Public Service
Electric and Gas
Company

Steven E. Miltenberger Public Service Electric and Gas Company P.O. Box 236, Hancocks Bridge, NJ 08038 609-339-4199

Vice President and Chief Nuclear Officer

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United States Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Gentlemen:

BIOLOGICAL ASSESSMENT OF PLANT IMPACTS ON SEA TURTLES
SALEM GENERATING STATION
UNIT NOS. 1 AND 2
DOCKET NOS. 50-272 AND 50-311
HOPE CREEK GENERATING STATION
DOCKET NO. 50-354

Pursuant to NRC approval (December 14, 1988 letter from J. C. Stone to S. E. Miltenberger), Public Service Electric and Gas Company has prepared a report entitled:

> "Assessment of the Impacts of the Salem and Hope Creek Generating Stations on Kemp's Ridley (*Lepidochelys kempi*) and Loggerhead (*Caretta caretta*) Sea Turtles".

Incorporated in this report are the requisite items outlined in the December 14, 1988 letter, and responses to subsequent NRC suggestions.

This report provides a detailed description of the plant and its environs, sea turtle life histories, historical sea turtle occurrences at the plant, and projections of future interactions between sea turtles and the plant. Based upon the information presented, the company concludes that there will be no significant impact from plant operations on sea turtles.

C 001

If you have any questions on this matter, please do not hesitate to contact us.

Sincerely,

Attachment

C Mr. J. C. Stone
Licensing Project Manager - Salem

Ms. K. Halvey Gibson
Senior Resident Inspector - Salem

Mr. C. Y. Shiraki
Licensing Project Manager - Hope Creek

Mr. G. W. Meyer
Senior Resident Inspector - Hope Creek

Mr. W. T. Russell, Administrator
Region I

Mr. Kent Tosch, Chief
New Jersey Department of Environmental Protection
Division of Environmental Quality
Bureau of Nuclear Engineering
CN 415
Trenton, NJ 08625

Dr. M. Masnik - USNRC

Elaine Chan, Esq. - USNRC

Robert Schoelkopf
Marine Mammal Stranding Center

Douglas Beach
National Marine Fisheries Service

ASSESSMENT OF THE IMPACTS OF THE SALEM AND HOPE CREEK GENERATING STATIONS ON KEMP'S RIDLEY (Lepidochelys kempi) AND LOGGERHEAD (Caretta caretta) SEA TURTLES

Prepared by
Public Service Electric and Gas Company
Nuclear Department

June 1989

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SECTION 1.0
SUMMARY AND CONCLUSIONS

This "biological assessment" was prepared by Public Service Electric and Gas Company (PSE&G) for submittal to the U.S. Nuclear Regulatory Commission and the National Marine Fisheries Service to comply with Section 7 of the Endangered Species Act (the Act). The purpose of this assessment is to examine the potential impacts associated with the continued operation of PSE&G's Salem and Hope Creek Generating Stations on sea turtle species protected under the Act.

PSE&G's Salem (Unit Nos. 1 and 2) and Hope Creek Generating Stations are located on the southern end of Artificial Island in Lower Alloways Creek Township, Salem County, New Jersey. The stations are situated on the eastern shore of the Delaware River Estuary.

Artificial Island is located approximately 2 miles (3.2 kilometers) upstream of the head of Delaware Bay and approximately 50 miles (80 kilometers) upstream of the mouth of the Bay. Freshwater flow in the estuary averages 23,352 cubic feet per second (661 cubic meters per second) and tidal flows average 399,710 cubic feet per second (11,320 cubic meters per second). The salinity ranges from zero parts per thousand (ppt) to a maximum of 20 ppt. Water temperature in the river in the vicinity of the Artificial Island varies from 32°F (0°C) to 86°F (30°C).

Salem Generating Station consists of two pressurized water nuclear reactors with an electrical capacity of approximately 1,100 megawatts (MWe) per unit. Salem Station has two water intake structures, the Circulating Water System (CWS) and the Service Water System (SWS). The CWS intake withdraws 1.1 million gallons per minute (gpm) to condense steam in the main condensers of each unit. The SWS intake withdraws approximately 40,000 gpm to cool heat exchangers for the remainder of the equipment for both units including the safety related cooling systems. Both intakes utilize trash racks and vertical traveling screens to remove river debris from the water. The CWS intake has been the modified with Ristroph fish buckets and a fish return system.

Hope Creek Generating Station consists of one boiling water nuclear reactor of 1,067 MWe. It has one Service Water Intake which withdraws approximately 30,000 gpm. This intake also utilizes trash racks and vertical traveling screens to remove river debris from the water. The traveling screens have also been modified with Ristroph fish buckets and equipped with a fish return system. Service water at Hope Creek passes through miscellaneous heat exchangers, including safety related cooling systems, and then is used for make-up for the closed-cycle CWS. Heat removal in the CWS is accomplished through a natural draft cooling tower.

Five species of sea turtles have been reported from Delaware Bay and coastal New Jersey and Delaware. These sea turtle species are: loggerhead (Caretta caretta), Kemp's ridley (Lepidochelys kempi), green turtle (Chelonia mydas), leatherback (Dermochelys coriacea), and hawksbill (Eretomochelys imbricata). Three of these sea turtles species, Kemp's ridley, hawksbill and leatherback, are listed as endangered and and two, the loggerhead and green turtle are listed as threatened. The loggerhead and Kemp's ridley sea turtles are distributed throughout the Bay. The leatherback, green and hawksbill sea turtles occur primarily in the coastal areas of New Jersey and Delaware and around the mouth of the Bay.

The loggerhead sea turtle is the most common sea turtle in the coastal waters of the United States and occurs in many other locations throughout the world. Population numbers along the south Atlantic Coast (North Carolina to Florida) have been estimated at 387,594 turtles based on extrapolations from aerial surveys. The loggerhead population in the southeast is considered to be stable by most investigators but the population is threatened by reductions in nesting and foraging habitat by the continued development of coastal areas and losses due to incidental capture in shrimp trawls. An estimated 9,800 turtles are lost annually from trawling without the use of turtle exclusion devices (TED's).

The Kemp's ridley is the most endangered of the sea turtle species. There is only a single known colony of this species, almost all of which nest near Rancho Nuevo, Mexico and represent the world population for this species. The population level for this species has been estimated at 2,200 turtles based on estimates derived from observed numbers of nesting females in recent years and other life history parameters. Observations over the past ten years suggest that this population is declining at a rate of 3 percent per year. The ridley population is also impacted by coastal development and shrimp trawling. An estimated 760 turtles are lost annually through trawling alone.

Sea turtles have been observed and incidentally captured at Salem Generating Station and during field sampling associated with the station since 1977. A total of 44 sea turtles have been reported since 1979. The majority of these, thirty-eight, have been collected from the stations' circulating water intake trash racks. Of the thirty-eight turtles from the intake, twenty-six were loggerhead sea turtles and twelve were Kemp's ridleys. All specimens were subadults or juveniles.

Loggerheads were the more common of the two species captured from the CWS intake. The number of loggerheads captured annually since 1980 ranged from zero to eight (mean = 3). Eight of the twenty-six loggerheads captured were alive and these were released back into the wild. Among the eighteen dead turtles, eight were considered fresh dead and had either collapsed lungs or internal infections or damage which may have contributed to their deaths. The other ten dead turtles were either moderately or severely decomposed. Necropsies available for these turtles showed evidence of boat propeller damage and internal infections.

Kemp's ridley sea turtles were the less common of the two species captured from the CWS intake. The number of ridleys captured annually since 1980 ranged from zero to three (mean = 1.3). Six of the twelve ridleys captured were alive and five of these were released back into the wild. Among the six dead turtles, three were considered fresh dead and had collapsed lungs. The other three dead turtles were either moderately or severely decomposed. Two of these turtles showed evidence of boat propeller damage.

The primary concern with sea turtles at Salem Generating Station is whether or not the losses of these endangered or threatened species "jeopardizes their continued existence." Federal regulation defines this term as engaging in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing the reproduction, numbers, or distribution of that species." A comparison was made of sea turtle losses at Salem Generating Station, assuming worst case losses, with population estimates for both species. This worst case estimate of losses includes turtles dying of natural mortality that account for a portion of the turtles captured at the Salem intake. Sea turtles captured alive at Salem and returned to the wild are not included. Calculated accordingly, the maximum, estimated, worst-case annual loss of loggerheads at the station is nine turtles which represents 0.0002 percent of the population in the U.S. southeast. The maximum, estimated, worst-case annual loss of Kemp's ridleys at Salem is one or two turtles which would represent 0.05 to 0.09 percent of the population. It is unlikely that losses at these levels would "appreciably reduce" the distribution or numbers of either species. Losses to reproduction would be restricted to "production foregone" due to the loss of juvenile/subadult animals which could potentially be recruited into the breeding female population at some time in the future.

Thermal impacts from the operation of Salem and Hope Creek Generating Stations, such as acute and chronic thermal impacts and coldshock, are not significant because the thermal discharge for Salem is an offshore, high-velocity bottom discharge which quickly dissipates and forms only a shallow surface plume. The Hope Creek thermal discharge is of such small volume that it is rapidly assimilated by the Delaware River. Both species of sea turtles, which have strong swimming ability, therefore can likely avoid the affected areas.

Administrative controls which have been instituted to enhance the timely removal of turtles from the intake and optimize their chances for survival include: inclusion of reporting/notification procedures for threatened and endangered species in the Event Classification Guides which are kept in each station's control room; issuance of an annual memorandum at the time of year sea turtles may be expected to occur detailing intake inspection procedures, turtle handling procedures and round-the-clock reporting procedures; and, providing operations with information to assist them in identifying sea turtles. Operational procedures which have been instituted to enhance the timely removal and survival of sea turtles from the intake include: daily (or more frequent) trash rack cleaning; and, once per shift and more frequent (once per two hours) intake inspections during times when turtles are known to be present. Structural modifications have also been made to the intake structure to reduce intake velocities and minimize the impingement of aquatic animals including sea turtles.

In summary, PSE&G concludes that the continued operation of Salem and Hope Creek Generating Stations will not jeopardize the continued existence of the either the loggerhead or Kemp's ridley sea turtle. The estimated losses of these species from the continued operation of these facilities, particularly the water intakes, will not "appreciably reduce" the distribution or numbers of either species. Losses to reproduction would be restricted to "production foregone" due to the loss of juvenile or subadult animals which could potentially be recruited into the breeding female population in the future.

SECTION 2.0
INTRODUCTION

2.1 PURPOSE

This "biological assessment" is submitted to the U.S. Nuclear Regulatory Commission (NRC) by Public Service Electric and Gas Company (PSE&G) in compliance with Section 7 of the Endangered Species Act of 1973 (as amended)[the Act].

The purpose of this assessment is to examine the potential impacts associated with the continued operation of PSE&G's Salem and Hope Creek Generating Stations on two sea turtle species protected under the Act. The species of concern are the Kemp's ridley (*Lepidochelys kempi*) and loggerhead (*Caretta caretta*) sea turtles both of which have been removed from the circulating water intake trash racks at Salem Generating Station. The U.S. Fish and Wildlife Service, "List of Endangered and Threatened Wildlife and Plants," lists the status of the Kemp's ridley sea turtle as endangered and the loggerhead sea turtle as threatened (50CFR117.11). The National Marine Fisheries Service (NMFS) has jurisdiction for both these species (50CFR222.23(a) and 50CFR227.4(b)).

2.2 ENDANGERED SPECIES ACT

This "biological assessment" is part of the formal consultation process provided under Section 7 of the Endangered Species Act. Detailed procedures for this consultation process are defined in 50CFR402.

2.3 CHRONOLOGY OF EVENTS LEADING UP TO THIS ASSESSMENT

A review of the sea turtle strandings at Salem Generating Station was recently requested in a letter from the NMFS to the NRC in August 1988 (D. C. Crestin, 1988). This letter followed a meeting between PSE&G and NMFS on August 3, 1988, where PSE&G summarized the sea turtle occurrence history at the Salem and Hope Creek Generating Stations since 1979. At this meeting PSE&G was advised of NMFS desire to pursue a formal review of this concern. The NRC was advised of this meeting on September 8, 1988, and PSE&G requested that if the formal Section 7 review progressed, that they be authorized to prepare the "biological assessment."

The issue of sea turtles at Salem Generating Station was initially addressed in 1979 and 1980 when two sea turtles were collected on the circulating water intake trash racks at Salem Generating Station. The matter was discussed jointly by PSE&G, NRC, NMFS, U.S. Environmental Protection Agency (EPA) and New Jersey Department of Environmental Protection (NJDEP) during October 1981 (informal Section 7 review). It was concluded from this discussion that the two specimens collected from the intake were probably dead before they appeared on the trash racks and that the intake structure did not have a role in their deaths. A procedure for PSE&G to report future occurrences of sea turtles was established at this meeting.

In the years following, PSE&G kept both NMFS and NRC apprised of the collection of threatened and endangered sea turtles at Salem Generating Station. In 1985 and again in 1987 and 1988, a number of turtles were collected from the trash racks which were either alive or showed no evidence of previous trauma. This was considered by NMFS to reflect new information concerning the effects of the Salem circulating water intake system which was not considered in the 1981 informal consultation.

Rather than initiating a new review, NMFS requested the reinitiation of the 1980 formal consultation which pertained to shortnose sturgeon (Acipenser brevirostrum) at Salem and Hope Creek Generating Stations. This request was made pursuant to 50CFR401.16 of the ESA Interagency Cooperation regulations.

Toward the end of September 1988, PSE&G received a letter from NRC (J. C. Stone, 1988) advising them of NMFS request and requesting a proposed schedule for preparation of the "biological assessment" and an outline of the material to be included in the document. This information was submitted to NRC in October 1988 (S. E. Miltenberger, 1988) and was discussed in a meeting with NRC on November 22, 1988. Following this meeting, NRC approved PSE&G's request to prepare the "biological assessment" with the understanding that several additional items be included in the document (J. C. Stone, 1988).

This document is PSE&G's, "Assessment of the Impacts of the Salem and Hope Creek Generating Stations on Kemp's Ridley (Lepidocheyls kempi) and Loggerhead (Caretta caretta) Sea Turtles."

SECTION 3.0
SITE DESCRIPTION

3.1 LOCATION

Public Service Electric and Gas Company's (PSE&G) Salem (Unit Nos. 1 and 2) and Hope Creek Generating Stations are located on the southern end of Artificial Island in Lower Alloways Creek Township, Salem County, New Jersey. These facilities are located 15 miles (24 kilometers) south of Wilmington, Delaware, 30 miles (48 kilometers) southwest of Philadelphia, Pennsylvania, and 7 miles (11 kilometers) southwest of Salem, New Jersey (Figure 3-1).

Artificial Island is actually a peninsula connected to the mainland of New Jersey by a strip of marshland and extends approximately one third of the way across the Delaware River (Figure 3-2). During the early 1900's, Artificial Island was a natural sand bar. At that time, the U.S. Army Corps of Engineers installed a retaining wall of oak pilings at the southern tip of the sand bar. A few years after the retaining wall was constructed, additional pilings were installed and the area was used for storing fill that was dredged from the Delaware River. The sand bar evolved into an island and finally into the peninsula it is today.

Artificial Island encompasses approximately 1,482 acres (600 hectares) (Figure 3-2). Topographically it is flat with an average elevation of 8.8 feet (2.7 meters) above mean sea level and a maximum elevation of 18 feet (5.5 meters) above mean sea level. The 740 acre (300 hectare) PSE&G site is located on the southernmost 25 percent of the peninsula and is divided into Salem Generating Station (220 acres or 89 hectares), Hope Creek Generating Station (153 acres or 62 hectares), and uncommitted land (367 acres or 148 hectares). The undeveloped areas of the island are characterized by diked dredge spoil disposal impoundments and tidal salt marsh.

3.2 MORPHOLOGY AND BATHYMETRY

Salem and Hope Creek Generating Stations are situated on the eastern shore (New Jersey) of the upper portion of the Delaware River Estuary.

The Delaware River Estuary is 132 miles (211 kilometers) long and extends from Capes May and Henlopen to Trenton, New Jersey. This region of the estuary is referred to as Delaware Bay and is 75 miles (120 kilometers) long and extends from the Capes to a line between stone markers located at Liston Point, Delaware and Hope Creek, New Jersey (Polis et al., 1973). The estuary varies in width from 11 miles (18 kilometers) at the Capes; to 27 miles (43 kilometers) at its widest point (near Miah Maull Shoal); to

1,000 feet (0.3 kilometer) at Trenton, New Jersey. Water depth in the bay is less than 30 feet (9.1 meters) deep in 80 percent of the bay and is less than 10 feet (3 meters) deep in much of the tidal river area. A navigation channel passes from deep water inside the entrance of the bay to Trenton, New Jersey. Authorized depth of the channel is 40 feet (12.1 meters) below mean sea level up to the Philadelphia (Naval Ship Yard) and then 25 feet (7.6 meters) below mear sea level to Trenton.

Artificial Island is located approximately 2 miles (3.2 kilometers) upstream of the hypothetical line demarking the head of Delaware Bay (Figure 3-3). The tidal river in this area narrows upstream of Artificial Island and makes a bend of nearly 60 degrees. Both the narrowing and bend are accentuated by the presence of Artificial Island. Furthermore, more than half of the typical river width in this area is relatively shallow, less than 18 feet (5.5 meters), while the deeper part, including the dredged shipping channel has depths of up to 40 feet (12.2 meters).

3.3 HYDROLOGY

The largest tributaries of the Delaware Estuary are the Schuylkill River in Pennsylvania, the Christina River in Delaware, and the Assunpink, Crosswicks, Rancocas and Salem Rivers, and Big Timber, Hope and Alloways Creeks in New Jersey (PSE&G, 1984). The head of the Delaware Estuary is at Trenton, New Jersey, about 84 miles (135 kilometers) upstream of Artificial Island (Figure 3-1). The Chesapeake and Delaware Canal, which connects the Delaware River with Chesapeake Bay, is located approximately 7 miles (11.3 miles) north of Artificial Island.

Of the total freshwater flow into the Delaware Estuary, annual average of 23,352 cubic feet per second (661 cubic meters per second), approximately 50 percent (11,759 cfs or 333 cubic meters per second) is contributed by the Delaware River at Trenton; 12 percent (2,715 cfs or 76.9 cubic meters per second) by the Schuylkill River; and, the remaining 38 percent by all other tributaries (USGS, 1981a; USGS, 1981b).

Tidal flow as measured near the Delaware Memorial Bridge, 20 miles above Artificial Island, was measured at 399,710 cfs (11,320 cubic meters per second)(USGS, 1966). Tidal flow of this magnitude is 17 times as great as the total average freshwater flow rate into the estuary. Proceeding toward the mouth of the estuary, tidal flow increasingly dominates freshwater downstream flow; proceeding upstream from the Delaware Memorial Bridge, the ratio of tidal flow to net downstream flow becomes smaller as tidal influence decreases.

Tides in the Delaware estuary are semidiurnal, with a period of 12.42 hours (Polis, D. F. et al., 1973). The mean tidal range averages 4.3 feet (1.3 meters) at the mouth of the estuary; 5.9 feet (1.8 meters) at Artificial Island; and, 6.7 feet (2 meters) Trenton, New Jersey. These ranges are influenced by heavy precipitation, storm surges and wave action. Tidal ranges as high as 14.1 feet (4.3 meters) have been observed at Artificial Island during periods of extreme flood and ebb conditions.

Current speed and direction throughout the Delaware estuary are dominated by the tide. Surface tidal currents generally are directed along the longitudinal axis of the estuary except in nearshore areas of the river bends and coves. At maximum ebbing or flooding tide, local currents at any point within the estuary may reach speeds of 3.3 to 4.3 feet per second (1.0 to 1.3 meters per second)(Roy F. Weston, Inc., 1982).

The average river velocity adjacent to the site is 1.2 feet per second (0.4 meters per second) with typical ebb and flood maximums of 3.2 and 2.5 feet per second (1 and 1.3 meters per second)(U.S. Commerce Department, 1982). Near field current velocities, within 100-feet of the intakes, are strongly influenced by tidal currents except for directly in front of the intakes (Roy F. Weston, 1982). Average current velocities within the CWS and SWS withdrawal zones were observed to be 1.1, 0.9, 0.8 and 0.7 feet per second (0.33, 0.27, 0.24 and 0.21 meters per second) respectively during ebb, low slack, flood and high slack tides. The greatest variation in velocities were observed during high slack tide which ranged from 0.2 to 2.0 feet per second (0.06 and 0.61 meters per second).

Velocity measurements at the face of the CWS intake show higher velocities near the surface and generally decrease at mid-depths. Velocities at some mid-depths of the intake and near the bottom were at or near zero feet per second. The average velocity for the water column is approximately 1 foot per second (design velocity)(Roy F. Weston, 1982). Velocity measurements at the face of the SWS intake (below the curtain wall) averaged 0.3 feet per second (0.1 meters per second).

The morphometric and bathymetric features of the river in the area of Artificial Island affect near field circulation patterns near the generating stations (Roy F. Weston, Inc., 1982). The bend in the river produces a persistent flow (averaged over several tidal periods) of near surface water away from the inside of the bend (i.e., away from Artificial Island, toward the west shore), with a compensating deep flow toward the inside (i.e., the New Jersey side) of the bend. Such flows generally work to keep stream channels on the outside of bends, since sediment is carried with the bottom current toward the shore at the inside, as well as being deposited by slower inside forces.

In addition, two artificial structures on the east shore (Figure 3-2), Hope Creek jetty and Sunken Ship Cove, also appear to influence the near-field current pattern, contributing to current deflection and shoreline drag. The resultant complex circulation results in changing sedimentation and erosion patterns. Reedy Island Breakwater is located near midriver but has little influence on current patterns near Artificial Island.

3.4 SALINITY

Salinity in the Delaware estuary varies from freshwater (typically defined as less than 1 part per thousand) at Trenton to typical ocean water concentrations of about 32 parts per thousand (ppt) on the continental shelf off the mouth of the Bay. Salinity at any particular location in the estuary is dependent on the amount of freshwater discharge from upstream and the extent of saltwater intrusion from downstream. Variables such as tidal phase, basin morphology, and meteorological conditions affect salinity (Polis, D. F. et al., 1973; PSE&G, 1984). Figure 3-4 illustrates the general seasonal patterns in the horizontal and vertical distribution of salinity in the estuary. High freshwater discharge conditions typical of spring runoff normally result in downstream displacement of the saltfront to about river kilometer 80 and increase vertical salinity stratification. During low freshwater flow conditions in late summer and fall, the saltfront normally extends to about 120 rkm and the system is well mixed vertically.

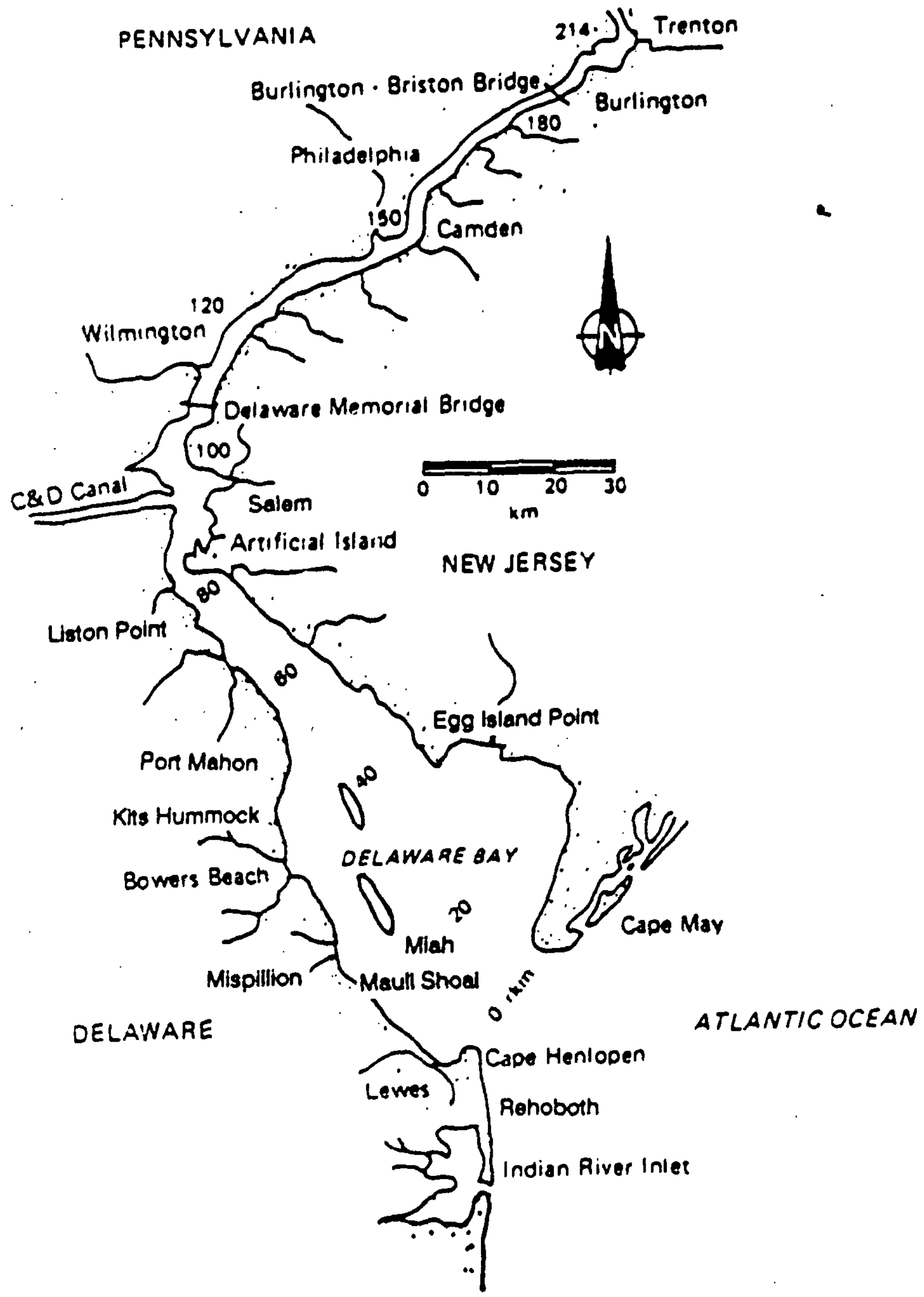
At Artificial Island, salinity typically ranges from near zero during periods of high river flow (December through March) to 10 or 12 parts per thousand (ppt) during periods of low river runoff (summer and fall). A maximum of 20 ppt has been recorded at Artificial Island. Salinity around Artificial Island and a short distance upstream from it is essentially homogeneous vertically, as variations at a given point are limited generally to less than 1 per cent per thousand between the surface and bottom. Some variation is observed across the estuary due in part to Coriolis forces, which tend to displace lower salinity water toward the western (Delaware) side which results in replacement by water of greater than average salinities on the east (New Jersey) shoreline. Thus, there is a relatively homogenous salinity distribution until a point is reached in the lower Delaware Bay where the tidal velocities are low enough to permit a degree of vertical stratification to develop. In the lower bay, downstream from Artificial Island, there is an extensive amount of stratification brought about by the combination of salinity gradients and meteorological conditions.

3.5 TEMPERATURE

Water temperature in the Delaware estuary is also determined by the flow characteristics of the entire drainage area. Temperature patterns in the estuary are determined by the thermal characteristics of the Delaware River, its tributaries, and the coastal ocean waters. Temperatures of these sources are altered by air temperature, humidity, wind, insolation, cloud cover, and tidal mixing.

