSEG (PSEG Nuclear, LLC). 2009e. Salem Generating Station – Updated Final Safety Analysis Report. Revision 24. May 11, 2009. ADAMS No. ML091390275.

PSEG (PSEG Nuclear, LLC). 2010. Letter from D. Lewis, Nuclear Development Project Director, and P. Davidson, Vice President of Operations Support, to Document Control Desk, NRC. Subject: Application for Early Site Permit for the PSEG Site. May 25, 2010. ADAMS No. ML101480484.