Temperature of the Delaware River at Trenton, which constitutes the major freshwater input to the estuary, varies annually from 0 degrees Centigrade (°C) in mid-winter to over 30°C in summer (Figure 3-5)(Polis, D. F. et al., 1973; PSE&G, 1984). Periods of rapid temperature change occur in spring and fall. Atlantic Ocean water that enters the estuary exhibits a less extreme annual range of temperature. Minimum mean temperatures of approximately 6°C usually occurs in February or March; a maximum of approximately 24 C occurs in August (Polis and Kupferman, 1973). Thus, the large volume of shelf water that enters the Bay on each tidal cycle and mixes with the fresher water tends to moderate the temperature of the lower Bay.

Water temperature in the Delaware River near Artificial Island ranges from near zero degrees centigrade (°C) in winter to about 30°C in summer (Figure 3-5)(PSE&G, 1984). Ice forms in the winter along the shoreline of the estuary, but is broken up by the tidal action. Due to shipping, the Delaware River has not been entirely covered by ice near the site in recent years. In early spring, ice from the upper Delaware River floats past the site to Delaware Bay.



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SEA TURTLE BIOLOGICAL ASSESSMENT

Figure 3-1. The Delaware River Estuary

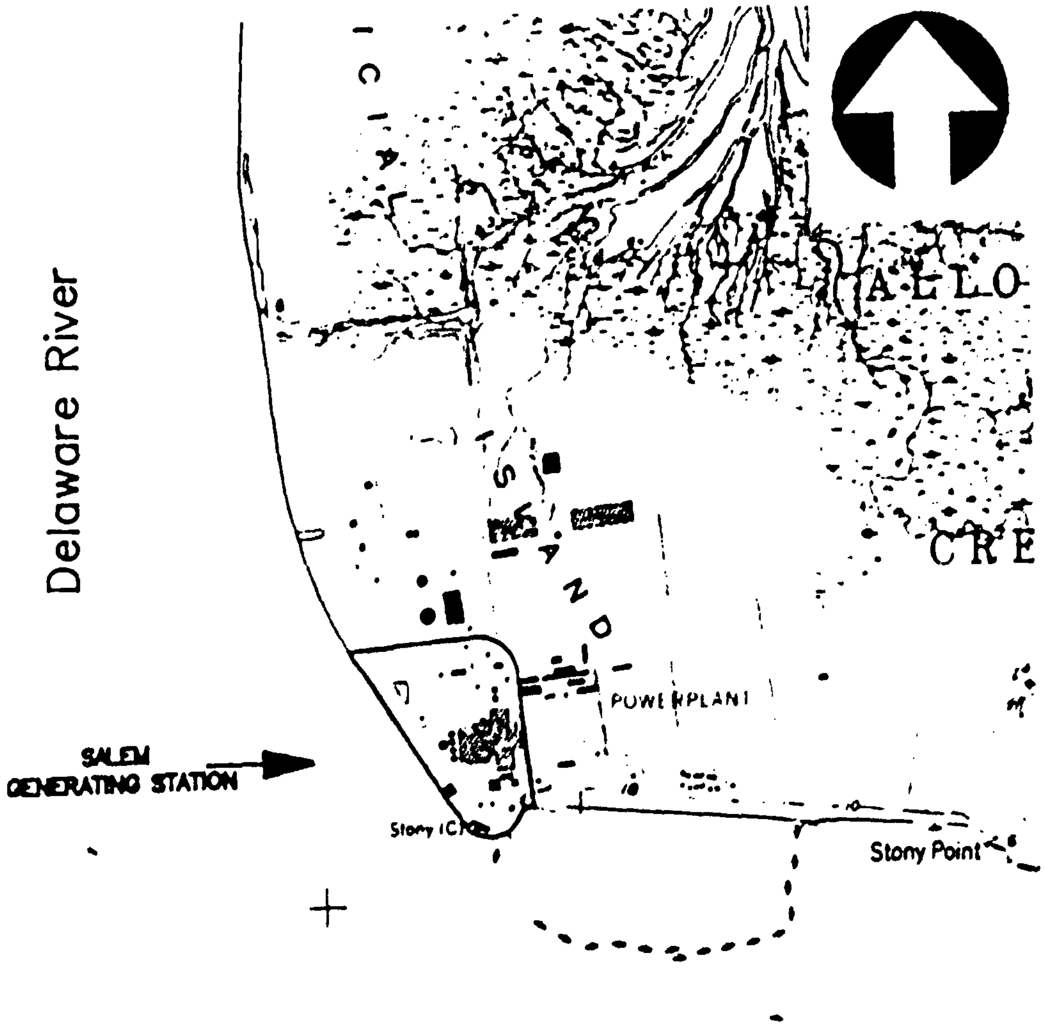

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Figure 3-2. Site Location Map of Artificial Island

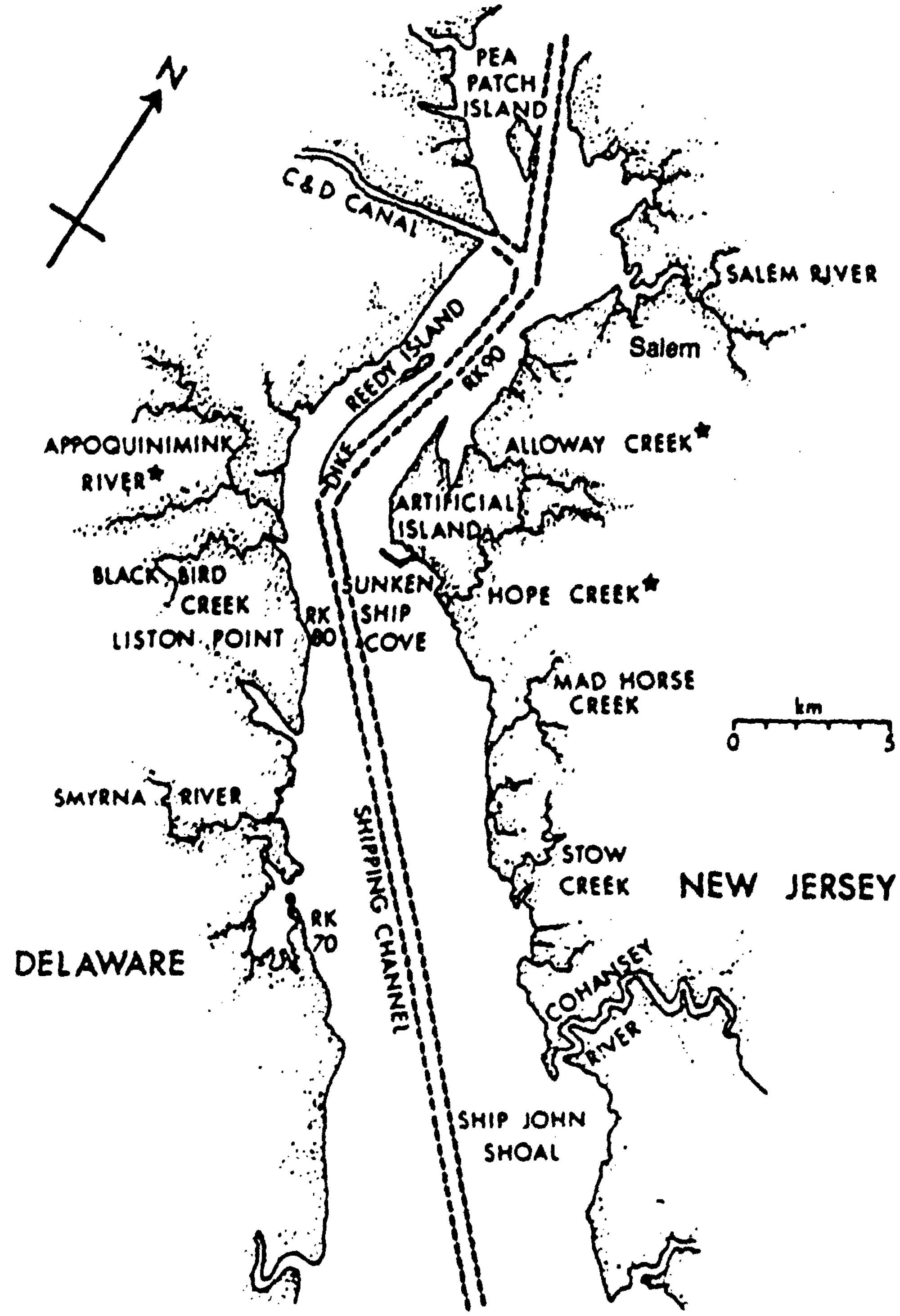

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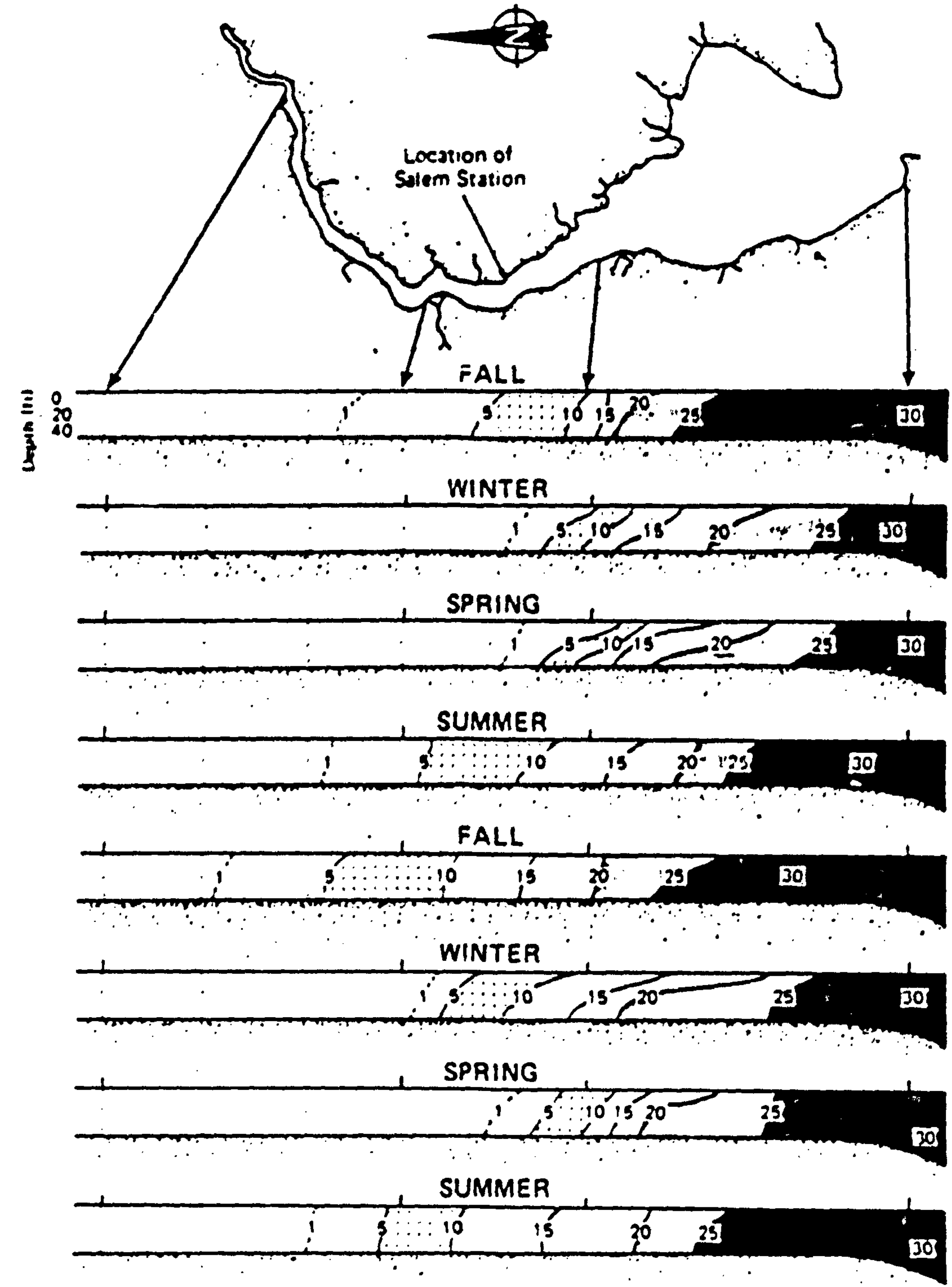
Figure 3-3. Delaware River near Artificial Island



Source: Cronin et al., 1962

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Figure 3-4. Seasonal Patterns of Salinity (ppt) Distribution in the Del. River Estuary

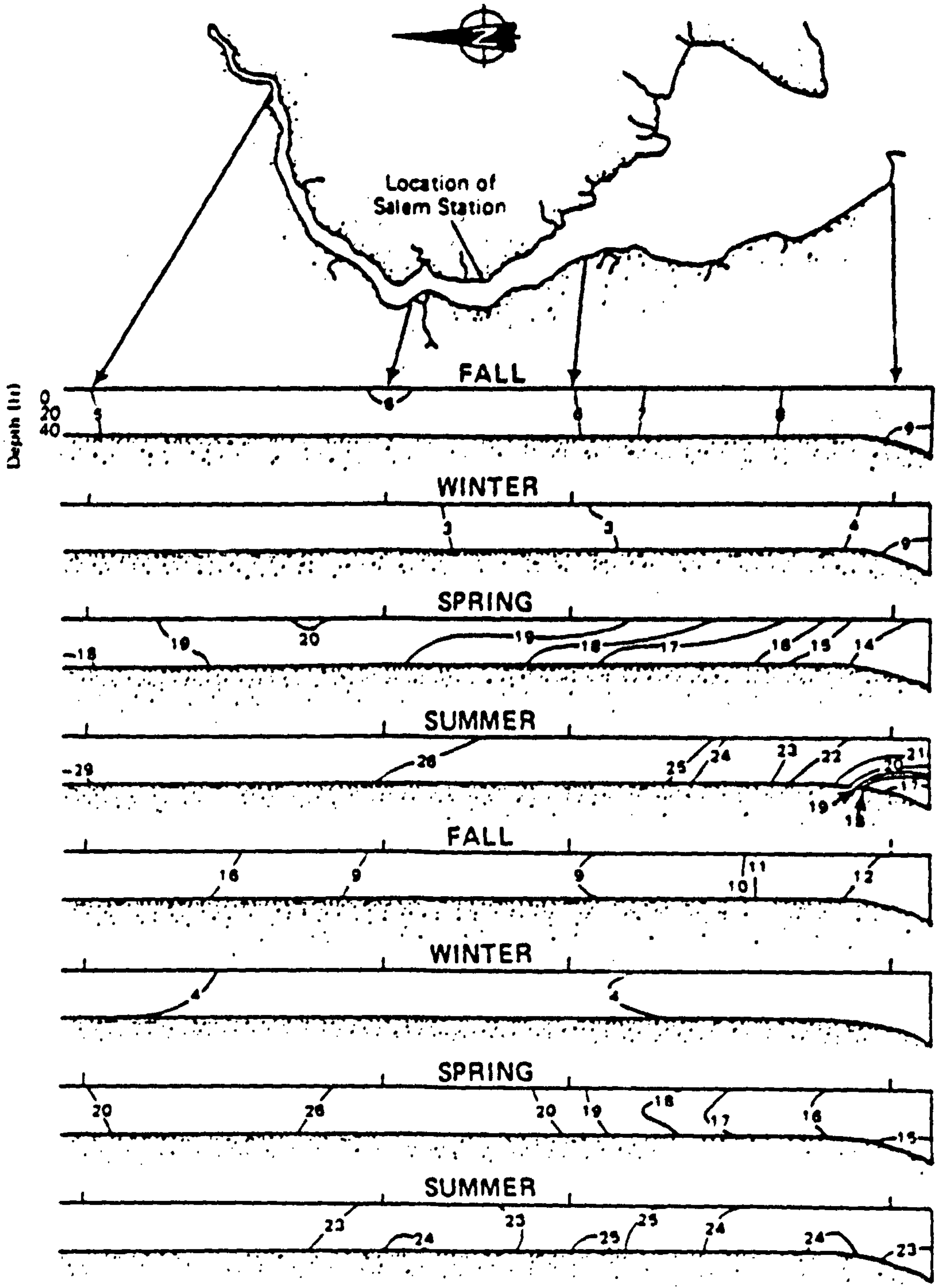

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Figure 3-5. Seasonal Patterns of Temperature (°C) Distribution in the Del. River Estuary

Source: Cronin et al., 1962

SECTION 4.0
SALEM AND HOPE CREEK GENERATING STATION DESCRIPTIONS

4.1 SALEM GENERATING STATION

Salem Generating Station consists of two pressurized water nuclear reactors (Unit Nos. 1 and 2) each with an electrical capability of approximately 1,100 megawatts per unit. Unit No. 1 began commercial operation during June 1977 and Unit No. 2 during October 1981.

The containment structures housing the reactors and the turbine, auxiliary and service buildings for both units are located on the southernmost part of Artificial Island (Figure 4-1). Two separate shoreline intakes provide cooling water for the station. The circulating water system intake (CWS) provides cooling water for both units main condensers and the service water system intake (SWS) provides cooling water for safety-related heat exchangers and coolers within the station. Cooling water from both systems is discharged via subsurface discharge pipes which discharge 500 feet (152 meters) offshore.

4.1.1 CIRCULATING WATER SYSTEM

The once-through CWS is designed to remove waste heat from the stations main condensers. The CWS withdraws cooling water from the Delaware River, routes it to the condensers, and returns warmed water to the river. The design flow (6 pumps) for each unit is 1.1 million gallons per minute (gpm). Maximum and normal temperature rises across the condensers are 36.4°F (20.2°C), and 14.8°F (8.2°C) respectively. The design intake velocity for water approaching the intake is 1 foot per second (30 centimeters per second) at mean low tide. A schematic diagram of the circulating water system is presented in Figure 4-2.

4.1.1.1 INTAKE STRUCTURE

The CWS intake, which serves both Unit Nos. 1 and 2, consists of twelve separate, independent intake cells, six per unit (Figure 4-3). Each intake cell is equipped with its own trash bars, traveling screens, and circulating water pump. Provisions for ice barriers, wave walls and stop logs are made within each cell.

Originally, the circulating water intake structure consisted of trash racks followed by conventional traveling screens whose primary purpose was to collect and remove debris from intake water. Traveling screens were intermittently cleaned via a front wash, high pressure spray system activated by differential pressure.

To mitigate fish impingement losses, modifications have been made to the original installation by adding: horizontal, water-filled fish survival buckets on the traveling screen baskets (Ristroph modification); a low pressure rear spray wash fish removal system; an enlarged rear fish and trash sluiceways; the capability to return fish to the river from the north and south ends of the circulating water intake structure depending on tidal flow; and, continuous traveling screen operation.

4.1.1.1.1 TRASH BARS

Twelve sets of trash bars protect each of the twelve intake cells from large debris, mats of detritus, and other large materials commonly found in the river. The bar assemblies are 39 foot high and extend from station grade, 89 feet PSD (Public Service Datum is an arbitrary scale where station grade level is set at an elevation of 100 feet, mean sea level is 89.3 feet PSD) to the bottom of each CWS intake cell (50 feet PSD) and are approximately 11 feet (3 meters) wide. Constructed of 0.5 inch (1.27 centimeter) wide steel bars on 3.5 inch (8.9 centimeter) centers, the trash bar racks have a slot size of 3 inches (7.6 centimeters) wide by 51 feet (15.5 meters) long.

The trash bars are inspected at least once per 8-hour shift, and debris is removed as needed by a Rex Chainbelt, Inc. mobile mechanical trash rake. The rake is self-contained and traverses the entire intake width; it contains a trash hopper which transports the material removed from the bars to debris pits at each end of the intake. Baskets line the pits and are removed as required. Debris removed from trash bars is disposed of at an offsite landfill.

Trash and debris are removed from the Salem circulating water intake trash bars by a heavy-duty, traversing type, mechanical trash rake manufactured by Rex Chainbelt, Incorporated. The rake is 11 foot, 2 inches wide and has a lift capacity of 5,000 pounds. The maximum traversing and raking speed is 30 feet per minute. The trash rake unit is mounted on rails which span the entire intake width. The unit is controlled by a single operator from a manual pushbutton control panel which is mounted on the unit's frame assembly. The trash rake unit consists of an integral frame assembly which houses the traversing drive, hoisting machinery, hopper and hydraulic control assemblies. The hoisting machinery includes a cable-operated raking device which is designed to remove large floating or submerged objects that may accumulate on the trash bar racks. Wide-flanged wheels permit the raking device to travel along the inclined bar rack which guides the cleaning device over the 50 feet of vertical bars.

4.1.1.1.2 TRAVELING SCREENS

Each intake cell is equipped with a Royce Equipment Company, vertical traveling screen. Each traveling screen unit contains sixty-two, stainless steel mesh fish-removal type screen panels. Each screen panel has a 2 inch (5.1 centimeter wide) lip, which creates a water-filled bucket (Figures 4-4 and 4-5). As the screen is raised through and out of the water, most impinged organisms drop off the screen into the bucket, which prevents them from falling back into the screen well and becoming reimpinged. It then transports them to a fish-return system which returns the organisms to the river.

Normal operation is to have the screens operate continuously at a speed of 0.9 inches per second (2.3 centimeters per second). Screens can be operated at alternate speeds of 1.9, 2.5 and 3.5 inches per second (4.8, 6.4 and 8.9 centimeters per second) depending on debris load.

For maximum fish survival, the screen wash operates with both low-pressure and high-pressure spray headers. As the screen basket travels over the head sprocket, organisms slide onto the screen face and are washed by one low-pressure (7 pounds per square inch) spray header located outside the screen unit, and two low-pressure (15 psi) spray headers located inside the screen unit, into an upper 15 by 30 inch (38 by 75 centimeter) sluice. This spray wash is designed to minimize descaling and other injuries that would occur with conventional high-pressure spray headers. Subsequently, heavier debris is washed into a lower 24 by 58 inch (60 x 146 centimeter) sluice by two high-pressure (90 psi) spray headers (Figure 4-4). At high debris loads, the screen travel speed increases automatically to the second speed and a second high-pressure wash header is placed into operation. If the debris load continues to increase, the screen proceeds to the third speed. Any further increase causes an alarm to sound and the screen travel speed to increase to the fourth speed. The operators may take other necessary action. Transport time of the individual screen baskets, from the water surface to the head sprocket at minimum screen speed, varies from 3.25 minutes at mean high water to 4.5 minutes at mean low water.

4.1.1.1.3 CIRCULATING WATER PUMPS

There are twelve CWS pumps located on the intake structure, one per cell, six per unit. They were manufactured by Worthington Pump Company and are of the vertical wet-pit type. Each is rated at 1.85×10^5 gallons per minute (gpm) (1.11×10^7 liters per minute) at 27 feet (8.2 meters) total dynamic head. The pumps are each powered by Allis Chalmers 2,000 horsepower, vertical shaft motors. The once-through cooling circuits from the intake to the discharge range from approximately 2,200 to 3,200 feet (671 to 976 meters) in length. Water is supplied to the condensers in six separate 84-inch (2.1 meter) water lines per unit at a velocity of 1.7 feet per second (3.2 meters per second).

4.1.1.1.4 OTHER EQUIPMENT

Ice Barriers

Removable ice barriers can be installed on the face of each of the twelve intake cells to prevent damage during severe river icing conditions. The barriers are constructed of pressure-treated lumber and are approximately 18 by 22 feet (5.5 by 6.5 meters). They extend from elevation 100 to elevation 78 feet PSD. The barriers are resilient structures built to withstand the crush of ice and to protect the trash bars. They are typically put into place in the winter and are removed in early spring; however, they can be left in place year-round for additional protection of the intake structure.

Fish-Return System

The contents of the upper fish and lower debris sluices are returned to the river through one of two return sluices at opposite ends of the CWS intake. The northern screen-wash water-return sluice is about 73 feet (22 meters) long and discharges to the river at 5 feet (1.5 meter) below mean low water. The southern return sluice is also about 73 feet (22 meters) long and discharges to the river at 3 feet (1.0 meter) below mean low water. Originally, all screen-wash water could be discharged only through one common outfall located at the northern end of the intake structure. To reduce circulation of impinged fish and detritus on ebb tide, the second outfall was installed prior to Unit No. 2 operation at the southern end of the intake structure and put into operation on July 14, 1978.

Gates were installed in the fish and trash troughs in the center and at each end of the troughs to permit discharge in the direction of tidal flow.

4.1.1.2 CONDENSERS

One single-pass, divided-circulation, triple-shell condenser is located in each turbine building. The condensers, each of which is nominally rated at 7.636×10^9 Btu per hour (1.924×10^9 kilocalories per hour) and provides approximately 8×10^5 square-feet (74,000 square-meters) of cooling surface area. At full power, CWS flows of up to 1.1×10^6 gallons per minute (4.2 cubic meters per minute) per unit experience about a 18.0°F (10°C) temperature rise. The water passes through the 1 inch (2.5 centimeter) diameter, 0.028 inch (0.07 centimeter) thick, 45 foot long condenser tubes at an average velocity of about 8 feet per second (2.3 meters per second), then out of the outlet waterbox through a 90 inch (2.44 meter) diameter connection.

The discharge piping from each half of the condenser waterbox are joined through a Y-type connection into a common 120 inch (3.05 meter) diameter pipe. These six pipes transport the condenser cooling water across the site to the Delaware River. The outlet of each of these pipes is at a depth of 25 to 30 feet (7.6 to 9.1 meters). The exit velocity is high enough (10.7 feet per second or 3.3 meters per second) to promote rapid mixing with ambient water. The velocity, arrangement, and location are designed to reduce thermal recirculation (PSE&G, 1984). The discharge piping extends 500 feet (152 meters) offshore along the river bottom before they discharge.

4.1.2 SERVICE WATER SYSTEM

The service water system (SWS) is designed to provide cooling water to safety-related equipment required for safe operation and maintenance of Salem station. The SWS withdraws cooling water from the Delaware River, routes it to various heat exchangers and coolers located in the auxiliary, reactor and turbine generator buildings and returns it to the Delaware River (Figure 4-6).

4.1.2.1 INTAKE STRUCTURE

The SWS intake is constructed of reinforced concrete designed to withstand specific floods, earthquakes, and damage. It consists of twelve intake bays arranged in groups of three and alternating between Unit Nos. 1 and 2 (Figure 4-7). Its internal compartments are designed to be watertight up to an elevation of 122 feet PSD. The intake, located at the river front, is fitted with ice barriers and marine dock bumpers and is designed to withstand the effects of tornadoes and missiles. Windbreaks are installed at elevation 112 feet PSD at the northern and southern ends of the structure. A heated enclosure with removable roof sections for maintenance and access is installed around the traveling screens and instrumentation.

The intake is equipped with a fish-escape passage, located in front of the traveling screens and behind the trash bars. The passage connects all SWS cells and exits through the front of the cofferdams at the ends of the intake.

4.1.2.1.1 TRASH BARS

The SWS trash bars are constructed in a manner similar to the CWS trash bars. They are constructed of 0.5 inch wide (1.27 centimeter) steel bars set on 3.5 inch (8.9 centimeter) centers. However, the SWS trash bar assemblies are 8 feet (2.4 meters) wide and 42 feet (12.8 meters) long.

4.1.2.1.2 TRAVELING SCREENS

Each intake cell is equipped with a Rex Equipment Company conventional, vertical traveling screen. Each traveling screen unit contains forty-nine, conventional screen panels constructed of 3/8 inch (1 centimeter) mesh. Each screen extends from the bottom of the cell (70 feet PSD) to the service deck (112 feet

PSD). The screens are chain-driven by an electric motor mounted on top of the housing.

The SWS intake screens are washed on the front side with a single series of high-pressure sprays to ensure that there is no clogging or fouling of the system. The screens operate intermittently at a single speed, controlled by differential pressure across the screen face. When not in the cleaning mode, they remain at rest. Debris collected in troughs in the deck at the 112-foot elevation is transferred to trash baskets at either end of the intake and properly disposed of in a landfill.

4.1.2.1.3 SERVICE WATER PUMPS

SWS pumps are located inside each of the twelve independent intake cells. Six Layne and Bowler, vertical, deepwell turbine pumps serve each unit. Each pump is rated at 10,875 gallons per minute (4.12×10^4 liters per minute) at a pump head of 240 feet (73 meters). The pumps are driven by Allis Chalmers vertical, solid-state, open-dripproof, air-cooled motors, each rated at 1,000 horsepower at 1,187 revolutions per minute. During normal operation, four pumps are in service.

4.1.2.1.4 OTHER EQUIPMENT

Ice Barriers

Because of the safety-related nature of the SWS intake, the ice barriers are always in place. The barriers extend from the operating deck (elevation 112 feet PSD) to elevation 83.1 feet PSD. They are constructed in the same manner as the CWS ice barrier.

Curtain Wall

The curtain walls are installed within each intake cell to provide protection from floating oil and fires. They extend from the operating deck (elevation 112 feet PSD) down to "lowest low-water "(elevation 81 feet PSD).

Automatic Strainer

Downstream of each SWS pump is located an automatic strainer. There are six strainers per unit, each manufactured by the R. P. Adams Company. The design flow is 12,500 gallons per minute (4.73×10^4 liters per minute) per strainer at a design pressure of 200 psi. The strainer mesh size is 0.010 inch (0.25 millimeters) and is constructed of stainless steel. The strainers are continuously washed, and wash water is combined and routed to a yard drain that discharges to the river.

4.1.3 DISCHARGE SYSTEM

Condenser cooling water from the CWS and cooling water from the SWS both are returned to the Delaware River via common discharge piping.

4.1.3.1 CIRCULATING WATER

After exiting the condenser discharge, piping from each half of the condenser water box joins in a 10 foot (3 meter) diameter pipe which runs to the river. The three pipes per unit convey the water approximately 500 feet (152 meters) offshore (Figure 4-1). The outlet of each of these pipes is at a depth of 25 to 30 feet (7.6 to 9.1 meters). The exit velocity is high enough (10.7 feet per second) to promote rapid mixing with ambient water. The velocity, arrangement, and location are designed to reduce thermal recirculation.

4.1.3.2 SERVICE WATER

Service water flows continuously and is released to the CWS, where it is returned to the Delaware River.

4.1.3.3 THERMAL PLUME STUDIES

The cooling water discharged from Salem Generating Station has been studied on several occasions to determine its distribution and volume. The geometric and dynamic behavior of the thermal plume, as a function of tidal phase, was studied through fixed-station monitoring, mobile mapping of the plume track, and a thermal infrared (IR) overflight survey on June 15-16, 1982.

During flood tide, clockwise circulation patterns directed the thermal plume upstream along the shoreline of Artificial Island. A 1°C (1.8°F) isotherm (i.e., a delta temperature of 1°C above ambient) was used to define the plume. Maximum upstream and lateral extent of the 1°C isotherm at the surface (as measured by IR imagery) was 19,800 and 1,485 feet (6,000 meters and 450 meters), respectively. No significant variation in temperature with depth, as measured by mobile mapping and fixed station sampling, was observed during flood tide.

During high slack tide, the plume exhibited lateral spreading near the discharge. As the tide reversed, shallow patches of residual heated water were apparent upstream. The longitudinal and lateral extent of the 1°C surface isotherm was 2,970 feet and 1,980 feet (900 meters and 600 meters), respectively. With the exception of the near discharge area, plume depth was limited to 9.9 feet (3 meters) and became more shallow with distance from the discharge.

During ebb tide, the plume was directed downstream of the discharge toward the southwest. Although a rapid decrease in temperature was observed outside the immediate vicinity of the discharge, 2.5°C (4.5°F) delta temperature pools were measured as far downriver as the Hope Creek Jetty. The longitudinal and lateral extent of the 1°C surface isotherm was 18,150 feet and 8,950 feet (5,500 meters and 1,500 meters), respectively. With the exception of the discharge area, plume depth was limited to less than 3.3 feet (1 meter).

Ebb tide reversed rapidly inhibiting lateral movement toward the river channel so the thermal plume configuration during low slack was similar to that of ebb tide. The longitudinal and lateral extent of the 1°C surface isotherm was 4,950 feet and 3,960 feet (1,500 meters and 1,200 meters), respectively. With the exception of the discharge area, plume depth was limited to 6.6 feet (2 meters), becoming more shallow with distance from the discharge.

With the exception of turbulent mixing near the discharge, salinity continuously increased from the surface to the bottom and toward the sea with no marked interface. Density variations had no observable effect on plume configuration, buoyancy, or movement.

4.2 HOPE CREEK GENERATING STATION

Hope Creek Generating Station consists of one boiling water nuclear reactor with an electrical capability of approximately 1,067 megawatts. Hope Creek began commercial operation during February 1986.

The containment structure housing the reactor and the turbine, auxiliary and service buildings for the station are located on the southern end of Artificial Island just to the north of Salem Generating Station (Figure 3-2). One shoreline intake provides cooling water for the station. The service water system (SWS) provides cooling water for safety related heat exchangers and coolers within the station and makeup water for the closed-cycle circulating water system.

4.2.1 SERVICE WATER SYSTEM

The service water system is designed to provide make-up water to the closed cycle circulating water system and cooling water to safety-related equipment required for safe operation and maintenance of the Hope Creek Station. The SWS withdraws cooling water from the Delaware River, routes it to accept heat rejected from certain essential heat exchangers, and then uses it as makeup to the closed-cycle circulating water system (Figure 4-8).

4.2.1.1 INTAKE STRUCTURE

The SWS intake structure is a shoreline intake constructed of reinforced concrete to withstand specific floods, earthquakes, and other damage (Figure 4-9).

4.2.1.1.1 TRASH BARS AND TRASH RAKE

A continuous line of trash racks is located 13 feet (4 meters) in front of the intake; river currents sweep the face of the intake structure, and the trash racks prevent heavy debris from entering the intake and damaging the traveling screens. The trash rack bars are coated carbon steel, 3 inches by 3/4 of an inch (7.5 centimeters by 1.9 centimeters), and are set on 3 inch (7.5 centimeter) centers. A Rex Chainbelt, Inc. mechanical rake is used when necessary to remove trash from the trash racks. Velocity through the trash racks is approximately 0.1 foot per second (three centimeters per second).

4.2.1.1.2 CURTAIN WALL

Intake water flows into the structure under a curtain wall at a maximum velocity of approximately 0.35 foot per second (0.1 meter per second) through four openings, 11 feet (3.4 meters) high by 9.5 feet (2.9 meters) wide. Once inside, the water flows through one of four vertical traveling screens, each located in a separate well, at a maximum velocity of approximately 0.39 foot per second (0.12 meters per second). All velocities are well below EPA guidelines for cooling water intake structures (USEPA 1976).

4.2.1.1.3 TRAVELING SCREENS

A traveling screen is an endless linkage of framed baskets. Each basket is approximately 2.5 feet (0.75 meter) high and 8.3 feet (2.5 meters) wide, and each holds a panel of 0.063 inch (0.16 millimeter) diameter monel wire mesh with openings that are 1/2 inch high by 1/8 inch wide (1.27 centimeter by 0.32 centimeter).

Each basket has a trough on the lower lip similar to those described for Salem Generating Station. This "fish bucket" is designed to prevent reimpingement of fish by reducing the number which flip off the baskets as they rise from the water. The baskets allow organisms to remain in water while being lifted to fish return troughs. The screens are intended for continuous rotation.

Organisms, trash and other objects small enough to pass through the trash racks collect on the traveling screens. Streams of water remove these objects from the baskets and sluice them into flumes. Water from screen wash pumps issues from a series of spray nozzles near the top of the screen as the bucket turns over and starts to travel downward. The first series of nozzles provides a gentle flow at 20 psi to wash fish and loose debris into the fish return trough. This low pressure reduces potential descaling and buffeting of fish. A second series of nozzles provides a high pressure spray at 90 psi to wash any remaining debris into the debris trough.

Organisms and debris removed from the screens are returned to the Delaware River approximately 50 feet (15.2 meters) south of the intake structure, to reduce the potential for reimpingement on the screens.

4.2.1.1.4 SERVICE WATER PUMPS

After passing through the traveling screens, the river water enters the service water pumps. Under normal circumstances, two pumps operate, and two additional pumps act as spares. There are no seasonal or operational reductions in pumping. Each well contains a vertical wet pit turbine type service water pump rated at 16,500 gallons per minuter (62,500 liters per minute) at 150 feet (46 meters) total head. Each service water pump discharges through a pipe to an automatic, self-cleaning service water strainer. Each strainer is of 250-micron mesh. The strainers continuously self-wash.

4.2.2 CIRCULATING WATER SYSTEM

The circulating water system serves as the principal heat sink for normal plant processes. The system pumps water from the cooling tower through the main condenser and again back the cooling tower, where heat rejection by evaporation to the atmosphere occurs. The system contains 9 million gallons (34 million liters) of water, recirculated at 552,000 gallons per minuter (2,080,000 liters per minute).

The system consists of one natural draft cooling tower with make-up, blowdown, basin overflow and fill bypass systems; four circulating water pumps; a two pass surface condenser and a closed loop circulating water piping arrangement (Figure 4-8).

4.2.2.1 CIRCULATING WATER PUMPS

Four vertical wet-pit circulating water pumps, each with a rated capacity of 138,000 gallons per minute (520,000 liters per minute) at approximately 100 feet (30 meters) total dynamic head, discharge into a 12 foot (3.6 meter) diameter tunnel leading to the main condenser.

4.2.2.2 CONDENSER

The main condenser is a double-pass, three shell, horizontal, deaerating type surface condenser. The tubes are 40 feet (12 meters) in effective length, constructed of Titanium B-338, Grade II alloy, and have a 0.875 inch (2.2 centimeter) nominal diameter. The effective total surface area is 821,430 square feet (76,300 square meters). Each shell has two tube bundles, two inlet-outlet boxes, and two reversing-end water boxes. The waterboxes are rubber-lined, and have provisions for cathodic protection to resist corrosion.

From the condenser the water returns to the cooling tower to complete the cycle.

In normal operation, four circulating water pumps continuously operate. Since approximately 7.86 x 10^9 Btu per hour (1.95 x 10^9 kilocalories per hour) are rejected to a circulating water flow of 2,080,000 liters per minute (552,000 gallons per minute), the circulating water temperature rises about 28°F (15.5°C).

At least two pumps must operate in order to sustain electric power production. Under these conditions 4.4 x 10^9 Btu per hour (1.10 x 10^9 kilocalories per hour) are rejected to water flowing at 306,000 gallons per minute (1,160,000 liters per minute). Circulating water temperature rise is 29°F (16°C).

Following normal shutdown the pumps continue running until the temperature of the turbine condenser unit is between 100 to 105°F (38°C). This is done to extend the service life of the condenser tubes.

Total average residence time for a parcel of water entering the circulating water system and discharging via blowdown or evaporation is about 4.5 hours, based on makeup water displacing approximately 32,000 gallons per minute (121,000 liters per minute). Average transit time for a parcel of water through the circulating water system is 16 minutes, assuming water normally circulates at 552,000 gallons per minute (2,080,000 liter per minute).

Dissolved and suspended solids build up in the circulating water because the cooling tower evaporates water. This results in sediment deposition in the cooling tower basin and scaling. Blowing down a quantity of water from the cooling tower basin over a stationary weir to the Delaware River reduces deposition and scaling. Cycles of concentration in the circulating water system (relative to makeup water) are maintained at 2.0 or less.

4.2.2.3 NATURAL DRAFT COOLING TOWER

A single counterflow, hyperbolic natural draft cooling tower dissipates the heat from the circulating water system. The cooling tower stands approximately 800 feet (244 meters) northeast of the turbine building.

Fabricated from reinforced concrete supported on a driven pipe pile foundation, the cooling tower is designed for a 45-year operating life. Cooling tower fill is non-combustible. A drift eliminator system provides a guaranteed drift rate not exceeding 0.0005 percent of total circulating water flow.

Usable basin depth is 6 feet (1.8 meters), to maintain a minimum water inventory in the circulating water system of 9 million gallons (34 million liters). Extra freeboard provides 30 percent additional capacity.

The natural draft cooling tower is designed for ambient (dry) air temperatures of 0 to 100°F (-18 to 38°C). Waste heat dissipation to ensure safe shutdown of the reactor does not require the natural draft cooling tower.

Duty, circulating water flow and meteorological conditions affect cooling tower performance. Consumptive water use varies from 9,600 gallons per minute (35,300 liters per minute) in January to 13,000 gallons per minute (49,200 liters per minute) in July. Cycles of concentration and blowdown temperatures vary also. The use of sodium hypochlorite prevents the buildup of slime in the tower fill. Caustic is also added to control Circulating Water chemistry.

4.2.3 DISCHARGE

4.2.3.1 COOLING TOWER BLOWDOWN

Cold-side cooling tower blowdown and other station effluents flow through an underground conduit to the Delaware River (Figure 4-8). The conduit terminates in a 4 foot (1.22 foot) inside diameter horizontal pipe, 10 feet (3 meters) offshore upriver of the intake. The centerline of the opening is about 6 feet (1.8 meters) below mean low water. Normally, the discharge velocity is about 3.5 feet per second (1.1 meters per second).

4.2.3.2 THERMAL PLUME

With an average tidal flow of approximately 400,000 cubic feet per second (11,000 cubic meters per second) past the site, there is no discernible far-field temperature rise in the river as a result of the cooling tower blowdown. Mathematical modeling has been used to determine seasonal behavior characteristics of the thermal plume in the Delaware River and to confirm compliance with water quality standards.

Seasonal simulations performed for a complete tidal cycle indicate that the discharge is predominantly negatively buoyant. During winter (February), at high slack tide, a distance of 2,230 feet (680 meters) is required for mixing in order to meet the 2.2°C (4°F) maximum temperature limitation. This distance is well within the 3,500 feet (1,070 meters) mixing zone requirement. Temperature increases above 2.2°C (4°F) at the surface during these same conditions are confined within 600 feet (180 meters) of the Hope Creek discharge. Under all other conditions, the thermal plume meets temperature standards at a mixing zone distance of less than 2,000 feet (610 meters).

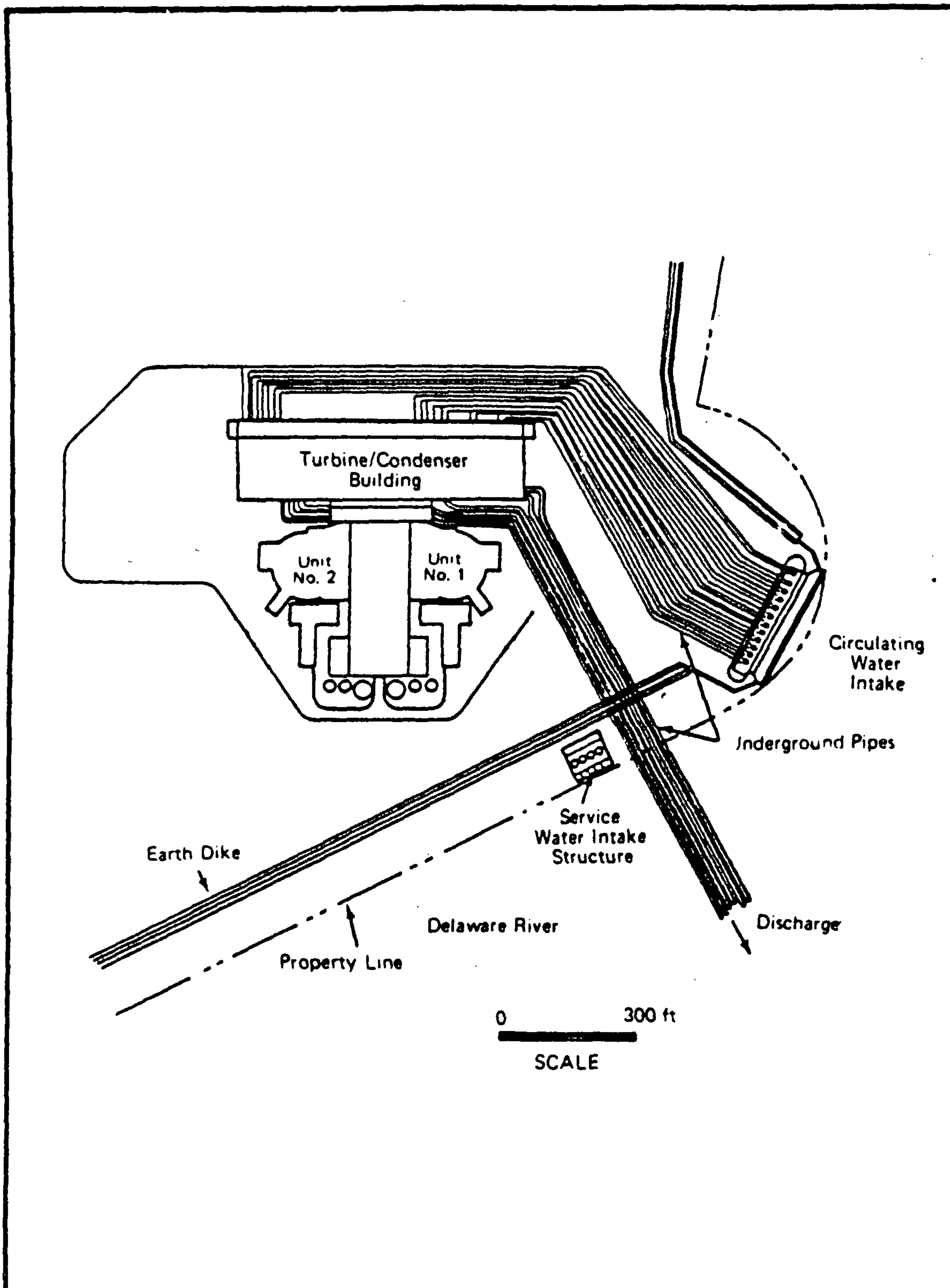


Figure 4-1. Salem Generating Station Layout with Cooling Water Piping Arrangement

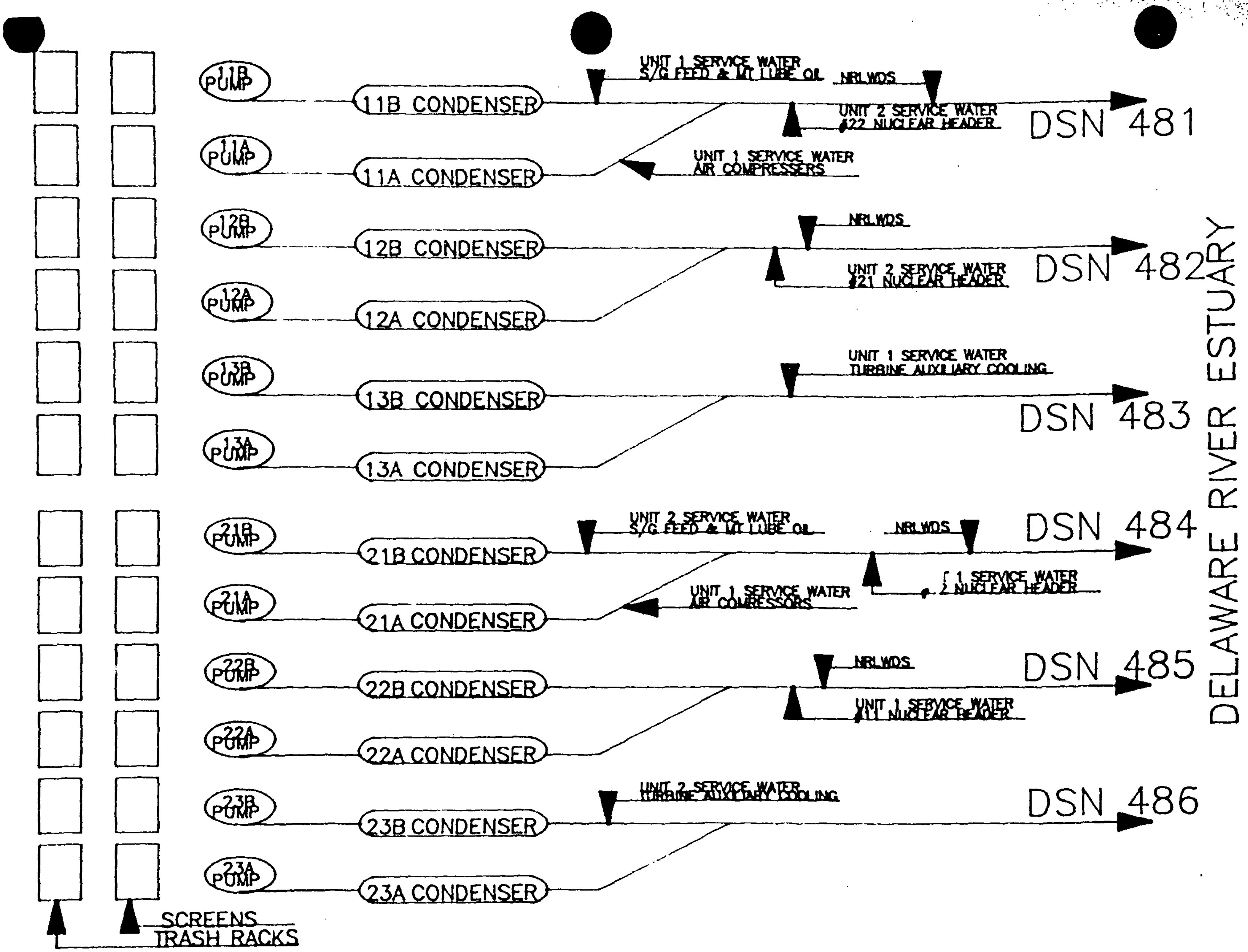


Figure 4-2. Schematic of Salem Generating Station Circulation Water System

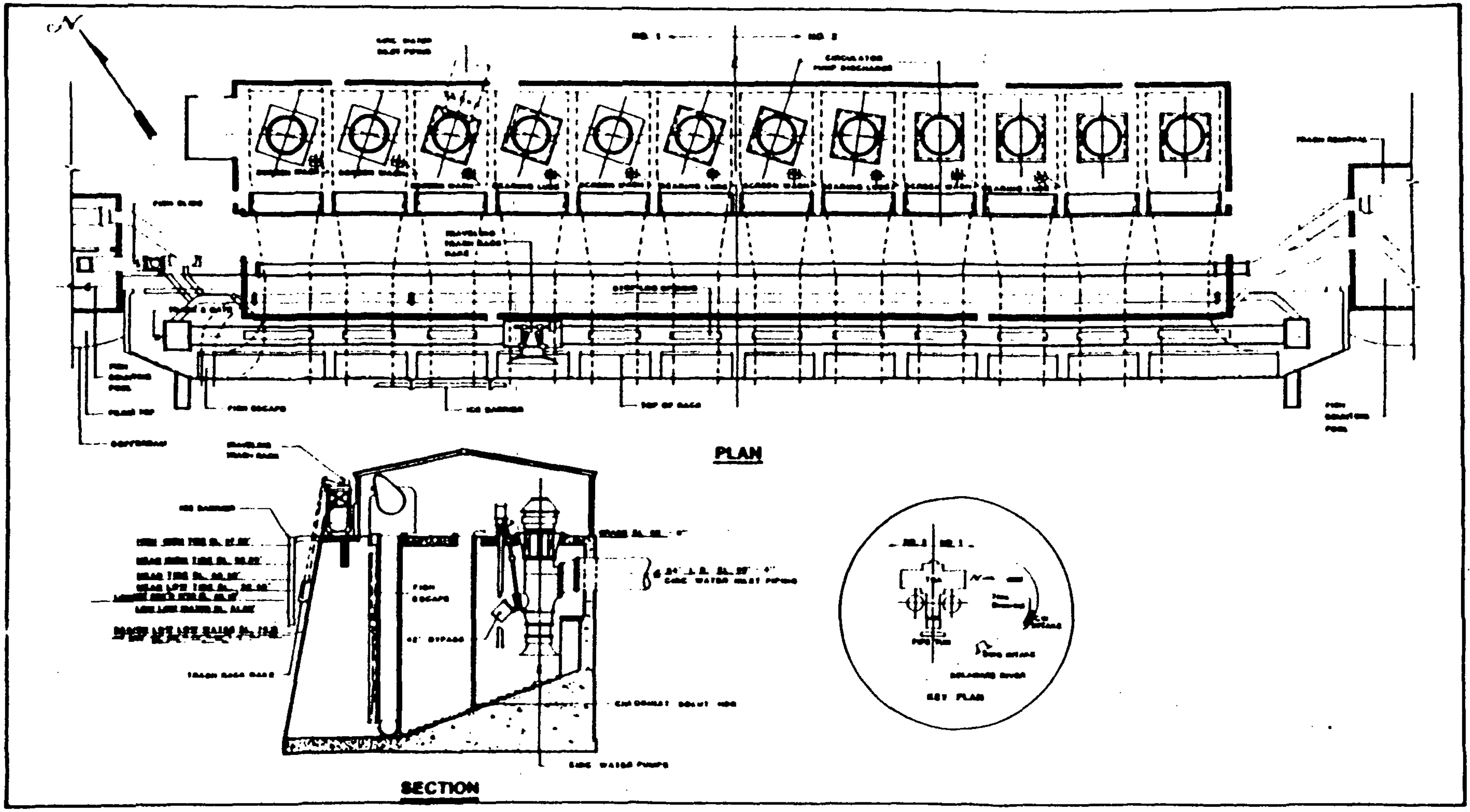


Figure 4-3. Salem Generating Station Circulating Water System Intake

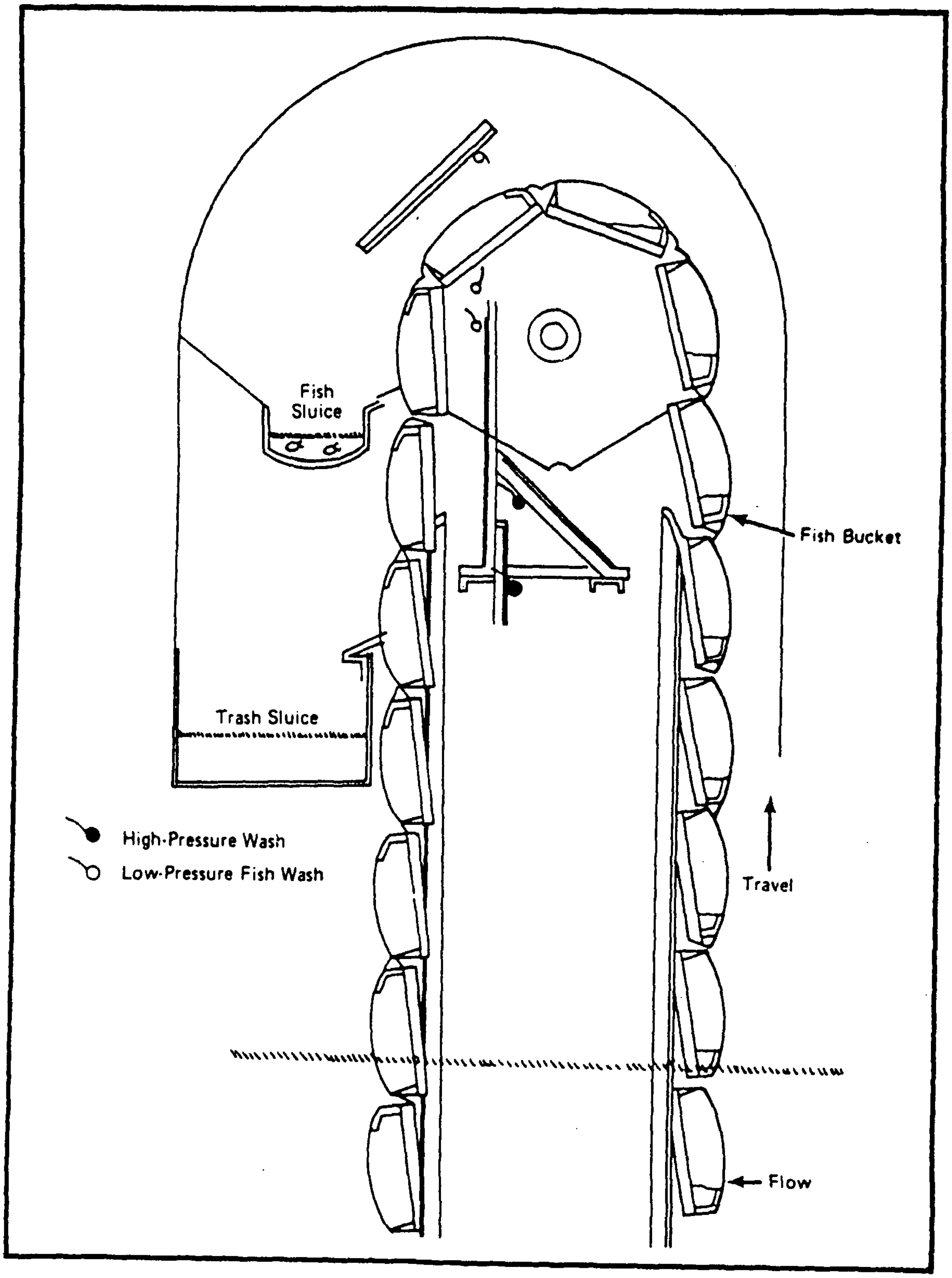


Figure 4-4. Modified Vertical Traveling Water Screen

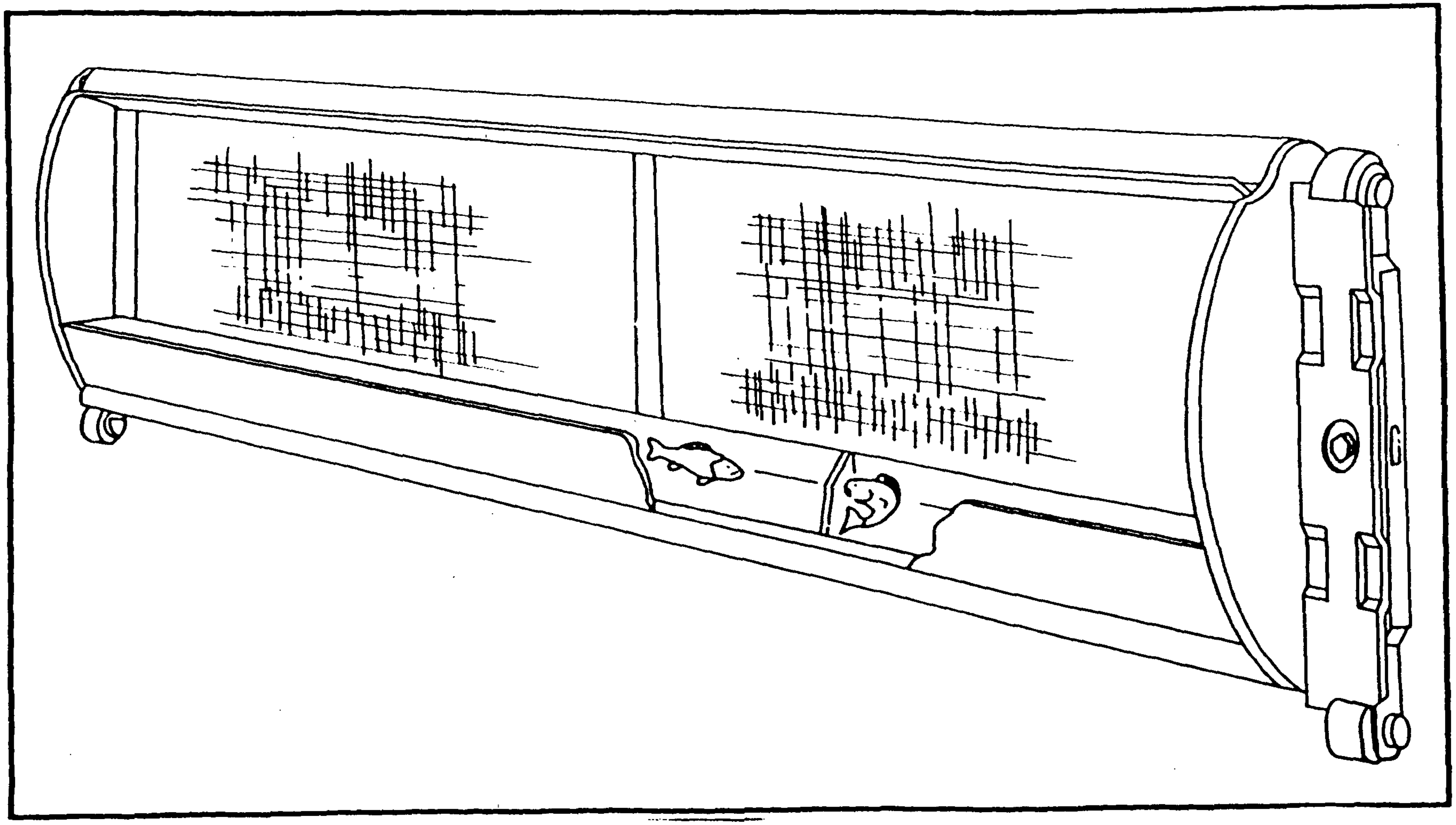


Figure 4-5. Fish Bucket-Type Screen Basket Assembly

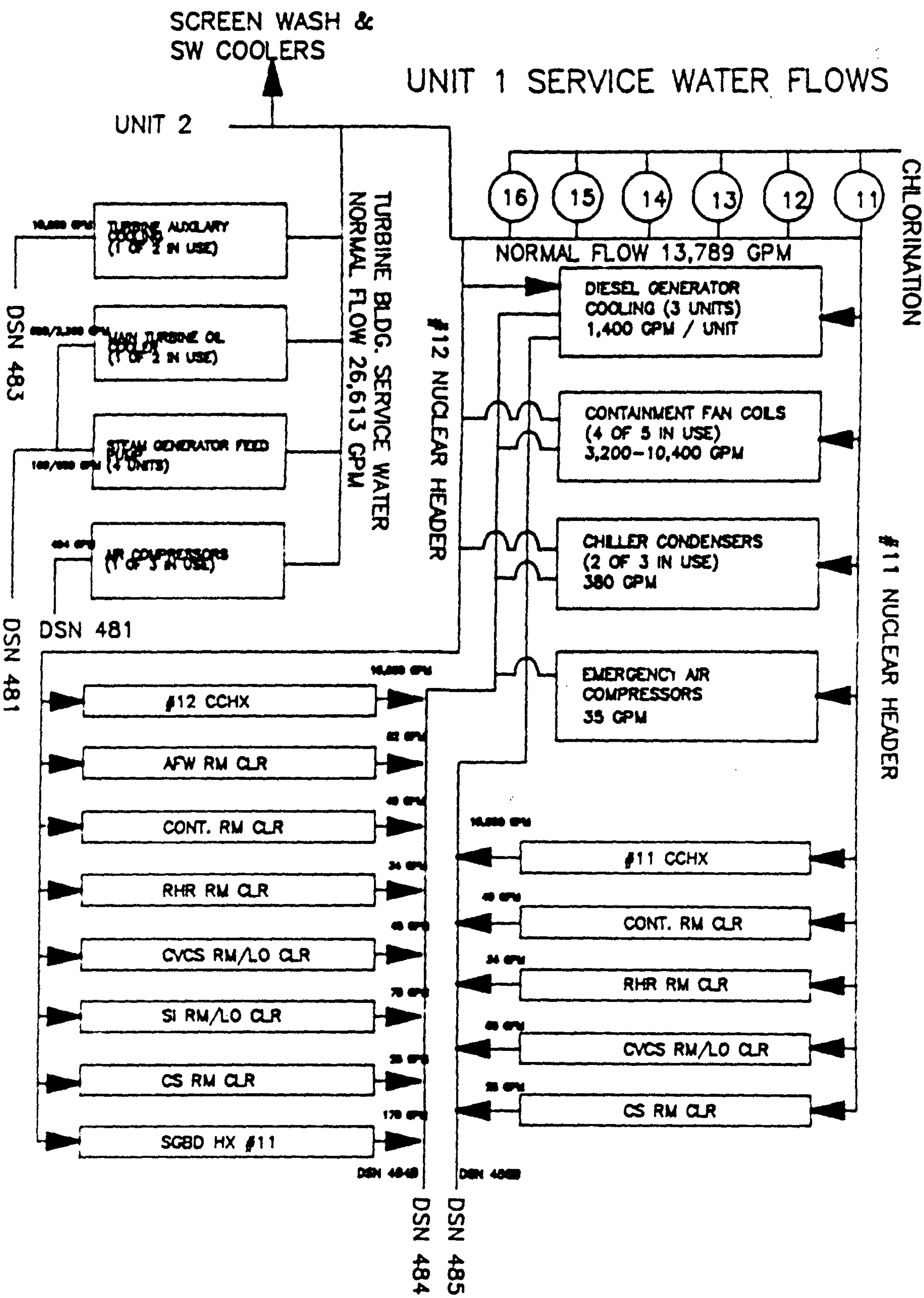


Figure 4-6. Salem Generating Station Service Water System

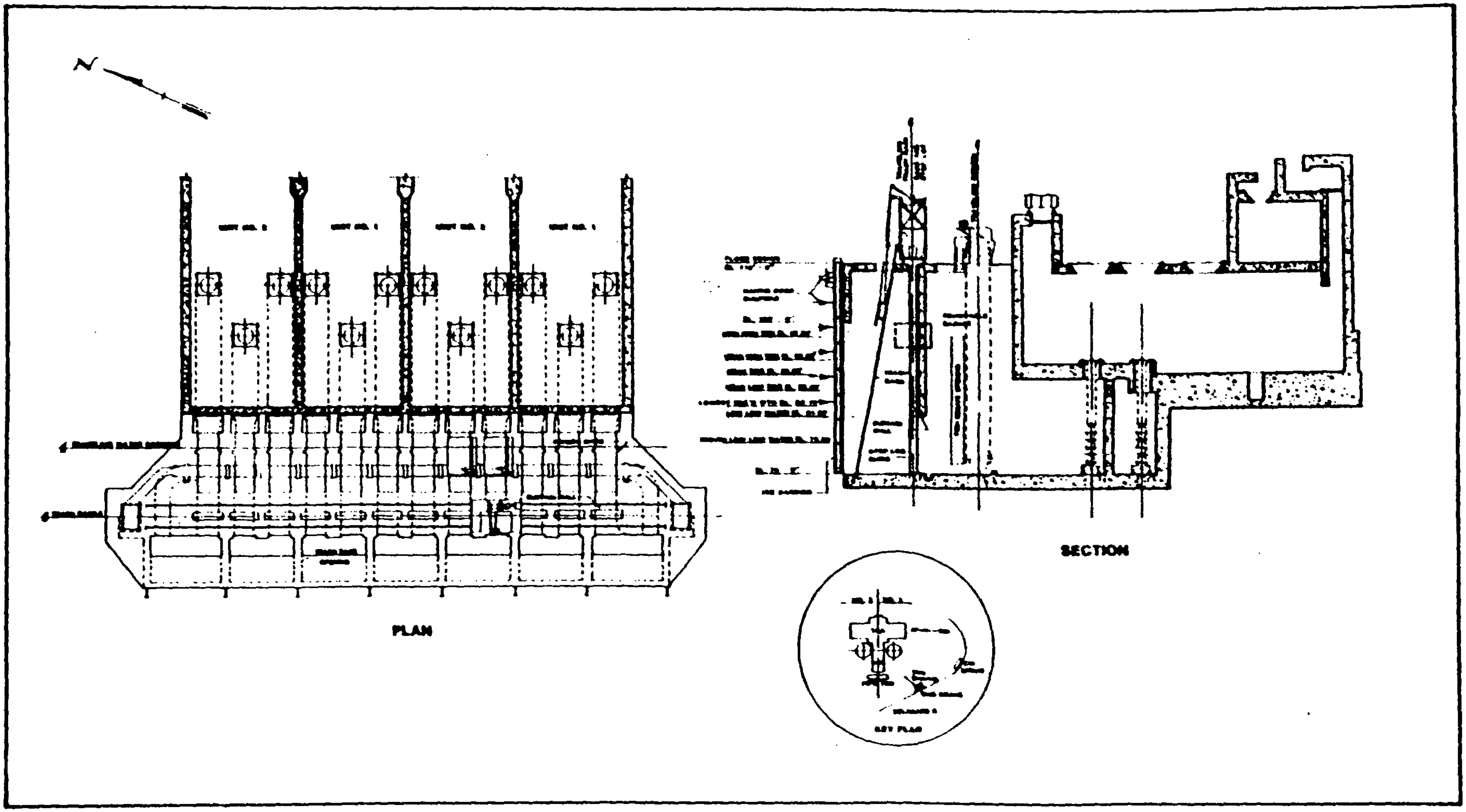


Figure 4-7. Salem Generating Station Service Water System Intake

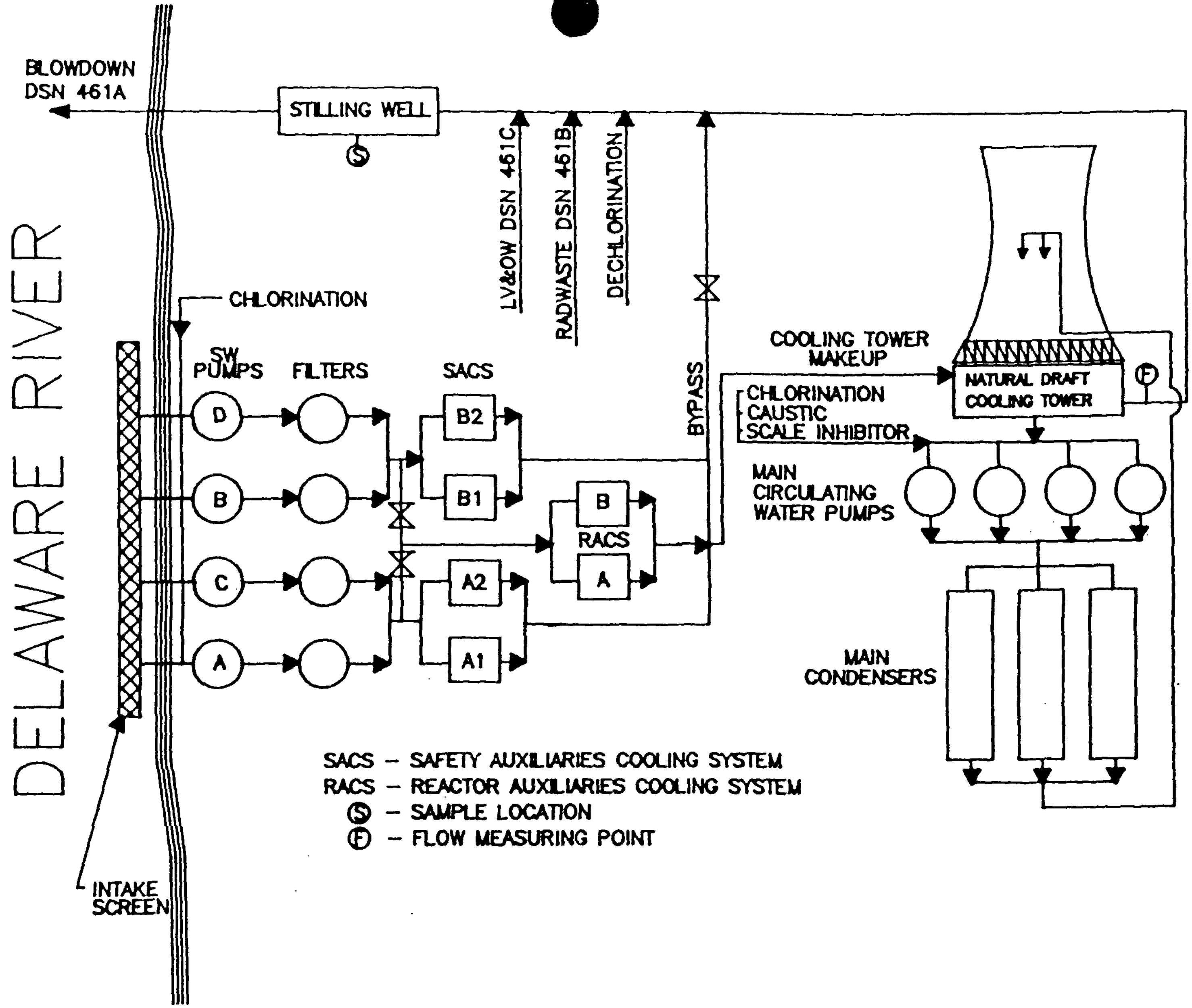


Figure 4-8. Hope Creek Service and Circulating Water Systems Schematic

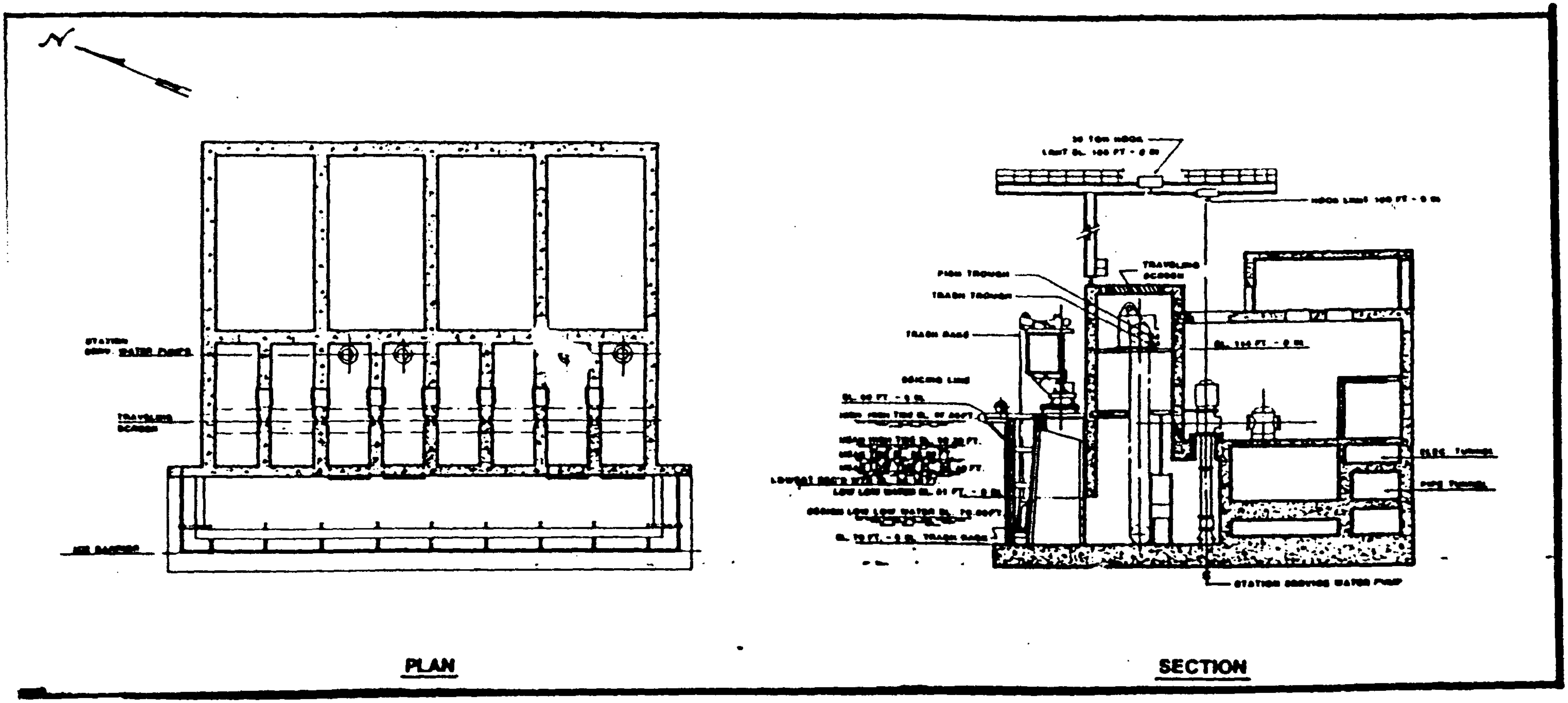


Figure 4-9. Hope Creek Generating Station Service Water System Intake

SECTION 5.0
SPECIES

5.1 GENERAL SEA TURTLE INFORMATION

Living sea turtles are taxonomically represented by two families, five genera, and seven species (Hopkins and Richardson 1984, Carr 1952). The family Cheloniidae is comprised of five genera and six distinct species. These species are Caretta caretta (loggerhead), Chelonia mydas (green turtle), C. depressa (flatback), Eretomochelys imbricata (hawksbill), Lepidochelys kempi (Kemp's ridley), and L. olivacea (olive ridley). The family Dermochelyidae is comprised of only one genus and species, Dermochelys coriacea, commonly referred to as the leatherback sea turtle.

Most of these seven sea turtle species are distributed throughout all of the tropical oceans. However, the loggerhead occurs primarily in temperate latitudes, and the leatherback, although nesting in the tropics, frequently migrates into cold waters at higher latitudes because of its unique physiology (Mager 1985).

Sea turtles are believed to be descended from species known from the late Jurassic and Cretaceous periods that were included in the extinct family Thallassemyidae (Carr 1952, Hopkins and Richardson 1984). Modern sea turtles have short, thick, incompletely retractile necks, and legs which have been modified to become flippers (Bustard 1972, Carr 1952). All species, except the leatherback, have a hard, bony carapace modified for marine existence by streamlining and weight reduction (Bustard 1972). Chelonians have only a thin layer of bone covered by overlaying scutes and Dermochelys has a smooth scaleless black skin and soft carapace with seven longitudinal keels (Carr 1952). These differences in structure are the principal reason for their designation as the only species in the monotypic family Dermochelidae (Carr 1952)

Sea turtles spend most of their lives in an aquatic environment and males of many species may never leave the water (Hopkins and Richardson 1984, Nelson 1988). The recognized life stages for these turtles are egg, hatchling, juvenile/subadult, and adult (Hirth 1971). A generalized sea turtle life cycle is presented in Figure 5-1.

Reproductive cycles in adults of all species involve some degree of migration in which the animals return to nest at the same beach year after year (Hopkins and Richardson 1984). Nesting generally begins about the middle of April and continues into September (Hopkins and Richarson 1984, Nelson 1988, Carr 1952). Mating and copulation occur just off the nesting beach and it is theorized that sperm from one nesting season may be stored by the female and thus fertilize a later season's eggs (Carr and Hirth 1962; Ehrhart 1980). A nesting female moved shoreward by the surf lands on the beach, and if suitable crawls to a point above the high water mark (Carr 1952). She then proceeds to excavate a shallow body pit by twisting her body in the sand (Bustard 1972). After digging the body pit she proceeds to excavate an egg chamber using her rear flipper (Carr 1952). Clutch size, egg size, and egg shape is species specific (Bustard 1972). Incubation periods for loggerheads and green turtles average 55 days but range from 45 to 65 days depending on local conditions (Nelson 1988).

Hatchlings emerge from the nest at night, breaking the egg shell and digging their way out of the nest (Carr 1952). They find their way across the beach to the surf by orienting to light reflecting off the breaking surf (Hopkins and Richardson 1984). Once in the surf, hatchlings exhibit behavior known as "swim frenzy," during which they swim in a straight line for many hours (Carr 1986). Once into the waters off the nesting beach, hatchlings enter a period known as the "lost year." It is not known where this time is spent, what habitat this age prefers, or mortality rates during this period. It is currently believed the period encompassed by the "lost year" may actually turn out to be several years. Various hypothesis have been put forth about the "lost year." One is that hatchlings may become associated with floating sargassum rafts offshore. These rafts provide shelter and are dispersed randomly by the currents (Carr 1986). Another hypothesis is that the "lost year" of some species may be spent in a salt marsh/estuarine system (Garmon 1981).

The functional ecology of sea turtles in the marine and/or estuarine ecosystem is varied. The loggerhead is primarily carnivorous and has jaws well-adapted to crushing molluscs and crustaceans and grazing on encrusted organisms attached to reefs, pilings and wrecks; the Kemp's ridley is omnivorous and feeds on swimming crabs and crustaceans; the green turtle is a herbivore and grazes on marine grasses and algae; and, the leatherback is a specialized feeder preying primarily upon jellyfish. Until recently, sea turtle populations were large and subsequently played a significant role in the marine ecosystem. This role has been greatly reduced in most locations as a result of declining turtle populations. These population declines are a result of natural factors such as disease and predation, habitat loss, commercial overutilization, and inadequate regulatory mechanisms for their protection. This has led to several species being in danger of or threatened with extinction.

However, due to changes in habitat use during different life history stages and seasons, sea turtle populations are difficult to census (Meylan 1982). Because of these problems estimates of population numbers have been derived from various indices such as numbers of nesting females, numbers of hatchlings per kilometer of nesting beach and number of subadult carcasses (strandings) washed ashore (Hopkins and Richardson 1984).

Six of the seven extant species of sea turtles are protected under the Endangered Species Act. Three of the turtles, Kemp's ridley, hawksbill and leatherback, were listed as endangered. The Florida nesting population of green turtle and Mexican west coast population of olive ridley are also endangered. All of the remaining populations of green turtle, olive ridley and loggerhead are threatened. The only unlisted species is the locally protected Australian flatback turtle (Hopkins and Richardson 1984). Only two species of sea turtles, loggerheads and Kemp's ridleys, occur in the Delaware estuary near the Salem and Hope Creek Generating Stations. Leatherbacks do occur in coastal New Jersey and Delaware and the mouth of Delaware Bay. Green turtles have only been sporadically reported from downbay areas and along the coast. Regional sea turtle distribution will be discussed in more detail later in the section.

5.2 LOGGERHEAD (Caretta caretta)

5.2.1 DESCRIPTION

The adult loggerhead turtle has a slightly elongated, heart-shaped carapace that tapers towards the posterior and has a broad triangular head (Pritchard et al. 1983). Loggerheads normally weigh up to 450 pounds (200 kilograms) and attain a carapace length (straight line) up to 48 inches (120 centimeters)(Pritchard et al. 1983). Their general coloration is reddish-brown dorsally and cream-yellow ventrally (Hopkins and Richardson 1984). Morphologically, the loggerhead is distinguishable from other sea turtle species by the following characteristics: 1) a hard shell; 2) two pairs of scutes on the front of the head, 3) five pairs of lateral scales on the carapace; 4) plastron with three pairs of enlarged scutes connecting the carapace; 5) two claws on each flipper; and, 6) reddish-brown coloration (Nelson 1988, Dodd 1988, Wolke and George 1981).

Loggerhead hatchlings are brown above with light margins below and have five pairs of lateral scales (Pritchard et al. 1983)

5.2.2 DISTRIBUTION

Loggerhead turtles are circumglobal, inhabiting continental shelves, bays, lagoons, and estuaries in the temperate, subtropical and tropical waters of the Atlantic, Pacific and Indian Oceans (Dodd 1988, Mager 1985).

In the western Atlantic Ocean, loggerhead turtles occur from Argentina northward to Nova Scotia including the Gulf of Mexico and the Caribbean Sea (Carr 1952, Dodd 1988, Mager 1985, Nelson 1988). Sporadic nesting is reported throughout the tropical and warmer temperate range of distribution, but the most important nesting areas are the Atlantic coast of Florida, Georgia and

South Carolina (Hopkins and Richardson 1984). The Florida nesting population of loggerheads has been estimated to be the second largest in the world (Ross 1982).

The foraging range of the loggerhead sea turtle extends throughout the warm waters of the U.S. continental shelf (Shoop et al. 1981). On a seasonal basis, loggerhead turtles are common as far north as the Canadian portions of the Gulf of Maine (Lazell 1980), but during cooler months of the year, distributions shift to the south (Shoop et al. 1981). Loggerheads frequently forage around coral reefs, rocky places and old boat wrecks; they commonly enter bays, lagoons and estuaries (Dodd 1988). Aerial surveys of loggerhead turtles at sea indicate that they are most common in waters less than 50-meters in depth (Shoop et al. 1981), but they occur pelagically as well (Carr 1986).

5.2.3 FOOD

Loggerheads are primarily carnivorous (Mortimer 1982). They eat a variety of benthic organisms including molluscs, crabs, shrimp, jellyfish, sea urchins, sponges, squids, and fishes (Nelson 1988). Adult loggerheads have been observed feeding in reef and hard bottom areas (Mortimer 1982). In the seagrass lagoons of Mosquito Lagoon, Florida, subadult loggerheads fed almost exclusively on horseshoe crab (Mendonca and Ehrhart 1982). Loggerheads may also eat animals discarded by commercial trawlers (Shoop and Ruckdeschel 1982). This benthic feeding characteristic may contribute to the capture of these turtles in trawls.

5.2.4 NESTING

The nesting season of the loggerhead is confined to the warmer months of the year in the temperate zones of the northern hemisphere. In south Florida nesting may occur from April through September but usually peaks in late June and July (Dodd 1988, Florida Power & Light Company 1983).

Loggerhead females generally nest every other year or every third year (Hopkins and Richardson 1984). When a loggerhead nests, it usually will lay 2 to 3 clutches of eggs per season and will lay 35 to 180 eggs per clutch (Hopkins and Richardson 1984). The eggs hatch in 46 to 65 days and hatchling emerge 2 or 3 days later (Hopkins and Richardson 1984).

Hatchling loggerheads are a little less than 2 inches (5 centimeters) in length when they emerge from the nest (Hopkins and Richardson 1984, Florida Power & Light Company 1983). They emerge from the nest as a group at night, orient themselves seaward and rapidly move towards the water (Hopkins and Richardson 1984). Many hatchlings fall prey to sea birds and other predators following emergence. Those hatchlings that reach the water quickly move offshore and exist pelagically (Carr 1986).

5.2.5 POPULATION SIZE

Loggerhead sea turtles are the most common sea turtle in the coastal waters of the United States. Based on numbers of nesting females, numbers of hatchlings per kilometer of nesting beach and number of subadult carcasses (strandings) washed ashore, the total number of mature loggerhead females in the southeastern United States have been estimated to be from 35,375 to 72,520 (Hopkins and Richarson 1984; Gordon 1983).

Adult and sub-adult (shell length greater than 60 centimeters) population estimates have also been based on aerial surveys of pelagic animals observed by NMFS during 1982 to 1984. Based on these studies the current estimated number of adult and sub-adult loggerhead sea turtles from Cape Hatteras, North Carolina to Key West, Florida is 387,594 (NMFS 1987). This number was arrived at by taking the number of observed turtles and converting it to a population abundance estimate using information on the amount of time loggerheads typically spend at the surface.

Some sea turtles which die at sea wash ashore and are found stranded. NMFS, Sea Turtle Salvage and Stranding Network collects stranded sea turtles along both the Atlantic and Gulf Coasts (NMFS 1988). Based on 1987 data, over 2,300 loggerhead turtles were reported by the network (Figures 5-2 and 5-3). The largest portion was collected from the southeast Atlantic Coast (1,414 turles) followed by the Gulf Coast (593 turtles) and northeast Atlantic Coast (347 turtles).

Onboard observation of offshore shrimp trawling by NMFS in the southeast Atlantic estimated that over 43,000 loggerheads are captured in shrimp trawls annually. The estimated number of loggerhead mortalities from this activity was estimated to be 9,874 turtles annually (NMFS 1987).

Based on these data, it is evident that a large population of loggerhead sea turtles does exist in the southeast Atlantic and Gulf of Mexico. Various populations estimates suggest that the number of adult and sub-adult turtles is probably in the hundreds of thousands in the southeastern United States alone. This plus the fact that other populations of loggerheads occur in many other parts of the world suggest that although this species needs to be conserved it is not in any immediate danger of becoming endangered. However, the continued development of coastal foraging areas and population mortalities due to offshore trawling is likely to have a negative impact on population numbers if continued. In fact, one researcher has suggested that loggerhead turtle nesting populations in the U.S. has been declining (Frazer 1986).

5.3 KEMPS RIDLEY (*Lepidochelys kempi*)

5.3.1 DESCRIPTION

The adult Kemp's ridley has a circular-shaped carapace and a medium sized pointed head (Pritchard et al. 1983). Ridleys normally weigh up to 90 pounds (42 kilograms) and attain a carapace length (straight line) up to 27 inches (70 centimeters)(Pritchard et al. 1983). Their general coloration is olive-green dorsally and yellow ventrally (Hopkins and Richardson 1984). Morphologically, the Kemp's ridley is distinguishable from other sea turtle species by the following characteristics: 1) a hard shell; 2) two pairs of scutes on the front of the head, 3) five pairs of lateral scutes on the carapace; 4) plastron with four pairs of scutes, with pores, connecting the carapace; 5) one claw on each front flipper and two on each back flipper; and, 6) olive-green coloration (Pritchard et al. 1983, Pritchard and Marquez 1973).

Kemp's ridley hatchlings are dark grey-black above and white below (Pritchard et al. 1983, Pritchard and Marquez 1973).

5.3.2 DISTRIBUTION

Kemp's ridley turtles inhabit sheltered coastal areas and frequent larger estuaries, bays and lagoons in the temperate, subtropical and tropical waters of the Atlantic Ocean and Gulf of Mexico (Mager 1985).

The foraging range of adult Kemp's ridley sea turtle appears to be restricted to the Gulf of Mexico. However, juveniles and subadult occur throughout the warm coastal waters of the U.S. Atlantic coast (Hopkins and Richardson 1984, Pritchard and Marquez 1973). On a seasonal basis ridleys are common as far north as the Canadian portions of the Gulf of Maine (Lazell 1980), but during cooler months of the year, they shift to the south (Morreale et al. 1988).

5.3.3 FOOD

Kemp's ridleys are omnivorous and feeds on crustaceans, swimming crabs, fish, jellyfish and molluscs (Pritchard and Marquez 1973).

5.3.4 NESTING

Kemp's ridley nesting is mainly restricted to a stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Pritchard and Marquez 1973, Hopkins and Richardson 1984). Occasional nesting has been reported in Padre Island, Texas and Veracruz, Mexico (Mager 1985).

The nesting season of the Kemp's ridley is confined to the warmer months of the year primarily from April through July.

Kemp's ridley females generally nest every other year or every third year (Pritchard et al. 1983). They will lay 2 to 3 clutches of eggs per season and will lay 50 to 185 eggs per clutch (Hopkins and Richardson 1984). The eggs hatch in 45 to 70 days and hatchling emerge 2 or 3 days later (Hopkins and Richardson 1984).

Hatchling ridleys are a little less than 2 inches (4.2 centimeters) in length when they emerge from the nest (Hopkins and Richardson 1984). They emerge from the nest as a group at night, orient themselves seaward and rapidly move towards the water (Hopkins and Richardson 1984). Following emergence, many hatchlings fall prey to sea birds, raccoons and crabs. Those hatchlings that reach the water quickly move offshore. Their existence after emerging is not well understood but is probably pelagic (Carr 1986).

5.3.5 POPULATION SIZE

Kemp's ridley sea turtles are the most endangered of the sea turtle species. There is only a single known colony of this species, almost all of which nest near Rancho Nuevo, Tamaulipas, Mexico. An estimated 40,000 females nested on a single day in 1947, but since 1978 there have been less than 1,000 nests per season (Figure 5-4). Based on nesting information from Rancho Nuevo, it appears that the population is declining at a rate of approximately 3 percent per year (Ross, 1989). Also based on the numbers of nest produced at Rancho Nuevo, this species nesting cycle, male-female ratios and fecundity, the adult Kemp's ridley population has been estimated to be approximately 2,200 adults (Marquez 1989).

Kemp's ridleys also die at sea and wash ashore. NMFS, Sea Turtle Salvage and Stranding Network collects stranded sea turtles along both the Atlantic and Gulf Coasts (NMFS 1988). Based on 1987 data, 767 ridleys were reported by the network (Figures 5-2 and 5-3). The largest portion was collected from the Gulf Coast (103 turtles) and mostly the western portion of the Gulf. Nearly equal numbers of ridleys were reported from the northeast and southeast Atlantic Coasts (64 and 50 respectively).

Onboard observation of offshore shrimp trawling by NMFS in the southeast Atlantic indicated that over 2,800 ridleys are captured in shrimp trawls annually. The estimated number of ridley mortalities from this activity was estimated to be 767 turtles annually and most of these (65 percent) occurred in the western portion of the Gulf of Mexico (NMFS 1987).

Based on these data it is evident the this population is in danger of extinction.

5.4 GREEN TURTLE (*Chelonia mydas*)

5.4.1 DESCRIPTION

The green turtle is a medium to large sea turtle with a nearly oval carapace and a small rounded head (Pritchard et al. 1983). Its carapace is smooth and olive-brown in color with darker streaks and spots. Its plastron is yellow. Greens normally weigh up to 220 pounds (100 kilograms) and attain a carapace length (straight line) up to 35 inches (90 centimeters) (Pritchard et al. 1983, Hopkins and Richardson 1984). Morphologically this species can be distinguished from the other sea turtles by the following characteristics: 1) a relatively smooth shell with no overlapping scutes; 2) one pair of scutes on the front of the head, 3) four pairs of lateral scutes on the carapace; 4) plastron with four pairs of enlarged scutes connecting the carapace; 5) one claw on each flipper; and, 6) olive, dark-brown mottled coloration (Nelson 1988, Pritchard et al. 1983, Carr 1952).

5.4.2 DISTRIBUTION

Green turtles are circumglobally distributed mainly in waters between the northern and southern 20°C isotherm (Mager 1985). In the western Atlantic, several major assemblages have been identified and studied (Parsons 1962, Pritchard 1969, Schulz 1975, Carr et al. 1978). In the continental U.S., however, the only known green turtle nesting occurs on the Atlantic coast of Florida (Mager 1985).

5.4.3 FOOD

Green sea turtles are primarily herbivores that eat sea grasses and algae. Other organisms living on sea grass blades and algae add to the diet (Mager 1985).

5.4.4 NESTING

Green turtle nesting occurs on the Atlantic coast of Florida from June to September (Hopkins and Richardson 1984). Mature females may nest three to seven times per season at about 10 to 18 day intervals. Average clutch sizes vary between 100 and 200 eggs that hatch usually within 45 to 60 days (Hopkins and Richardson 1984). Hatchlings emerge, mostly at night, travel quickly to the water, and swim out to sea. At this point, they enter a period which is poorly understood but is likely spent pelagically in areas where currents concentrate debris and floating vegetation such as sargassum (Carr 1986).

5.4.5 POPULATION SIZE

The number of green sea turtles that existed before commercial exploitation and the total number that now exists are not known.

Records show drastic declines in the Florida catch during the 1800's and similar declines occurred in other areas (Hopkins and Richardson 1984).
The decline and elimination of many nesting beaches and less frequent encounters with green turtles provide inferential evidence that stocks are generally declining (Mayer 1985, Hopkins and Richardson 1984).

5.5 LEATHERBACK TURTLE (Dermochelys coriacea)

5.5.1 DESCRIPTION

The leatherback turtle is the largest of the sea turtles. It has an elongated, somewhat triangularly shaped body with longitudinal ridges or keels. It has a leathery blue-black shell composed of a thick layer of oily, vascularized cartilaginous material, strengthened by a mosaic of thousands of small bones. This blue-black shell which may also have variable white spotting (Pritchard et al. 1983). Its plastron is white. Leatherbacks normally weigh up to 660 pounds (300 kilograms) and attain a carapace length (straight line) of 55 inches (140 centimeters) (Pritchard et al. 1983, Hopkins and Richardson 1984). Specimens as large as 910 kilograms (2,000 pounds) have been observed.

Morphologically this species can be easily distinguished from the other sea turtles by the following characteristics: 1) its smooth unscaled carapace; 2) carapace with seven longitudinal ridges; 3) head and flippers covered with unscaled skin; and, 4) no claws on the flippers (Nelson 1988, Pritchard et al. 1983, Pritchard 1971, Carr 1952).

5.5.2 DISTRIBUTION

Leatherbacks have a circumglobal distribution and occur in the Atlantic, Indian and Pacific Oceans. They range as far north as Labrador and Alaska to as far south as Chile and the Cape of Good Hope, farther north than other sea turtle species, probably because of their ability to maintain a warmer body temperature over longer period of time (NMFS 1985).

5.5.3 FOOD

The diet of the leatherback consists primarily of soft-bodied animals such as jellyfish and tunicates, together with juvenile fishes, amphipods and other organisms (Hopkins and Richardson 1984).

5.5.4 NESTING

Leatherback turtle nesting occurs on the mid-Atlantic coast of Florida from March to September (Hopkins and Richardson 1984). Mature females may nest one to nine times per season at about 9 to 17 day intervals. Average clutch sizes vary between 50 and

170 eggs that hatch usually within 50 to 70 days (Hopkins and Richardson 1984). Hatchlings emerge, mostly at night, travel quickly to the water, and swim out to sea. The life history of the leatherback is poorly understood since juvenile turtles are rarely observed.

5.5.5 POPULATION SIZE

The world population estimates for the leatherback have been revised upward to over 100,000 females in recent years due the discovery of nesting beaches in Mexico (Pritchard 1983).

5.6 SEA TURTLES IN THE DELAWARE RIVER ESTUARY

Five species of sea turtles have recently been reported to occur in the Delaware River Estuary and coastal New Jersey and Delaware. This information was obtained by the Marine Mammal Stranding Center (MMSC), Brigantine, New Jersey (Schoelkopf 1989) and the Delaware Department of Natural Resources (Thomas 1988) both of which are members of the Northeast Turtle Salvage and Stranding Network supported by NMFS. The five species which have been observed in the estuary by these organizations are the loggerhead, Kemp's ridley, leatherback, green turtle and hawksbill.

Loggerheads were the most common sea turtle species observed by DEDNR. They reported sixty-five loggerhead strandings and/or sightings in the estuary from 1976 to 1988 and three from coastal Delaware (Table 5-1). The strandings/sightings in the bay were reported primarily from areas south of Liston Point. Kemp's ridleys were not common as loggerheads but eleven turtles were reported in the bay by DEDNR during the same time period. Leatherbacks were observed by DEDNR in the bay proper on one occasion but were more commonly observed along the Delaware coast (four turtles) between Rehoboth Beach and the Indian River Inlet just south of the mouth of the bay. DEDNR also reported one green turtle near Kitts Hummock and one hawksbill near Port Mahon.

The Marine Mammal Stranding Center has reported over 242 sea turtle strandings in coastal New Jersey and Delaware Bay since 1980. Of these, thirty-one were strandings (Table 5-2) from the bay (excludes turtles from Salem Generating Station). They have reported sea turtle strandings and/or sightings from Burlington, New Jersey to the Capes. In the bay, loggerheads were the most commonly stranded turtle (26 stranding reports). Kemp's ridleys and leatherback were less common (1 and 4 strandings respectively). No green or hawksbill sea turtles were reported by MMSC from 1980 to 1988.

PSE&G has also incidentally captured several sea turtles in sample trawls being used to collect fish for station related environmental studies. Three turtles were collected during these trawls including two loggerheads and one green turtle. The green turtle was captured at an unspecified location near the Mispillion River and loggerheads were captured near Egg Island Point.

Seasonally, most of the strandings and/or sightings reported by DEDNR and MMSC occur in the spring and summer (Tables 5-1 and 5-2). September appears to be the most common month for strandings although they occur virtually all year.
Based on stomach content analyses from dead turtles, it appears that the primary food for loggerheads from the bay is blue crab and horseshoe crab. Blue crab occur year round in the lower bay and move up bay in the spring as the saltfront moves. This, in conjunction with the northward migratory movements observed in loggerheads, could account for their occurrence in the bay. Horseshoe crab move upbay to lay eggs in the spring and also occur at a time which coincides with the movement of loggerheads along the coast. Kemp's ridley stomachs which have been examined have contained primarily blue crab. From a functional ecological viewpoint, loggerhead and Kemp's ridleys would be secondary consumers (Figure 5-5). Their significance in the bay, however, is not clear since population information is not available for either species in the bay.

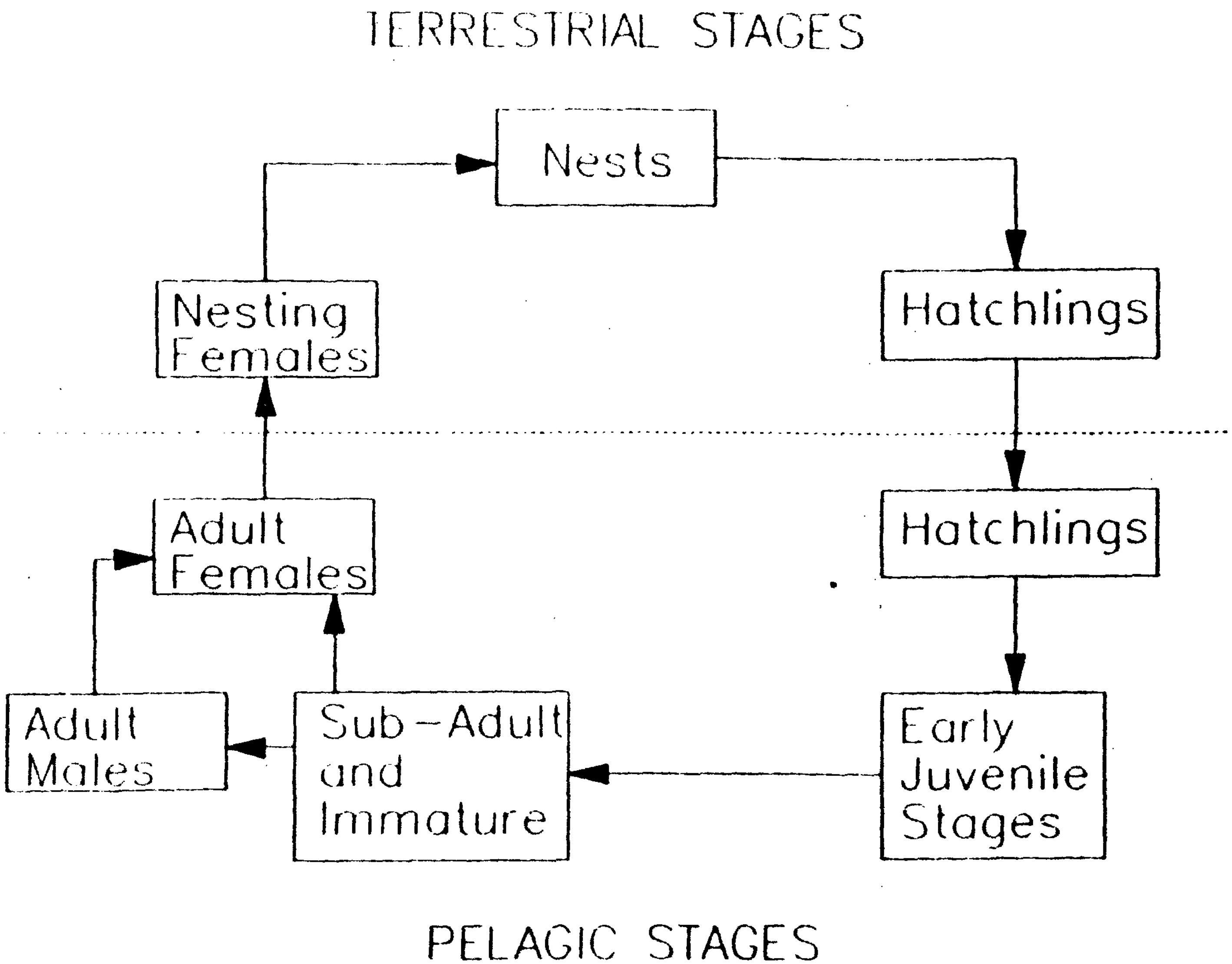


Figure 5-1. Generalized Sea Turtle Life Cycle

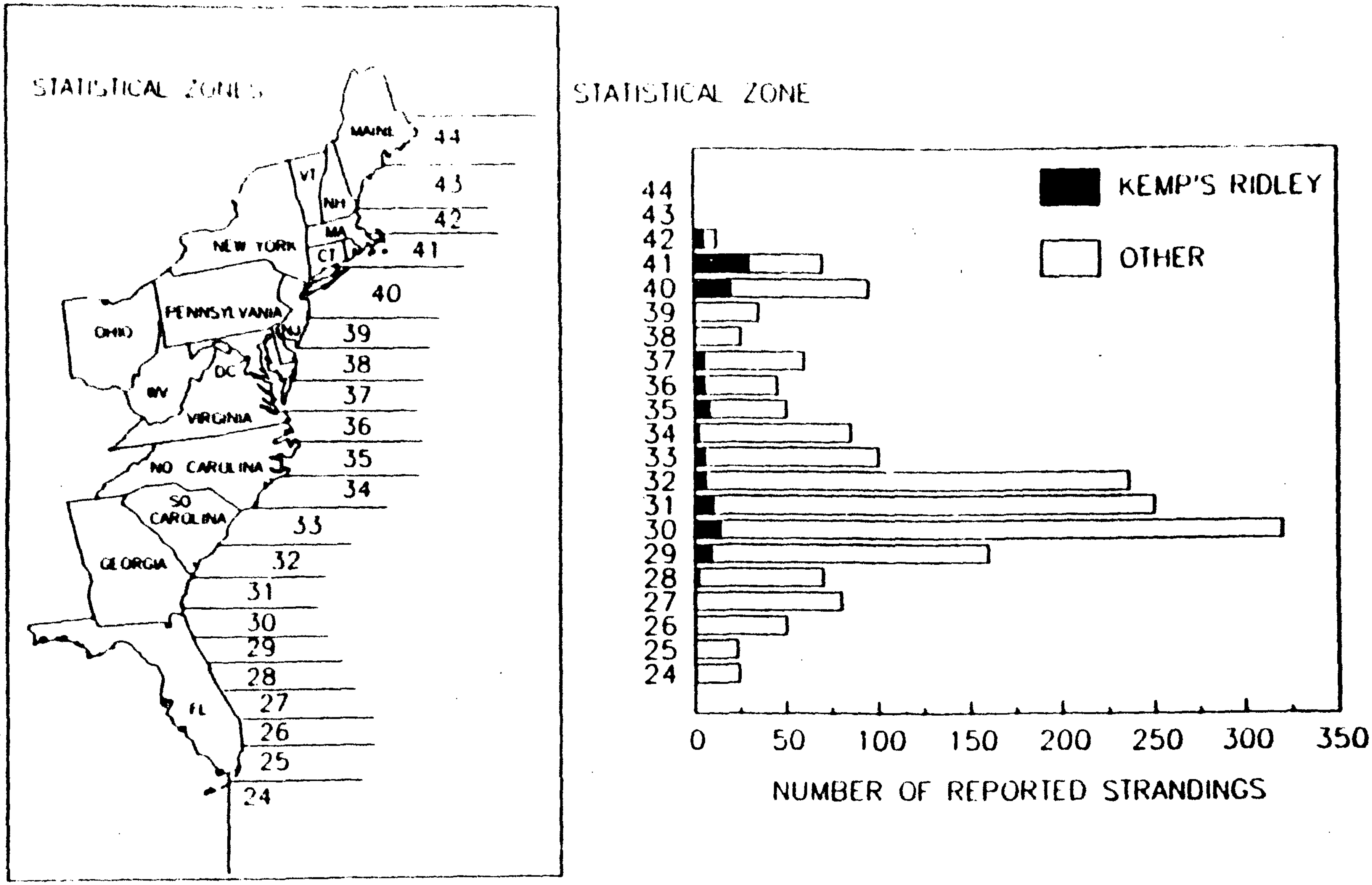
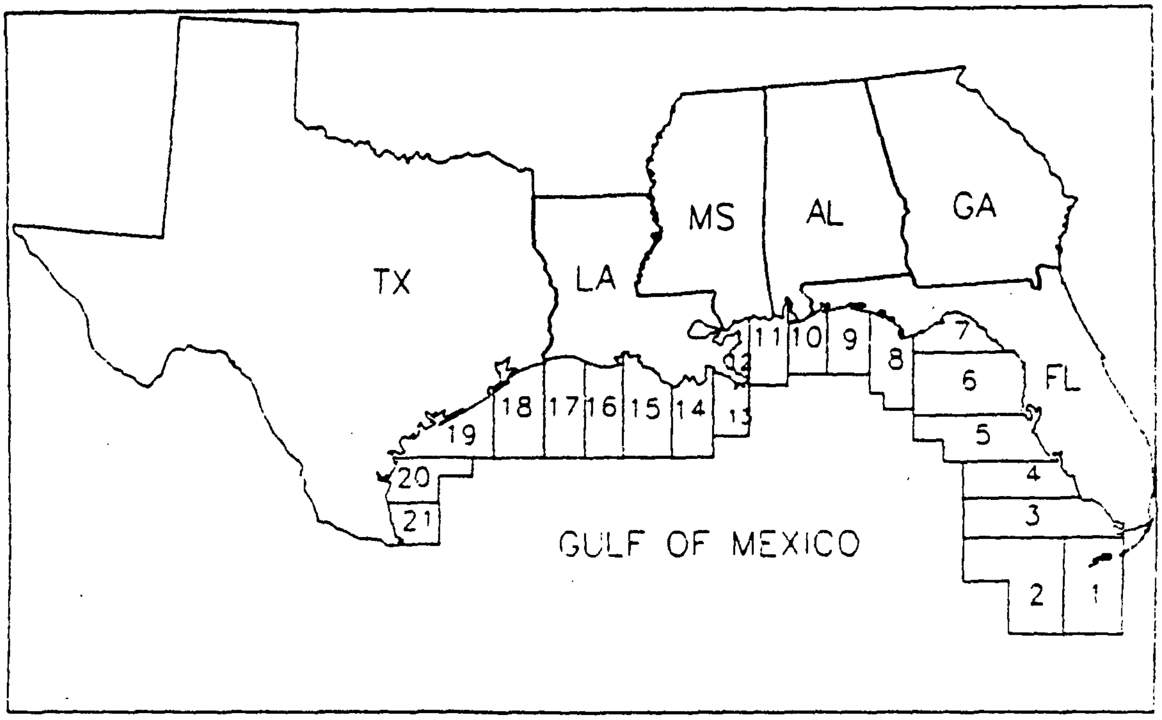


Figure 5-2. Sea Turtle Strandings, U. S. Atlantic Coast 1987 (NMFS 1987)



GULF OF MEXICO

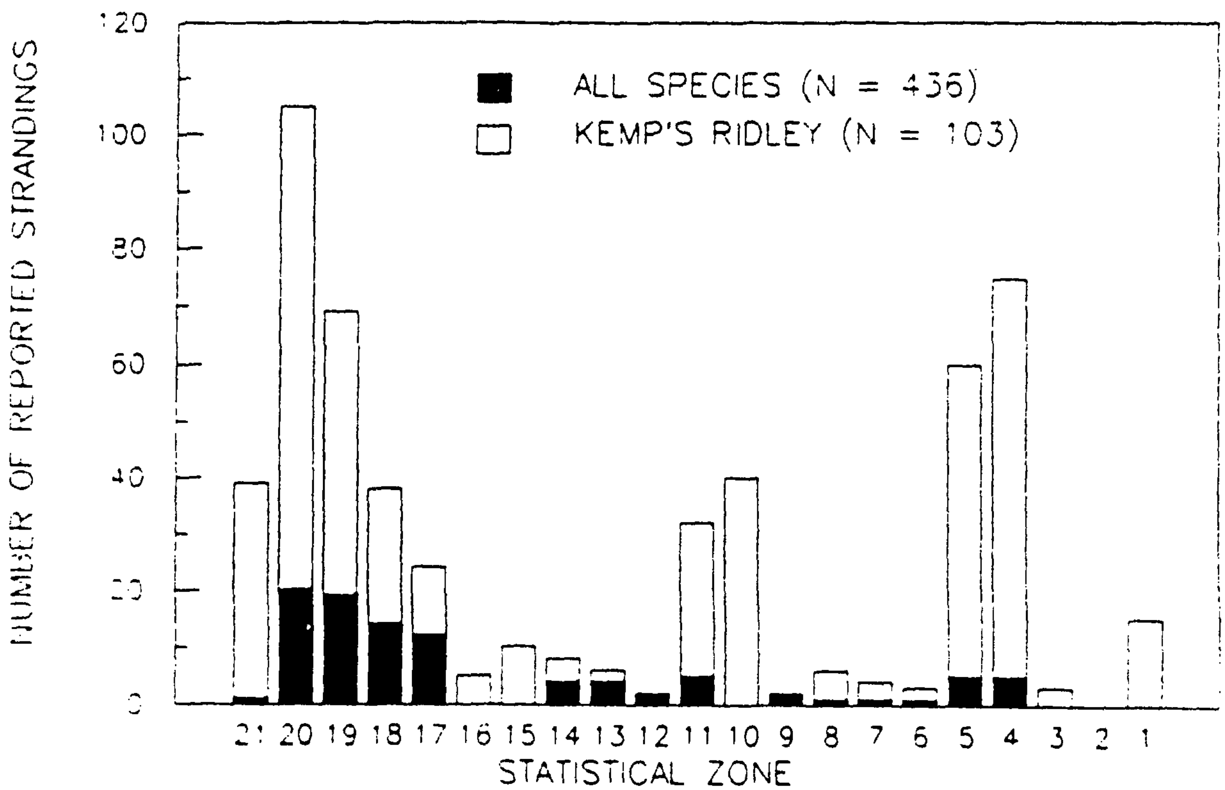


Figure 5-3. Sea Turtle Strandings, U.S. Gulf of Mexico 1987 (NMFS 1988)

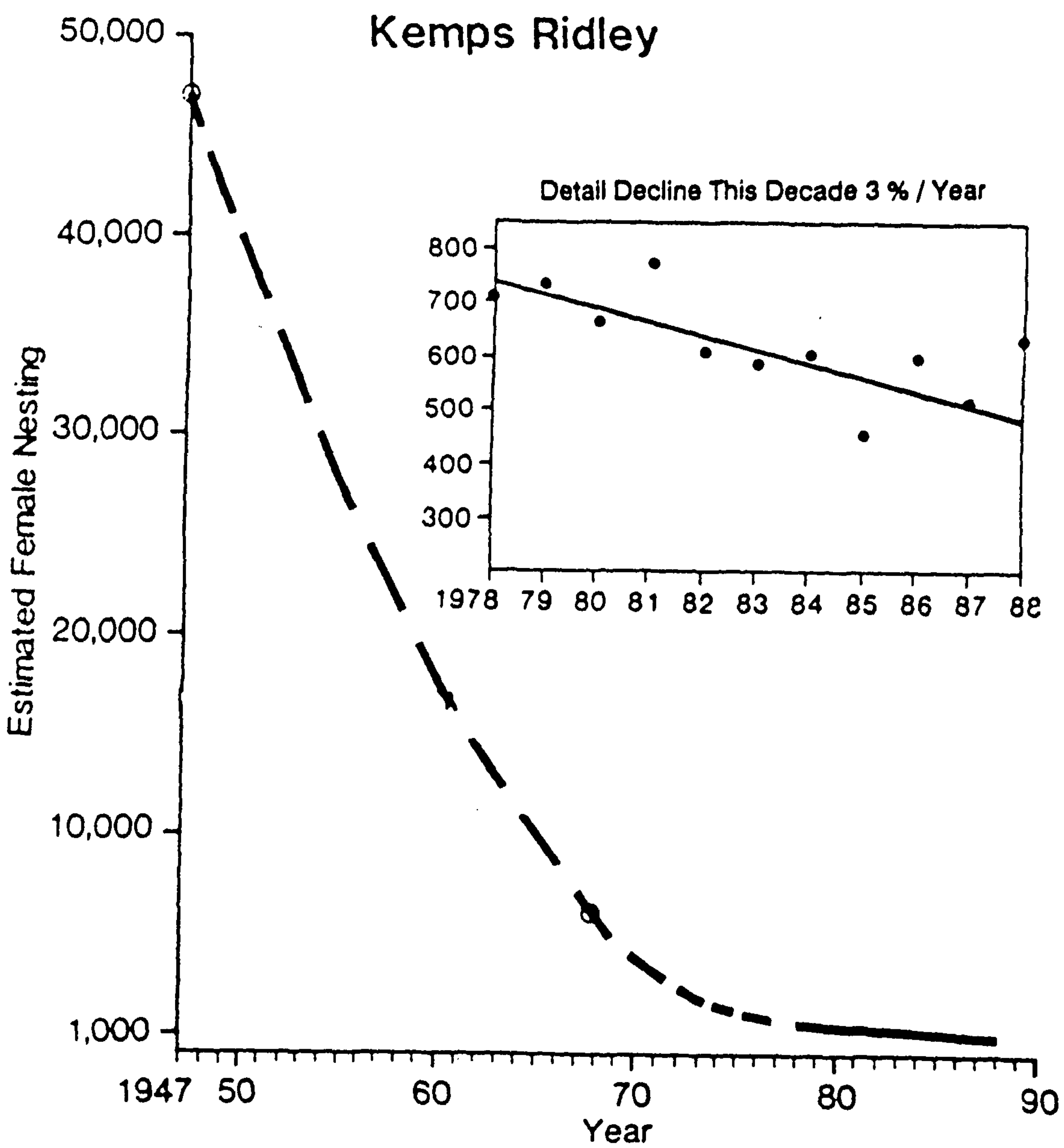


Figure 5-4. Estimated Annual Number of Nesting Female Kemp's Ridley Sea Turtles (Ross 1989)

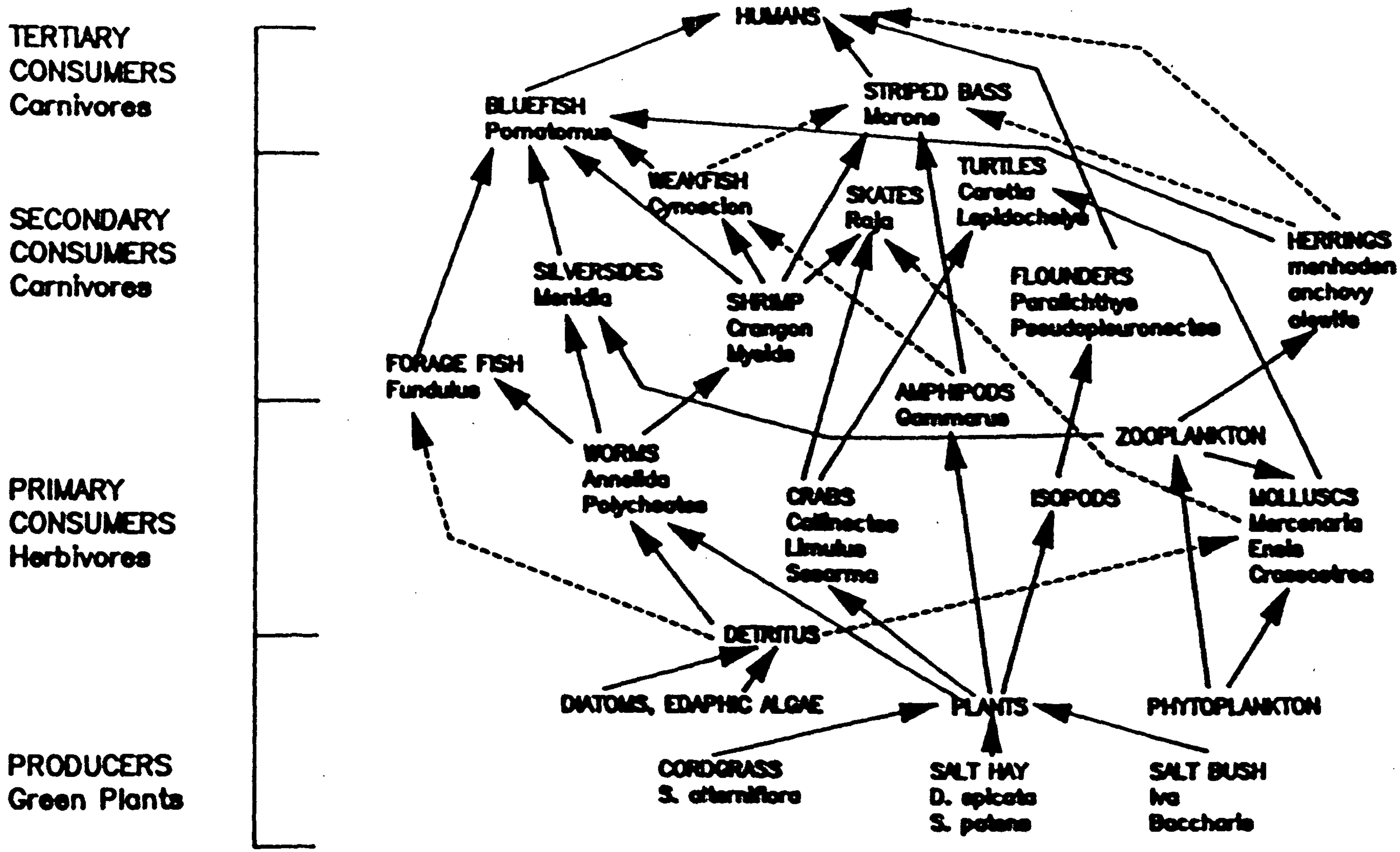


Figure 5-5. Generalized Food Web for Upper Delaware Bay

TABLE 5-1

SEA TURTLE STRANDINGS IN COASTAL DELAWARE AND DELAWARE BAY
REPORTED BY DELAWARE DEPARTMENT OF NATURAL RESOURCES
(Thomas 1988)

ANNUAL DISTRIBUTION*

Year	Loggerhead	Ridley	Leatherback	Green	Hawksbill
1976	1	0	0	0	0
1977	0(4)	0	0	0	0
1978	1(3)	0	0	0	0
1979	0(4)	0(5)	0	0	0
1980	0	0(3)	0	0	0
1981	0(9)	0(1)	4	0	0
1982	0(1)	0	0	0	0
1983	0(3)	0	0	0	0
1984	0(5)	0(1)	0	0	0
1985	0(17)	0	0	0(1)	0
1986	1(10)	0(1)	0	0	0(1)
1987	0(8)	0	0	0	0
1988	0(1)	0	0(1)	0	0
Totals	3(65)	0(11)	4(1)	0(1)	0(1)

* Number for Delaware Bay in parenthesis.

MONTHLY DISTRIBUTION

Month	Loggerhead	Ridley	Leatherback	Green	Hawksbill
Jan	2	0	0	0	0
Feb	1	0	0	0	0
Mar	1	0	0	0	0
Apr	0	0	0	0	0
May	0	1	0	0	1
Jun	6	0	0	0	0
Jul	11	0	5	0	0
Aug	11	2	0	1	0
Sep	14	4	0	0	0
Oct	20	4	0	0	0
Nov	0	0	0	0	0
Dec	2	0	0	0	0
Totals	68	11	5	1	1

TABLE 5-2

SEA TURTLE STRANDINGS IN COASTAL NEW JERSEY AND DELAWARE BAY REPORTED BY MARINE MAMMAL STRANDING CENTER (Schoelkopf 1989)

ANNUAL DISTRIBUTION*

Year	Loggerhead	Ridley	Leatherback
1980	9(1)	0	2(1)
1981	4(4)	0	13(1)
1982	2(2)	0	13(0)
1983	8(5)	4(0)	9(0)
1984	8(1)	0	2(0)
1985	22(4)	1(0)	7(0)
1986	15(1)	0(1)	2(0)
1987	37(2)	1(0)	33(1)
1988	13(6)	0	6(1)
Totals	118(26)	6(1)	87(4)

* Number for Delaware Bay in parenthesis.

MONTHLY DISTRIBUTION

Month	Loggerhead	Ridley	Leatherback
Jan	1	0	2
Feb	0	0	1
Mar	0	0	1
Apr	0	0	0
May	0	0	2
Jun	8	0	2
Jul	25	0	8
Aug	36	1	11
Sep	46	0	34
Oct	24	0	24
Nov	4	0	6
Dec	0	0	0
Totals	144	1	91

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Author Name	MILTENBERGER S
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Public Service
Electric and Gas
Company

Steven E. Miltenberger Public Service Electric and Gas Company P.O. Box 236, Hancocks Bridge, NJ 08038 609-339-4199

Vice President and Chief Nuclear Officer

July 12, 1989

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Gentlemen:

BIOLOGICAL ASSESSMENT OF PLANT IMPACTS ON SEA TURTLES
SALEM GENERATING STATION
UNIT NOS. 1 AND 2
DOCKET NOS. 50-272 AND 50-311
HOPE CREEK GENERATING STATION
DOCKET NO. 50-354

Pursuant to NRC approval (December 14, 1988 letter from J. C. Stone to S. E. Miltenberger), Public Service Electric and Gas Company has prepared a report entitled:

> "Assessment of the Impacts of the Salem and Hope Creek Generating Stations on Kemp's Ridley (*Lepidochelys kempi*) and Loggerhead (*Caretta caretta*) Sea Turtles".

Incorporated in this report are the requisite items outlined in the December 14, 1988 letter, and responses to subsequent NRC suggestions.

This report provides a detailed description of the plant and its environs, sea turtle life histories, historical sea turtle occurrences at the plant, and projections of future interactions between sea turtles and the plant. Based upon the information presented, the company concludes that there will be no significant impact from plant operations on sea turtles.

C 001

If you have any questions on this matter, please do not hesitate to contact us.

Sincerely,

Attachment

C Mr. J. C. Stone
Licensing Project Manager - Salem

Ms. K. Halvey Gibson
Senior Resident Inspector - Salem

Mr. C. Y. Shiraki
Licensing Project Manager - Hope Creek

Mr. G. W. Meyer
Senior Resident Inspector - Hope Creek

Mr. W. T. Russell, Administrator
Region I

Mr. Kent Tosch, Chief
New Jersey Department of Environmental Protection
Division of Environmental Quality
Bureau of Nuclear Engineering
CN 415
Trenton, NJ 08625

Dr. M. Masnik - USNRC

Elaine Chan, Esq. - USNRC

Robert Schoelkopf
Marine Mammal Stranding Center

Douglas Beach
National Marine Fisheries Service

ASSESSMENT OF THE IMPACTS OF THE SALEM AND HOPE CREEK GENERATING STATIONS ON KEMP'S RIDLEY (*Lepidochelys kempi*) AND LOGGERHEAD (*Caretta caretta*) SEA TURTLES

Prepared by
Public Service Electric and Gas Company
Nuclear Department

June 1989

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SECTION 1.0
SUMMARY AND CONCLUSIONS

This "biological assessment" was prepared by Public Service Electric and Gas Company (PSE&G) for submittal to the U.S. Nuclear Regulatory Commission and the National Marine Fisheries Service to comply with Section 7 of the Endangered Species Act (the Act). The purpose of this assessment is to examine the potential impacts associated with the continued operation of PSE&G's Salem and Hope Creek Generating Stations on sea turtle species protected under the Act.

PSE&G's Salem (Unit Nos. 1 and 2) and Hope Creek Generating Stations are located on the southern end of Artificial Island in Lower Alloways Creek Township, Salem County, New Jersey. The stations are situated on the eastern shore of the Delaware River Estuary.

Artificial Island is located approximately 2 miles (3.2 kilometers) upstream of the head of Delaware Bay and approximately 50 miles (80 kilometers) upstream of the mouth of the Bay. Freshwater flow in the estuary averages 23,352 cubic feet per second (661 cubic meters per second) and tidal flows average 399,710 cubic feet per second (11,320 cubic meters per second). The salinity ranges from zero parts per thousand (ppt) to a maximum of 20 ppt. Water temperature in the river in the vicinity of the Artificial Island varies from 32°F (0°C) to 86°F (30°C).

Salem Generating Station consists of two pressurized water nuclear reactors with an electrical capacity of approximately 1,100 megawatts (MWe) per unit. Salem Station has two water intake structures, the Circulating Water System (CWS) and the Service Water System (SWS). The CWS intake withdraws 1.1 million gallons per minute (gpm) to condense steam in the main condensers of each unit. The SWS intake withdraws approximately 40,000 gpm to cool heat exchangers for the remainder of the equipment for both units including the safety related cooling systems. Both intakes utilize trash racks and vertical traveling screens to remove river debris from the water. The CWS intake has been the modified with Ristroph fish buckets and a fish return system.

Hope Creek Generating Station consists of one boiling water nuclear reactor of 1,067 MWe. It has one Service Water Intake which withdraws approximately 30,000 gpm. This intake also utilizes trash racks and vertical traveling screens to remove river debris from the water. The traveling screens have also been modified with Ristroph fish buckets and equipped with a fish return system. Service water at Hope Creek passes through miscellaneous heat exchangers, including safety related cooling systems, and then is used for make-up for the closed-cycle CWS. Heat removal in the CWS is accomplished through a natural draft cooling tower.

Five species of sea turtles have been reported from Delaware Bay and coastal New Jersey and Delaware. These sea turtle species are: loggerhead (Caretta caretta), Kemp's ridley (Lepidochelys kempi), green turtle (Chelonia mydas), leatherback (Dermochelys coriacea), and hawksbill (Eretomochelys imbricata). Three of these sea turtles species, Kemp's ridley, hawksbill and leatherback, are listed as endangered and and two, the loggerhead and green turtle are listed as threatened. The loggerhead and Kemp's ridley sea turtles are distributed throughout the Bay. The leatherback, green and hawksbill sea turtles occur primarily in the coastal areas of New Jersey and Delaware and around the mouth of the Bay.

The loggerhead sea turtle is the most common sea turtle in the coastal waters of the United States and occurs in many other locations throughout the world. Population numbers along the south Atlantic Coast (North Carolina to Florida) have been estimated at 387,594 turtles based on extrapolations from aerial surveys. The loggerhead population in the southeast is considered to be stable by most investigators but the population is threatened by reductions in nesting and foraging habitat by the continued development of coastal areas and losses due to incidental capture in shrimp trawls. An estimated 9,800 turtles are lost annually from trawling without the use of turtle exclusion devices (TED's).

The Kemp's ridley is the most endangered of the sea turtle species. There is only a single known colony of this species, almost all of which nest near Rancho Nuevo, Mexico and represent the world population for this species. The population level for this species has been estimated at 2,200 turtles based on estimates derived from observed numbers of nesting females in recent years and other life history parameters. Observations over the past ten years suggest that this population is declining at a rate of 3 percent per year. The ridley population is also impacted by coastal development and shrimp trawling. An estimated 760 turtles are lost annually through trawling alone.

Sea turtles have been observed and incidentally captured at Salem Generating Station and during field sampling associated with the station since 1977. A total of 44 sea turtles have been reported since 1979. The majority of these, thirty-eight, have been collected from the stations' circulating water intake trash racks. Of the thirty-eight turtles from the intake, twenty-six were loggerhead sea turtles and twelve were Kemp's ridleys. All specimens were subadults or juveniles.

Loggerheads were the more common of the two species captured from the CWS intake. The number of loggerheads captured annually since 1980 ranged from zero to eight (mean = 3). Eight of the twenty-six loggerheads captured were alive and these were released back into the wild. Among the eighteen dead turtles, eight were considered fresh dead and had either collapsed lungs or internal infections or damage which may have contributed to their deaths. The other ten dead turtles were either moderately or severely decomposed. Necropsies available for these turtles showed evidence of boat propeller damage and internal infections.

Kemp's ridley sea turtles were the less common of the two species captured from the CWS intake. The number of ridleys captured annually since 1980 ranged from zero to three (mean = 1.3). Six of the twelve ridleys captured were alive and five of these were released back into the wild. Among the six dead turtles, three were considered fresh dead and had collapsed lungs. The other three dead turtles were either moderately or severely decomposed. Two of these turtles showed evidence of boat propeller damage.

The primary concern with sea turtles at Salem Generating Station is whether or not the losses of these endangered or threatened species "jeopardizes their continued existence." Federal regulation defines this term as engaging in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing the reproduction, numbers, or distribution of that species." A comparison was made of sea turtle losses at Salem Generating Station, assuming worst case losses, with population estimates for both species. This worst case estimate of losses includes turtles dying of natural mortality that account for a portion of the turtles captured at the Salem intake. Sea turtles captured alive at Salem and returned to the wild are not included. Calculated accordingly, the maximum, estimated, worst-case annual loss of loggerheads at the station is nine turtles which represents 0.0002 percent of the population in the U.S. southeast. The maximum, estimated, worst-case annual loss of Kemp's ridleys at Salem is one or two turtles which would represent 0.05 to 0.09 percent of the population. It is unlikely that losses at these levels would "appreciably reduce" the distribution or numbers of either species. Losses to reproduction would be restricted to "production foregone" due to the loss of juvenile/subadult animals which could potentially be recruited into the breeding female population at some time in the future.

Thermal impacts from the operation of Salem and Hope Creek Generating Stations, such as acute and chronic thermal impacts and coldshock, are not significant because the thermal discharge for Salem is an offshore, high-velocity bottom discharge which quickly dissipates and forms only a shallow surface plume. The Hope Creek thermal discharge is of such small volume that it is rapidly assimilated by the Delaware River. Both species of sea turtles, which have strong swimming ability, therefore can likely avoid the affected areas.

Administrative controls which have been instituted to enhance the timely removal of turtles from the intake and optimize their chances for survival include: inclusion of reporting/notification procedures for threatened and endangered species in the Event Classification Guides which are kept in each station's control room; issuance of an annual memorandum at the time of year sea turtles may be expected to occur detailing intake inspection procedures, turtle handling procedures and round-the-clock reporting procedures; and, providing operations with information to assist them in identifying sea turtles. Operational procedures which have been instituted to enhance the timely removal and survival of sea turtles from the intake include: daily (or more frequent) trash rack cleaning; and, once per shift and more frequent (once per two hours) intake inspections during times when turtles are known to be present. Structural modifications have also been made to the intake structure to reduce intake velocities and minimize the impingement of aquatic animals including sea turtles.

In summary, PSE&G concludes that the continued operation of Salem and Hope Creek Generating Stations will not jeopardize the continued existence of the either the loggerhead or Kemp's ridley sea turtle. The estimated losses of these species from the continued operation of these facilities, particularly the water intakes, will not "appreciably reduce" the distribution or numbers of either species. Losses to reproduction would be restricted to "production foregone" due to the loss of juvenile or subadult animals which could potentially be recruited into the breeding female population in the future.

SECTION 2.0
INTRODUCTION

2.1 PURPOSE

This "biological assessment" is submitted to the U.S. Nuclear Regulatory Commission (NRC) by Public Service Electric and Gas Company (PSE&G) in compliance with Section 7 of the Endangered Species Act of 1973 (as amended)[the Act].

The purpose of this assessment is to examine the potential impacts associated with the continued operation of PSE&G's Salem and Hope Creek Generating Stations on two sea turtle species protected under the Act. The species of concern are the Kemp's ridley (Lepidochelys kempi) and loggerhead (Caretta caretta) sea turtles both of which have been removed from the circulating water intake trash racks at Salem Generating Station. The U.S. Fish and Wildlife Service, "List of Endangered and Threatened Wildlife and Plants," lists the status of the Kemp's ridley sea turtle as endangered and the loggerhead sea turtle as threatened (50CFR117.11). The National Marine Fisheries Service (NMFS) has jurisdiction for both these species (50CFR222.23(a) and 50CFR227.4(b)).

2.2 ENDANGERED SPECIES ACT

This "biological assessment" is part of the formal consultation process provided under Section 7 of the Endangered Species Act. Detailed procedures for this consultation process are defined in 50CFR402.

2.3 CHRONOLOGY OF EVENTS LEADING UP TO THIS ASSESSMENT

A review of the sea turtle strandings at Salem Generating Station was recently requested in a letter from the NMFS to the NRC in August 1988 (D. C. Crestin, 1988). This letter followed a meeting between PSE&G and NMFS on August 3, 1988, where PSE&G summarized the sea turtle occurrence history at the Salem and Hope Creek Generating Stations since 1979. At this meeting PSE&G was advised of NMFS desire to pursue a formal review of this concern. The NRC was advised of this meeting on September 8, 1988, and PSE&G requested that if the formal Section 7 review progressed, that they be authorized to prepare the "biological assessment."

The issue of sea turtles at Salem Generating Station was initially addressed in 1979 and 1980 when two sea turtles were collected on the circulating water intake trash racks at Salem Generating Station. The matter was discussed jointly by PSE&G, NRC, NMFS, U.S. Environmental Protection Agency (EPA) and New Jersey Department of Environmental Protection (NJDEP) during October 1981 (informal Section 7 review). It was concluded from this discussion that the two specimens collected from the intake were probably dead before they appeared on the trash racks and that the intake structure did not have a role in their deaths. A procedure for PSE&G to report future occurrences of sea turtles was established at this meeting.

In the years following, PSE&G kept both NMFS and NRC apprised of the collection of threatened and endangered sea turtles at Salem Generating Station. In 1985 and again in 1987 and 1988, a number of turtles were collected from the trash racks which were either alive or showed no evidence of previous trauma. This was considered by NMFS to reflect new information concerning the effects of the Salem circulating water intake system which was not considered in the 1981 informal consultation.

Rather than initiating a new review, NMFS requested the reinitiation of the 1980 formal consultation which pertained to shortnose sturgeon (Acipenser brevirostrum) at Salem and Hope Creek Generating Stations. This request was made pursuant to 50CFR401.16 of the ESA Interagency Cooperation regulations.

Toward the end of September 1988, PSE&G received a letter from NRC (J. C. Stone, 1988) advising them of NMFS request and requesting a proposed schedule for preparation of the "biological assessment" and an outline of the material to be included in the document. This information was submitted to NRC in October 1988 (S. E. Miltenberger, 1988) and was discussed in a meeting with NRC on November 22, 1988. Following this meeting, NRC approved PSE&G's request to prepare the "biological assessment" with the understanding that several additional items be included in the document (J. C. Stone, 1988).

This document is PSE&G's, "Assessment of the Impacts of the Salem and Hope Creek Generating Stations on Kemp's Ridley (Lepidocheyls kempi) and Loggerhead (Caretta caretta) Sea Turtles."

SECTION 3.0
SITE DESCRIPTION

3.1 LOCATION

Public Service Electric and Gas Company's (PSE&G) Salem (Unit Nos. 1 and 2) and Hope Creek Generating Stations are located on the southern end of Artificial Island in Lower Alloways Creek Township, Salem County, New Jersey. These facilities are located 15 miles (24 kilometers) south of Wilmington, Delaware, 30 miles (48 kilometers) southwest of Philadelphia, Pennsylvania, and 7 miles (11 kilometers) southwest of Salem, New Jersey (Figure 3-1).

Artificial Island is actually a peninsula connected to the mainland of New Jersey by a strip of marshland and extends approximately one third of the way across the Delaware River (Figure 3-2). During the early 1900's, Artificial Island was a natural sand bar. At that time, the U.S. Army Corps of Engineers installed a retaining wall of oak pilings at the southern tip of the sand bar. A few years after the retaining wall was constructed, additional pilings were installed and the area was used for storing fill that was dredged from the Delaware River. The sand bar evolved into an island and finally into the peninsula it is today.

Artificial Island encompasses approximately 1,482 acres (600 hectares) (Figure 3-2). Topographically it is flat with an average elevation of 8.8 feet (2.7 meters) above mean sea level and a maximum elevation of 18 feet (5.5 meters) above mean sea level. The 740 acre (300 hectare) PSE&G site is located on the southernmost 25 percent of the peninsula and is divided into Salem Generating Station (220 acres or 89 hectares), Hope Creek Generating Station (153 acres or 62 hectares), and uncommitted land (367 acres or 148 hectares). The undeveloped areas of the island are characterized by diked dredge spoil disposal impoundments and tidal salt marsh.

3.2 MORPHOLOGY AND BATHYMETRY

Salem and Hope Creek Generating Stations are situated on the eastern shore (New Jersey) of the upper portion of the Delaware River Estuary.

The Delaware River Estuary is 132 miles (211 kilometers) long and extends from Capes May and Henlopen to Trenton, New Jersey. This region of the estuary is referred to as Delaware Bay and is 75 miles (120 kilometers) long and extends from the Capes to a line between stone markers located at Liston Point, Delaware and Hope Creek, New Jersey (Polis et al., 1973). The estuary varies in width from 11 miles (18 kilometers) at the Capes; to 27 miles (43 kilometers) at its widest point (near Miah Maull Shoal); to

1,000 feet (0.3 kilometer) at Trenton, New Jersey. Water depth in the bay is less than 30 feet (9.1 meters) deep in 80 percent of the bay and is less than 10 feet (3 meters) deep in much of the tidal river area. A navigation channel passes from deep water inside the entrance of the bay to Trenton, New Jersey. Authorized depth of the channel is 40 feet (12.1 meters) below mean sea level up to the Philadelphia (Naval Ship Yard) and then 25 feet (7.6 meters) below mear sea level to Trenton.

Artificial Island is located approximately 2 miles (3.2 kilometers) upstream of the hypothetical line demarking the head of Delaware Bay (Figure 3-3). The tidal river in this area narrows upstream of Artificial Island and makes a bend of nearly 60 degrees. Both the narrowing and bend are accentuated by the presence of Artificial Island. Furthermore, more than half of the typical river width in this area is relatively shallow, less than 18 feet (5.5 meters), while the deeper part, including the dredged shipping channel has depths of up to 40 feet (12.2 meters).

3.3 HYDROLOGY

The largest tributaries of the Delaware Estuary are the Schuylkill River in Pennsylvania, the Christina River in Delaware, and the Assunpink, Crosswicks, Rancocas and Salem Rivers, and Big Timber, Hope and Alloways Creeks in New Jersey (PSE&G, 1984). The head of the Delaware Estuary is at Trenton, New Jersey, about 84 miles (135 kilometers) upstream of Artificial Island (Figure 3-1). The Chesapeake and Delaware Canal, which connects the Delaware River with Chesapeake Bay, is located approximately 7 miles (11.3 miles) north of Artificial Island.

Of the total freshwater flow into the Delaware Estuary, annual average of 23,352 cubic feet per second (661 cubic meters per second), approximately 50 percent (11,759 cfs or 333 cubic meters per second) is contributed by the Delaware River at Trenton; 12 percent (2,715 cfs or 76.9 cubic meters per second) by the Schuylkill River; and, the remaining 38 percent by all other tributaries (USGS, 1981a; USGS, 1981b).

Tidal flow as measured near the Delaware Memorial Bridge, 20 miles above Artificial Island, was measured at 399,710 cfs (11,320 cubic meters per second)(USGS, 1966). Tidal flow of this magnitude is 17 times as great as the total average freshwater flow rate into the estuary. Proceeding toward the mouth of the estuary, tidal flow increasingly dominates freshwater downstream flow; proceeding upstream from the Delaware Memorial Bridge, the ratio of tidal flow to net downstream flow becomes smaller as tidal influence decreases.

Tides in the Delaware estuary are semidiurnal, with a period of 12.42 hours (Polis, D. F. et al., 1973). The mean tidal range averages 4.3 feet (1.3 meters) at the mouth of the estuary; 5.9 feet (1.8 meters) at Artificial Island; and, 6.7 feet (2 meters) Trenton, New Jersey. These ranges are influenced by heavy precipitation, storm surges and wave action. Tidal ranges as high as 14.1 feet (4.3 meters) have been observed at Artificial Island during periods of extreme flood and ebb conditions.

Current speed and direction throughout the Delaware estuary are dominated by the tide. Surface tidal currents generally are directed along the longitudinal axis of the estuary except in nearshore areas of the river bends and coves. At maximum ebbing or flooding tide, local currents at any point within the estuary may reach speeds of 3.3 to 4.3 feet per second (1.0 to 1.3 meters per second)(Roy F. Weston, Inc., 1982).

The average river velocity adjacent to the site is 1.2 feet per second (0.4 meters per second) with typical ebb and flood maximums of 3.2 and 2.5 feet per second (1 and 1.3 meters per second)(U.S. Commerce Department, 1982). Near field current velocities, within 100-feet of the intakes, are strongly influenced by tidal currents except for directly in front of the intakes (Roy F. Weston, 1982). Average current velocities within the CWS and SWS withdrawal zones were observed to be 1.1, 0.9, 0.8 and 0.7 feet per second (0.33, 0.27, 0.24 and 0.21 meters per second) respectively during ebb, low slack, flood and high slack tides. The greatest variation in velocities were observed during high slack tide which ranged from 0.2 to 2.0 feet per second (0.06 and 0.61 meters per second).

Velocity measurements at the face of the CWS intake show higher velocities near the surface and generally decrease at mid-depths. Velocities at some mid-depths of the intake and near the bottom were at or near zero feet per second. The average velocity for the water column is approximately 1 foot per second (design velocity)(Roy F. Weston, 1982). Velocity measurements at the face of the SWS intake (below the curtain wall) averaged 0.3 feet per second (0.1 meters per second).

The morphometric and bathymetric features of the river in the area of Artificial Island affect near field circulation patterns near the generating stations (Roy F. Weston, Inc., 1982). The bend in the river produces a persistent flow (averaged over several tidal periods) of near surface water away from the inside of the bend (i.e., away from Artificial Island, toward the west shore), with a compensating deep flow toward the inside (i.e., the New Jersey side) of the bend. Such flows generally work to keep stream channels on the outside of bends, since sediment is carried with the bottom current toward the shore at the inside, as well as being deposited by slower inside forces.

In addition, two artificial structures on the east shore (Figure 3-2), Hope Creek jetty and Sunken Ship Cove, also appear to influence the near-field current pattern, contributing to current deflection and shoreline drag. The resultant complex circulation results in changing sedimentation and erosion patterns. Reedy Island Breakwater is located near midriver but has little influence on current patterns near Artificial Island.

3.4 SALINITY

Salinity in the Delaware estuary varies from freshwater (typically defined as less than 1 part per thousand) at Trenton to typical ocean water concentrations of about 32 parts per thousand (ppt) on the continental shelf off the mouth of the Bay. Salinity at any particular location in the estuary is dependent on the amount of freshwater discharge from upstream and the extent of saltwater intrusion from downstream. Variables such as tidal phase, basin morphology, and meteorological conditions affect salinity (Polis, D. F. et al., 1973; PSE&G, 1984). Figure 3-4 illustrates the general seasonal patterns in the horizontal and vertical distribution of salinity in the estuary. High freshwater discharge conditions typical of spring runoff normally result in downstream displacement of the saltfront to about river kilometer 80 and increase vertical salinity stratification. During low freshwater flow conditions in late summer and fall, the saltfront normally extends to about 120 rkm and the system is well mixed vertically.

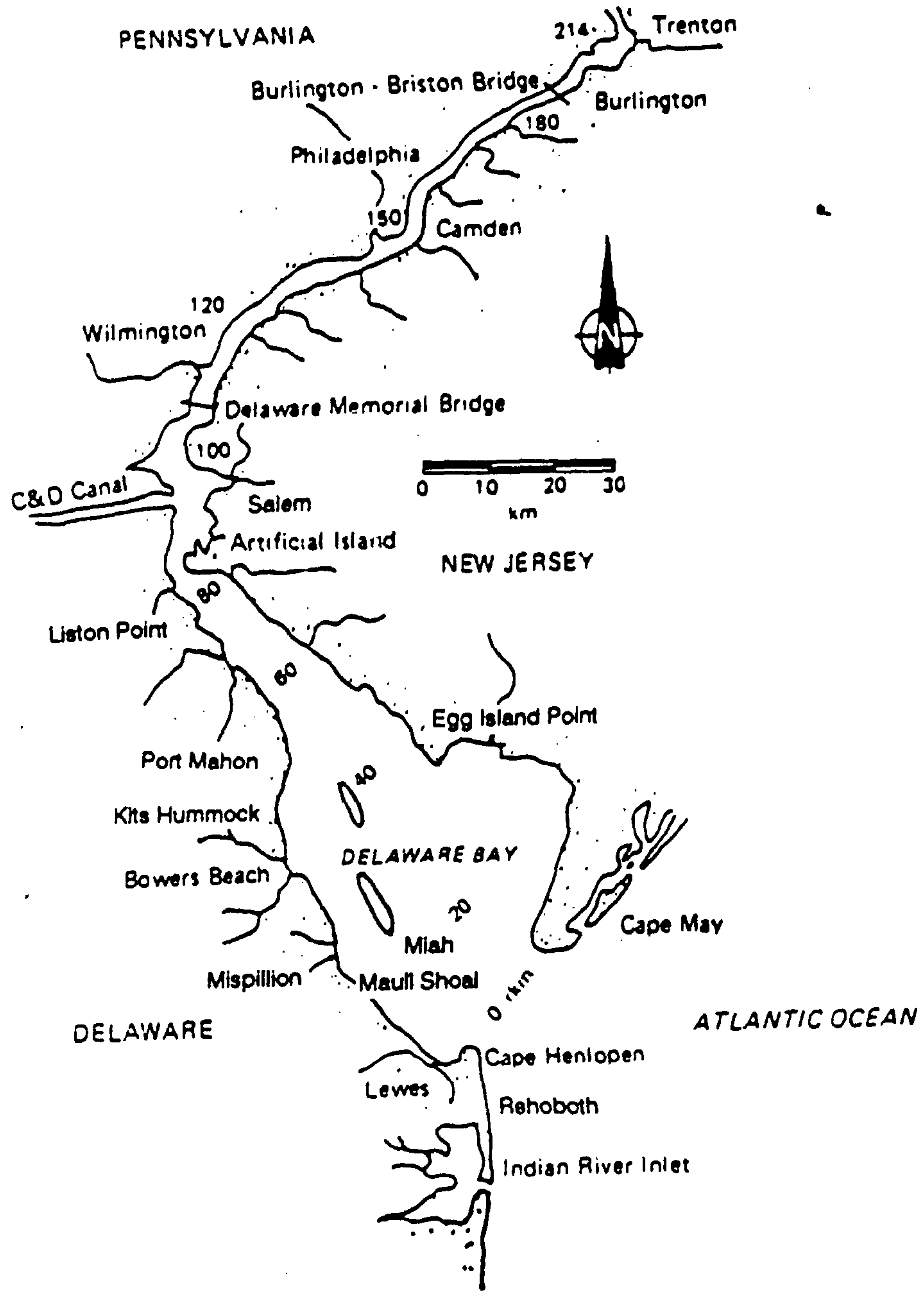
At Artificial Island, salinity typically ranges from near zero during periods of high river flow (December through March) to 10 or 12 parts per thousand (ppt) during periods of low river runoff (summer and fall). A maximum of 20 ppt has been recorded at Artificial Island. Salinity around Artificial Island and a short distance upstream from it is essentially homogeneous vertically, as variations at a given point are limited generally to less than 1 per cent per thousand between the surface and bottom. Some variation is observed across the estuary due in part to Coriolis forces, which tend to displace lower salinity water toward the western (Delaware) side which results in replacement by water of greater than average salinities on the east (New Jersey) shoreline. Thus, there is a relatively homogenous salinity distribution until a point is reached in the lower Delaware Bay where the tidal velocities are low enough to permit a degree of vertical stratification to develop. In the lower bay, downstream from Artificial Island, there is an extensive amount of stratification brought about by the combination of salinity gradients and meteorological conditions.

3.5 TEMPERATURE

Water temperature in the Delaware estuary is also determined by the flow characteristics of the entire drainage area. Temperature patterns in the estuary are determined by the thermal characteristics of the Delaware River, its tributaries, and the coastal ocean waters. Temperatures of these sources are altered by air temperature, humidity, wind, insolation, cloud cover, and tidal mixing.

Temperature of the Delaware River at Trenton, which constitutes the major freshwater input to the estuary, varies annually from 0 degrees Centigrade (°C) in mid-winter to over 30°C in summer (Figure 3-5)(Polis, D. F. et al., 1973; PSE&G, 1984). Periods of rapid temperature change occur in spring and fall. Atlantic Ocean water that enters the estuary exhibits a less extreme annual range of temperature. Minimum mean temperatures of approximately 6°C usually occurs in February or March; a maximum of approximately 24 C occurs in August (Polis and Kupferman, 1973). Thus, the large volume of shelf water that enters the Bay on each tidal cycle and mixes with the fresher water tends to moderate the temperature of the lower Bay.

Water temperature in the Delaware River near Artificial Island ranges from near zero degrees centigrade (°C) in winter to about 30°C in summer (Figure 3-5)(PSE&G, 1984). Ice forms in the winter along the shoreline of the estuary, but is broken up by the tidal action. Due to shipping, the Delaware River has not been entirely covered by ice near the site in recent years. In early spring, ice from the upper Delaware River floats past the site to Delaware Bay.



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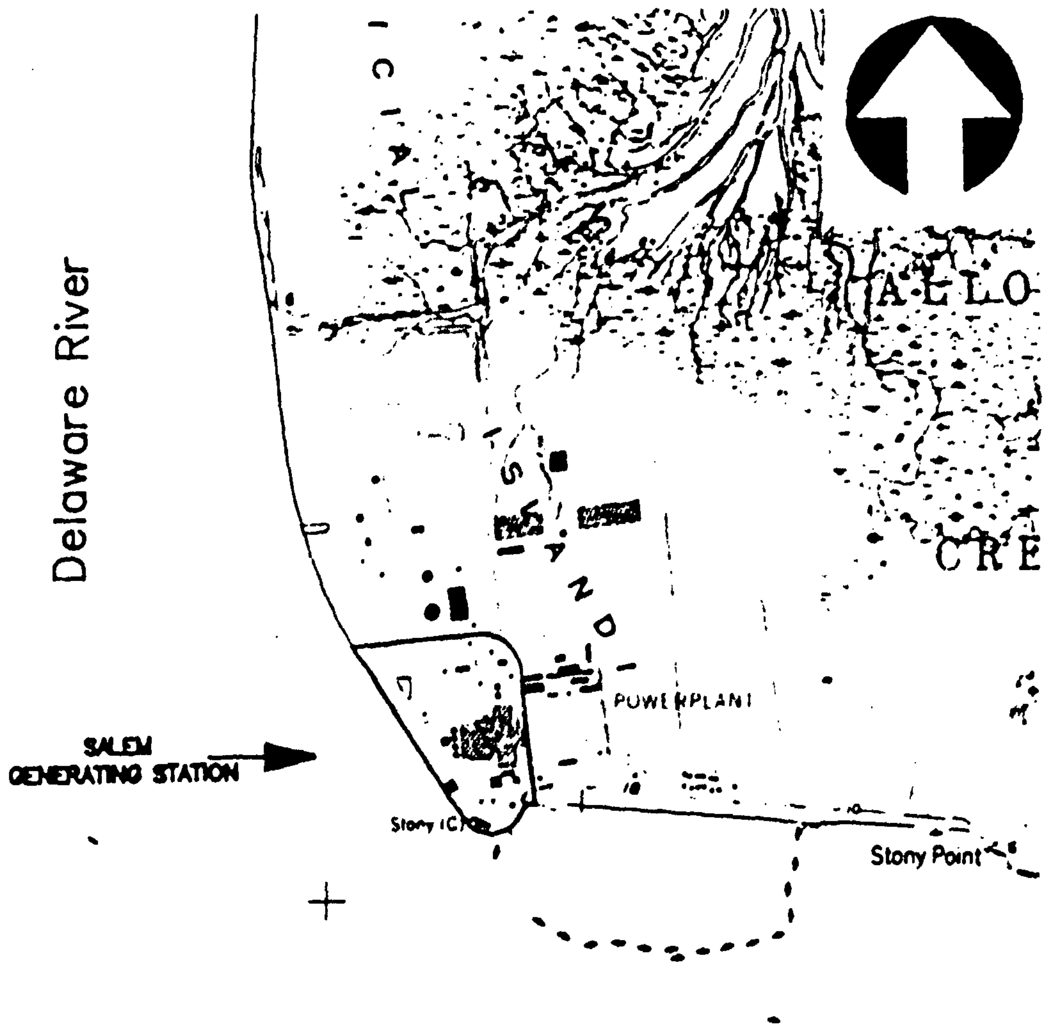
SEA TURTLE BIOLOGICAL ASSESSMENT

Figure 3—1. The Delaware River Estuary



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SEA TURTLE BIOLOGICAL ASSESSMENT

Figure 3-2. Site Location Map of Artificial Island

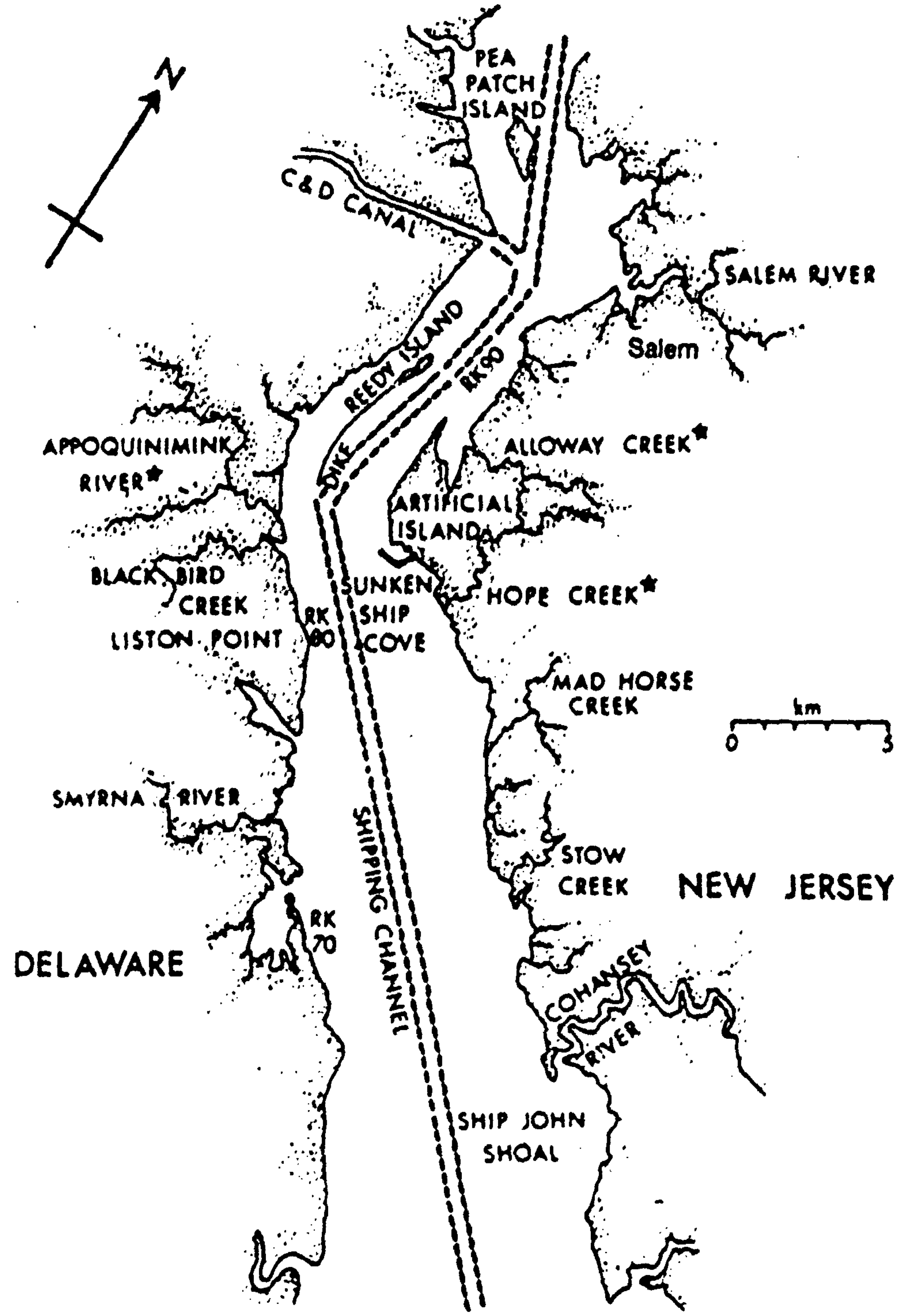

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Figure 3–3. Delaware River near Artificial Island

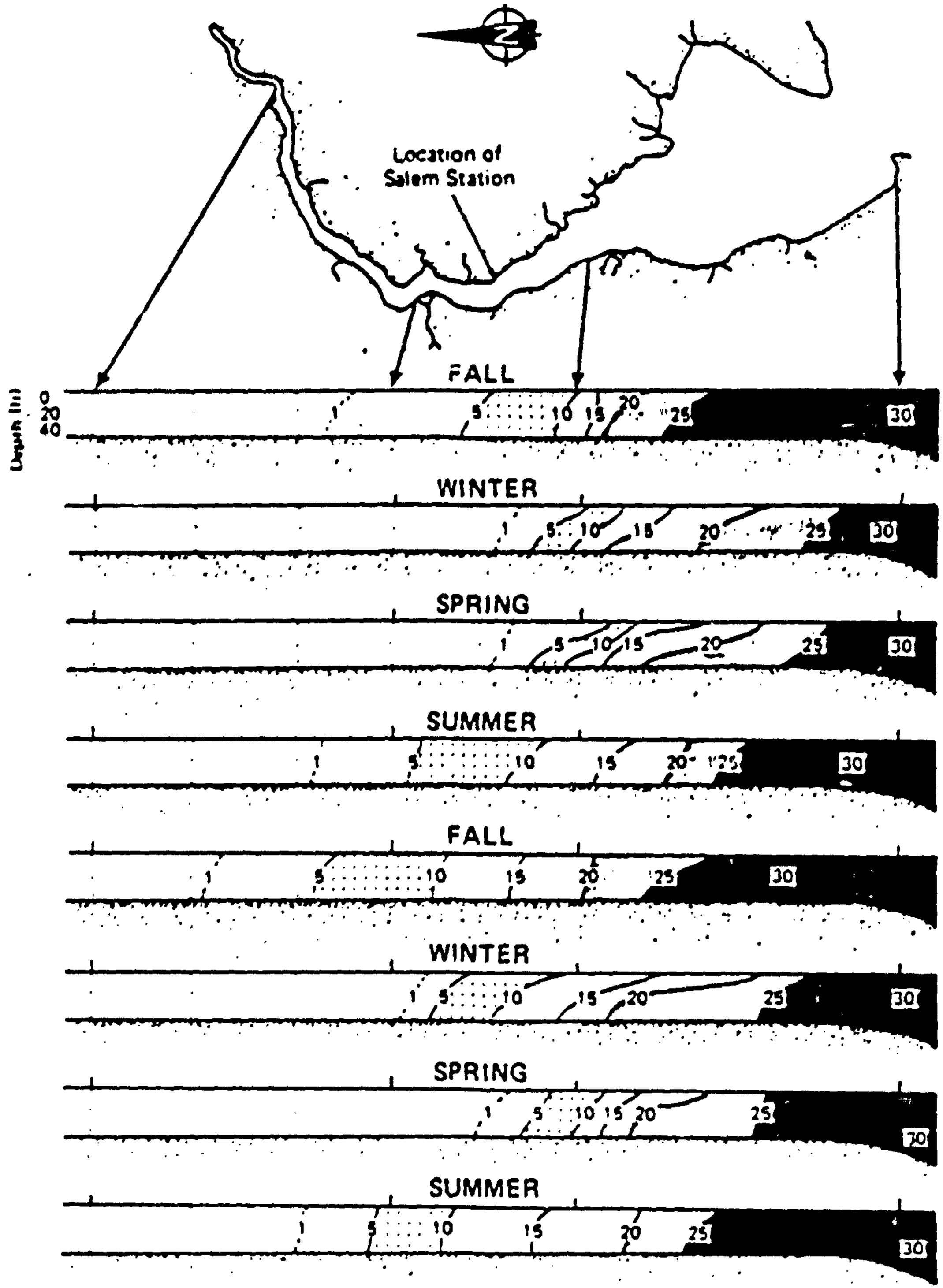

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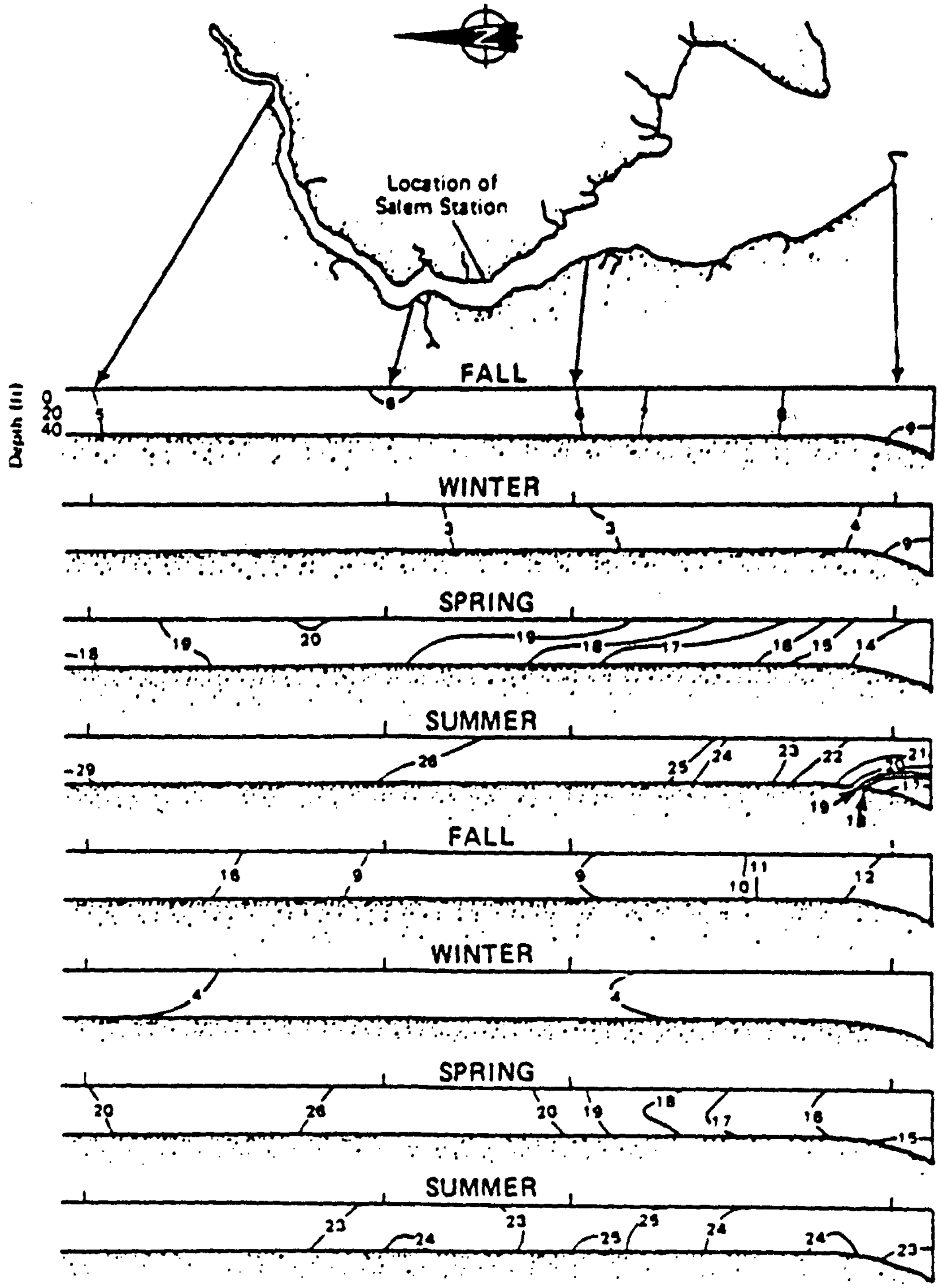
Figure 3–4. Seasonal Patterns of Salinity (ppt) Distribution in the Del. River Estuary

Source: Cronin et al., 1962



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SEA TURTLE BIOLOGICAL ASSESSMENT

Figure 3-5. Seasonal Patterns of Temperature (°C) Distribution in the Del. River Estuary

Source: Cronin et al., 1962

SECTION 4.0
SALEM AND HOPE CREEK GENERATING STATION DESCRIPTIONS

4.1 SALEM GENERATING STATION

Salem Generating Station consists of two pressurized water nuclear reactors (Unit Nos. 1 and 2) each with an electrical capability of approximately 1,100 megawatts per unit. Unit No. 1 began commercial operation during June 1977 and Unit No. 2 during October 1981.

The containment structures housing the reactors and the turbine, auxiliary and service buildings for both units are located on the southernmost part of Artificial Island (Figure 4-1). Two separate shoreline intakes provide cooling water for the station. The circulating water system intake (CWS) provides cooling water for both units main condensers and the service water system intake (SWS) provides cooling water for safety-related heat exchangers and coolers within the station. Cooling water from both systems is discharged via subsurface discharge pipes which discharge 500 feet (152 meters) offshore.

4.1.1 CIRCULATING WATER SYSTEM

The once-through CWS is designed to remove waste heat from the stations main condensers. The CWS withdraws cooling water from the Delaware River, routes it to the condensers, and returns warmed water to the river. The design flow (6 pumps) for each unit is 1.1 million gallons per minute (gpm). Maximum and normal temperature rises across the condensers are 36.4°F (20.2°C), and 14.8°F (8.2°C) respectively. The design intake velocity for water approaching the intake is 1 foot per second (30 centimeters per second) at mean low tide. A schematic diagram of the circulating water system is presented in Figure 4-2.

4.1.1.1 INTAKE STRUCTURE

The CWS intake, which serves both Unit Nos. 1 and 2, consists of twelve separate, independent intake cells, six per unit (Figure 4-3). Each intake cell is equipped with its own trash bars, traveling screens, and circulating water pump. Provisions for ice barriers, wave walls and stop logs are made within each cell.

Originally, the circulating water intake structure consisted of trash racks followed by conventional traveling screens whose primary purpose was to collect and remove debris from intake water. Traveling screens were intermittently cleaned via a front wash, high pressure spray system activated by differential pressure.

To mitigate fish impingement losses, modifications have been made to the original installation by adding: horizontal, water-filled fish survival buckets on the traveling screen baskets (Ristroph modification); a low pressure rear spray wash fish removal system; an enlarged rear fish and trash sluiceways; the capability to return fish to the river from the north and south ends of the circulating water intake structure depending on tidal flow; and, continuous traveling screen operation.

4.1.1.1.1 TRASH BARS

Twelve sets of trash bars protect each of the twelve intake cells from large debris, mats of detritus, and other large materials commonly found in the river. The bar assemblies are 39 foot high and extend from station grade, 89 feet PSD (Public Service Datum is an arbitrary scale where station grade level is set at an elevation of 100 feet, mean sea level is 89.3 feet PSD) to the bottom of each CWS intake cell (50 feet PSD) and are approximately 11 feet (3 meters) wide. Constructed of 0.5 inch (1.27 centimeter) wide steel bars on 3.5 inch (8.9 centimeter) centers, the trash bar racks have a slot size of 3 inches (7.6 centimeters) wide by 51 feet (15.5 meters) long.

The trash bars are inspected at least once per 8-hour shift, and debris is removed as needed by a Rex Chainbelt, Inc. mobile mechanical trash rake. The rake is self-contained and traverses the entire intake width; it contains a trash hopper which transports the material removed from the bars to debris pits at each end of the intake. Baskets line the pits and are removed as required. Debris removed from trash bars is disposed of at an offsite landfill.

Trash and debris are removed from the Salem circulating water intake trash bars by a heavy-duty, traversing type, mechanical trash rake manufactured by Rex Chainbelt, Incorporated. The rake is 11 foot, 2 inches wide and has a lift capacity of 5,000 pounds. The maximum traversing and raking speed is 30 feet per minute. The trash rake unit is mounted on rails which span the entire intake width. The unit is controlled by a single operator from a manual pushbutton control panel which is mounted on the unit's frame assembly. The trash rake unit consists of an integral frame assembly which houses the traversing drive, hoisting machinery, hopper and hydraulic control assemblies. The hoisting machinery includes a cable-operated raking device which is designed to remove large floating or submerged objects that may accumulate on the trash bar racks. Wide-flanged wheels permit the raking device to travel along the inclined bar rack which guides the cleaning device over the 50 feet of vertical bars.

4.1.1.1.2 TRAVELING SCREENS

Each intake cell is equipped with a Royce Equipment Company, vertical traveling screen. Each traveling screen unit contains sixty-two, stainless steel mesh fish-removal type screen panels. Each screen panel has a 2 inch (5.1 centimeter wide) lip, which creates a water-filled bucket (Figures 4-4 and 4-5). As the screen is raised through and out of the water, most impinged organisms drop off the screen into the bucket, which prevents them from falling back into the screen well and becoming reimpinged. It then transports them to a fish-return system which returns the organisms to the river.

Normal operation is to have the screens operate continuously at a speed of 0.9 inches per second (2.3 centimeters per second). Screens can be operated at alternate speeds of 1.9, 2.5 and 3.5 inches per second (4.8, 6.4 and 8.9 centimeters per second) depending on debris load.

For maximum fish survival, the screen wash operates with both low-pressure and high-pressure spray headers. As the screen basket travels over the head sprocket, organisms slide onto the screen face and are washed by one low-pressure (7 pounds per square inch) spray header located outside the screen unit, and two low-pressure (15 psi) spray headers located inside the screen unit, into an upper 15 by 30 inch (38 by 75 centimeter) sluice. This spray wash is designed to minimize descaling and other injuries that would occur with conventional high-pressure spray headers. Subsequently, heavier debris is washed into a lower 24 by 58 inch (60 x 146 centimeter) sluice by two high-pressure (90 psi) spray headers (Figure 4-4). At high debris loads, the screen travel speed increases automatically to the second speed and a second high-pressure wash header is placed into operation. If the debris load continues to increase, the screen proceeds to the third speed. Any further increase causes an alarm to sound and the screen travel speed to increase to the fourth speed. The operators may take other necessary action. Transport time of the individual screen baskets, from the water surface to the head sprocket at minimum screen speed, varies from 3.25 minutes at mean high water to 4.5 minutes at mean low water.

4.1.1.1.3 CIRCULATING WATER PUMPS

There are twelve CWS pumps located on the intake structure, one per cell, six per unit. They were manufactured by Worthington Pump Company and are of the vertical wet-pit type. Each is rated at 1.85×10^5 gallons per minute (gpm) (1.11×10^7 liters per minute) at 27 feet (8.2 meters) total dynamic head. The pumps are each powered by Allis Chalmers 2,000 horsepower, vertical shaft motors. The once-through cooling circuits from the intake to the discharge range from approximately 2,200 to 3,200 feet (671 to 976 meters) in length. Water is supplied to the condensers in six separate 84-inch (2.1 meter) water lines per unit at a velocity of 1.7 feet per second (3.2 meters per second).

4.1.1.1.4 OTHER EQUIPMENT

Ice Barriers

Removable ice barriers can be installed on the face of each of the twelve intake cells to prevent damage during severe river icing conditions. The barriers are constructed of pressure-treated lumber and are approximately 18 by 22 feet (5.5 by 6.5 meters). They extend from elevation 100 to elevation 78 feet PSD. The barriers are resilient structures built to withstand the crush of ice and to protect the trash bars. They are typically put into place in the winter and are removed in early spring; however, they can be left in place year-round for additional protection of the intake structure.

Fish-Return System

The contents of the upper fish and lower debris sluices are returned to the river through one of two return sluices at opposite ends of the CWS intake. The northern screen-wash water-return sluice is about 73 feet (22 meters) long and discharges to the river at 5 feet (1.5 meter) below mean low water. The southern return sluice is also about 73 feet (22 meters) long and discharges to the river at 3 feet (1.0 meter) below mean low water. Originally, all screen-wash water could be discharged only through one common outfall located at the northern end of the intake structure. To reduce circulation of impinged fish and detritus on ebb tide, the second outfall was installed prior to Unit No. 2 operation at the southern end of the intake structure and put into operation on July 14, 1978.

Gates were installed in the fish and trash troughs in the center and at each end of the troughs to permit discharge in the direction of tidal flow.

4.1.1.2 CONDENSERS

One single-pass, divided-circulation, triple-shell condenser is located in each turbine building. The condensers, each of which is nominally rated at 7.636×10^9 Btu per hour (1.924×10^9 kilocalories per hour) and provides approximately 8×10^5 square-feet (74,000 square-meters) of cooling surface area. At full power, CWS flows of up to 1.1×10^6 gallons per minute (4.2 cubic meters per minute) per unit experience about a 18.0°F (10°C) temperature rise. The water passes through the 1 inch (2.5 centimeter) diameter, 0.028 inch (0.07 centimeter) thick, 45 foot long condenser tubes at an average velocity of about 8 feet per second (2.3 meters per second), then out of the outlet waterbox through a 90 inch (2.44 meter) diameter connection.

The discharge piping from each half of the condenser waterbox are joined through a Y-type connection into a common 120 inch (3.05 meter) diameter pipe. These six pipes transport the condenser cooling water across the site to the Delaware River. The outlet of each of these pipes is at a depth of 25 to 30 feet (7.6 to 9.1 meters). The exit velocity is high enough (10.7 feet per second or 3.3 meters per second) to promote rapid mixing with ambient water. The velocity, arrangement, and location are designed to reduce thermal recirculation (PSE&G, 1984). The discharge piping extends 500 feet (152 meters) offshore along the river bottom before they discharge.

4.1.2 SERVICE WATER SYSTEM

The service water system (SWS) is designed to provide cooling water to safety-related equipment required for safe operation and maintenance of Salem station. The SWS withdraws cooling water from the Delaware River, routes it to various heat exchangers and coolers located in the auxiliary, reactor and turbine generator buildings and returns it to the Delaware River (Figure 4-6).

4.1.2.1 INTAKE STRUCTURE

The SWS intake is constructed of reinforced concrete designed to withstand specific floods, earthquakes, and damage. It consists of twelve intake bays arranged in groups of three and alternating between Unit Nos. 1 and 2 (Figure 4-7). Its internal compartments are designed to be watertight up to an elevation of 122 feet PSD. The intake, located at the river front, is fitted with ice barriers and marine dock bumpers and is designed to withstand the effects of tornadoes and missiles. Windbreaks are installed at elevation 112 feet PSD at the northern and southern ends of the structure. A heated enclosure with removable roof sections for maintenance and access is installed around the traveling screens and instrumentation.

The intake is equipped with a fish-escape passage, located in front of the traveling screens and behind the trash bars. The passage connects all SWS cells and exits through the front of the cofferdams at the ends of the intake.

4.1.2.1.1 TRASH BARS

The SWS trash bars are constructed in a manner similar to the CWS trash bars. They are constructed of 0.5 inch wide (1.27 centimeter) steel bars set on 3.5 inch (8.9 centimeter) centers. However, the SWS trash bar assemblies are 8 feet (2.4 meters) wide and 42 feet (12.8 meters) long.

4.1.2.1.2 TRAVELING SCREENS

Each intake cell is equipped with a Rex Equipment Company conventional, vertical traveling screen. Each traveling screen unit contains forty-nine, conventional screen panels constructed of 3/8 inch (1 centimeter) mesh. Each screen extends from the bottom of the cell (70 feet PSD) to the service deck (112 feet

PSD). The screens are chain-driven by an electric motor mounted on top of the housing.

The SWS intake screens are washed on the front side with a single series of high-pressure sprays to ensure that there is no clogging or fouling of the system. The screens operate intermittently at a single speed, controlled by differential pressure across the screen face. When not in the cleaning mode, they remain at rest. Debris collected in troughs in the deck at the 112-foot elevation is transferred to trash baskets at either end of the intake and properly disposed of in a landfill.

4.1.2.1.3 SERVICE WATER PUMPS

SWS pumps are located inside each of the twelve independent intake cells. Six Layne and Bowler, vertical, deepwell turbine pumps serve each unit. Each pump is rated at 10,875 gallons per minute (4.12×10^4 liters per minute) at a pump head of 240 feet (73 meters). The pumps are driven by Allis Chalmers vertical, solid-state, open-dripproof, air-cooled motors, each rated at 1,000 horsepower at 1,187 revolutions per minute. During normal operation, four pumps are in service.

4.1.2.1.4 OTHER EQUIPMENT

Ice Barriers

Because of the safety-related nature of the SWS intake, the ice barriers are always in place. The barriers extend from the operating deck (elevation 112 feet PSD) to elevation 83.1 feet PSD. They are constructed in the same manner as the CWS ice barrier.

Curtain Wall

The curtain walls are installed within each intake cell to provide protection from floating oil and fires. They extend from the operating deck (elevation 112 feet PSD) down to "lowest low-water "(elevation 81 feet PSD).

Automatic Strainer

Downstream of each SWS pump is located an automatic strainer. There are six strainers per unit, each manufactured by the R. P. Adams Company. The design flow is 12,500 gallons per minute (4.73×10^4 liters per minute) per strainer at a design pressure of 200 psi. The strainer mesh size is 0.010 inch (0.25 millimeters) and is constructed of stainless steel. The strainers are continuously washed, and wash water is combined and routed to a yard drain that discharges to the river.

4.1.3 DISCHARGE SYSTEM

Condenser cooling water from the CWS and cooling water from the SWS both are returned to the Delaware River via common discharge piping.

4.1.3.1 CIRCULATING WATER

After exiting the condenser discharge, piping from each half of the condenser water box joins in a 10 foot (3 meter) diameter pipe which runs to the river. The three pipes per unit convey the water approximately 500 feet (152 meters) offshore (Figure 4-1). The outlet of each of these pipes is at a depth of 25 to 30 feet (7.6 to 9.1 meters). The exit velocity is high enough (10.7 feet per second) to promote rapid mixing with ambient water. The velocity, arrangement, and location are designed to reduce thermal recirculation.

4.1.3.2 SERVICE WATER

Service water flows continuously and is released to the CWS, where it is returned to the Delaware River.

4.1.3.3 THERMAL PLUME STUDIES

The cooling water discharged from Salem Generating Station has been studied on several occasions to determine its distribution and volume. The geometric and dynamic behavior of the thermal plume, as a function of tidal phase, was studied through fixed-station monitoring, mobile mapping of the plume track, and a thermal infrared (IR) overflight survey on June 15-16, 1982.

During flood tide, clockwise circulation patterns directed the thermal plume upstream along the shoreline of Artificial Island. A 1°C (1.8°F) isotherm (i.e., a delta temperature of 1°C above ambient) was used to define the plume. Maximum upstream and lateral extent of the 1°C isotherm at the surface (as measured by IR imagery) was 19,800 and 1,485 feet (6,000 meters and 450 meters), respectively. No significant variation in temperature with depth, as measured by mobile mapping and fixed station sampling, was observed during flood tide.

During high slack tide, the plume exhibited lateral spreading near the discharge. As the tide reversed, shallow patches of residual heated water were apparent upstream. The longitudinal and lateral extent of the 1°C surface isotherm was 2,970 feet and 1,980 feet (900 meters and 600 meters), respectively. With the exception of the near discharge area, plume depth was limited to 9.9 feet (3 meters) and became more shallow with distance from the discharge.

During ebb tide, the plume was directed downstream of the discharge toward the southwest. Although a rapid decrease in temperature was observed outside the immediate vicinity of the discharge, 2.5°C (4.5°F) delta temperature pools were measured as far downriver as the Hope Creek Jetty. The longitudinal and lateral extent of the 1°C surface isotherm was 18,150 feet and 8,950 feet (5,500 meters and 1,500 meters), respectively. With the exception of the discharge area, plume depth was limited to less than 3.3 feet (1 meter).

Ebb tide reversed rapidly inhibiting lateral movement toward the river channel so the thermal plume configuration during low slack was similar to that of ebb tide. The longitudinal and lateral extent of the 1°C surface isotherm was 4,950 feet and 3,960 feet (1,500 meters and 1,200 meters), respectively. With the exception of the discharge area, plume depth was limited to 6.6 feet (2 meters), becoming more shallow with distance from the discharge.

With the exception of turbulent mixing near the discharge, salinity continuously increased from the surface to the bottom and toward the sea with no marked interface. Density variations had no observable effect on plume configuration, buoyancy, or movement.

4.2 HOPE CREEK GENERATING STATION

Hope Creek Generating Station consists of one boiling water nuclear reactor with an electrical capability of approximately 1,067 megawatts. Hope Creek began commercial operation during February 1986.

The containment structure housing the reactor and the turbine, auxiliary and service buildings for the station are located on the southern end of Artificial Island just to the north of Salem Generating Station (Figure 3-2). One shoreline intake provides cooling water for the station. The service water system (SWS) provides cooling water for safety related heat exchangers and coolers within the station and makeup water for the closed-cycle circulating water system.

4.2.1 SERVICE WATER SYSTEM

The service water system is designed to provide make-up water to the closed cycle circulating water system and cooling water to safety-related equipment required for safe operation and maintenance of the Hope Creek Station. The SWS withdraws cooling water from the Delaware River, routes it to accept heat rejected from certain essential heat exchangers, and then uses it as makeup to the closed-cycle circulating water system (Figure 4-8).

4.2.1.1 INTAKE STRUCTURE

The SWS intake structure is a shoreline intake constructed of reinforced concrete to withstand specific floods, earthquakes, and other damage (Figure 4-9).

4.2.1.1.1 TRASH BARS AND TRASH RAKE

A continuous line of trash racks is located 13 feet (4 meters) in front of the intake; river currents sweep the face of the intake structure, and the trash racks prevent heavy debris from entering the intake and damaging the traveling screens. The trash rack bars are coated carbon steel, 3 inches by 3/4 of an inch (7.5 centimeters by 1.9 centimeters), and are set on 3 inch (7.5 centimeter) centers. A Rex Chainbelt, Inc. mechanical rake is used when necessary to remove trash from the trash racks. Velocity through the trash racks is approximately 0.1 foot per second (three centimeters per second).

4.2.1.1.2 CURTAIN WALL

Intake water flows into the structure under a curtain wall at a maximum velocity of approximately 0.35 foot per second (0.1 meter per second) through four openings, 11 feet (3.4 meters) high by 9.5 feet (2.9 meters) wide. Once inside, the water flows through one of four vertical traveling screens, each located in a separate well, at a maximum velocity of approximately 0.39 foot per second (0.12 meters per second). All velocities are well below EPA guidelines for cooling water intake structures (USEPA 1976).

4.2.1.1.3 TRAVELING SCREENS

A traveling screen is an endless linkage of framed baskets. Each basket is approximately 2.5 feet (0.75 meter) high and 8.3 feet (2.5 meters) wide, and each holds a panel of 0.063 inch (0.16 millimeter) diameter monel wire mesh with openings that are 1/2 inch high by 1/8 inch wide (1.27 centimeter by 0.32 centimeter).

Each basket has a trough on the lower lip similar to those described for Salem Generating Station. This "fish bucket" is designed to prevent reimpingement of fish by reducing the number which flip off the baskets as they rise from the water. The baskets allow organisms to remain in water while being lifted to fish return troughs. The screens are intended for continuous rotation.

Organisms, trash and other objects small enough to pass through the trash racks collect on the traveling screens. Streams of water remove these objects from the baskets and sluice them into flumes. Water from screen wash pumps issues from a series of spray nozzles near the top of the screen as the bucket turns over and starts to travel downward. The first series of nozzles provides a gentle flow at 20 psi to wash fish and loose debris into the fish return trough. This low pressure reduces potential descaling and buffeting of fish. A second series of nozzles provides a high pressure spray at 90 psi to wash any remaining debris into the debris trough.

Organisms and debris removed from the screens are returned to the Delaware River approximately 50 feet (15.2 meters) south of the intake structure, to reduce the potential for reimpingement on the screens.

4.2.1.1.4 SERVICE WATER PUMPS

After passing through the traveling screens, the river water enters the service water pumps. Under normal circumstances, two pumps operate, and two additional pumps act as spares. There are no seasonal or operational reductions in pumping. Each well contains a vertical wet pit turbine type service water pump rated at 16,500 gallons per minuter (62,500 liters per minute) at 150 feet (46 meters) total head. Each service water pump discharges through a pipe to an automatic, self-cleaning service water strainer. Each strainer is of 250-micron mesh. The strainers continuously self-wash.

4.2.2 CIRCULATING WATER SYSTEM

The circulating water system serves as the principal heat sink for normal plant processes. The system pumps water from the cooling tower through the main condenser and again back the cooling tower, where heat rejection by evaporation to the atmosphere occurs. The system contains 9 million gallons (34 million liters) of water, recirculated at 552,000 gallons per minuter (2,080,000 liters per minute).

The system consists of one natural draft cooling tower with make-up, blowdown, basin overflow and fill bypass systems; four circulating water pumps; a two pass surface condenser and a closed loop circulating water piping arrangement (Figure 4-8).

4.2.2.1 CIRCULATING WATER PUMPS

Four vertical wet-pit circulating water pumps, each with a rated capacity of 138,000 gallons per minute (520,000 liters per minute) at approximately 100 feet (30 meters) total dynamic head, discharge into a 12 foot (3.6 meter) diameter tunnel leading to the main condenser.

4.2.2.2 CONDENSER

The main condenser is a double-pass, three shell, horizontal, deaerating type surface condenser. The tubes are 40 feet (12 meters) in effective length, constructed of Titanium B-338, Grade II alloy, and have a 0.875 inch (2.2 centimeter) nominal diameter. The effective total surface area is 821,430 square feet (76,300 square meters). Each shell has two tube bundles, two inlet-outlet boxes, and two reversing-end water boxes. The waterboxes are rubber-lined, and have provisions for cathodic protection to resist corrosion.

From the condenser the water returns to the cooling tower to complete the cycle.

In normal operation, four circulating water pumps continuously operate. Since approximately 7.86 x 10^9 Btu per hour (1.95 x 10^9 kilocalories per hour) are rejected to a circulating water flow of 2,080,000 liters per minute (552,000 gallons per minute), the circulating water temperature rises about 28°F (15.5°C).

At least two pumps must operate in order to sustain electric power production. Under these conditions 4.4 x 10^9 Btu per hour (1.10 x 10^9 kilocalories per hour) are rejected to water flowing at 306,000 gallons per minute (1,160,000 liters per minute). Circulating water temperature rise is 29°F (16°C).

Following normal shutdown the pumps continue running until the temperature of the turbine condenser unit is between 100 to 105°F (38°C). This is done to extend the service life of the condenser tubes.

Total average residence time for a parcel of water entering the circulating water system and discharging via blowdown or evaporation is about 4.5 hours, based on makeup water displacing approximately 32,000 gallons per minute (121,000 liters per minute). Average transit time for a parcel of water through the circulating water system is 16 minutes, assuming water normally circulates at 552,000 gallons per minute (2,080,000 liter per minute).

Dissolved and suspended solids build up in the circulating water because the cooling tower evaporates water. This results in sediment deposition in the cooling tower basin and scaling. Blowing down a quantity of water from the cooling tower basin over a stationary weir to the Delaware River reduces deposition and scaling. Cycles of concentration in the circulating water system (relative to makeup water) are maintained at 2.0 or less.

4.2.2.3 NATURAL DRAFT COOLING TOWER

A single counterflow, hyperbolic natural draft cooling tower dissipates the heat from the circulating water system. The cooling tower stands approximately 800 feet (244 meters) northeast of the turbine building.

Fabricated from reinforced concrete supported on a driven pipe pile foundation, the cooling tower is designed for a 45-year operating life. Cooling tower fill is non-combustible. A drift eliminator system provides a guaranteed drift rate not exceeding 0.0005 percent of total circulating water flow.

Usable basin depth is 6 feet (1.8 meters), to maintain a minimum water inventory in the circulating water system of 9 million gallons (34 million liters). Extra freeboard provides 30 percent additional capacity.

The natural draft cooling tower is designed for ambient (dry) air temperatures of 0 to 100°F (-18 to 38°C). Waste heat dissipation to ensure safe shutdown of the reactor does not require the natural draft cooling tower.

Duty, circulating water flow and meteorological conditions affect cooling tower performance. Consumptive water use varies from 9,600 gallons per minute (35,300 liters per minute) in January to 13,000 gallons per minute (49,200 liters per minute) in July. Cycles of concentration and blowdown temperatures vary also. The use of sodium hypochlorite prevents the buildup of slime in the tower fill. Caustic is also added to control Circulating Water chemistry.

4.2.3 DISCHARGE

4.2.3.1 COOLING TOWER BLOWDOWN

Cold-side cooling tower blowdown and other station effluents flow through an underground conduit to the Delaware River (Figure 4-8). The conduit terminates in a 4 foot (1.22 foot) inside diameter horizontal pipe, 10 feet (3 meters) offshore upriver of the intake. The centerline of the opening is about 6 feet (1.8 meters) below mean low water. Normally, the discharge velocity is about 3.5 feet per second (1.1 meters per second).

4.2.3.2 THERMAL PLUME

With an average tidal flow of approximately 400,000 cubic feet per second (11,000 cubic meters per second) past the site, there is no discernible far-field temperature rise in the river as a result of the cooling tower blowdown. Mathematical modeling has been used to determine seasonal behavior characteristics of the thermal plume in the Delaware River and to confirm compliance with water quality standards.

Seasonal simulations performed for a complete tidal cycle indicate that the discharge is predominantly negatively buoyant. During winter (February), at high slack tide, a distance of 2,230 feet (680 meters) is required for mixing in order to meet the 2.2°C (4°F) maximum temperature limitation. This distance is well within the 3,500 feet (1,070 meters) mixing zone requirement. Temperature increases above 2.2°C (4°F) at the surface during these same conditions are confined within 600 feet (180 meters) of the Hope Creek discharge. Under all other conditions, the thermal plume meets temperature standards at a mixing zone distance of less than 2,000 feet (610 meters).

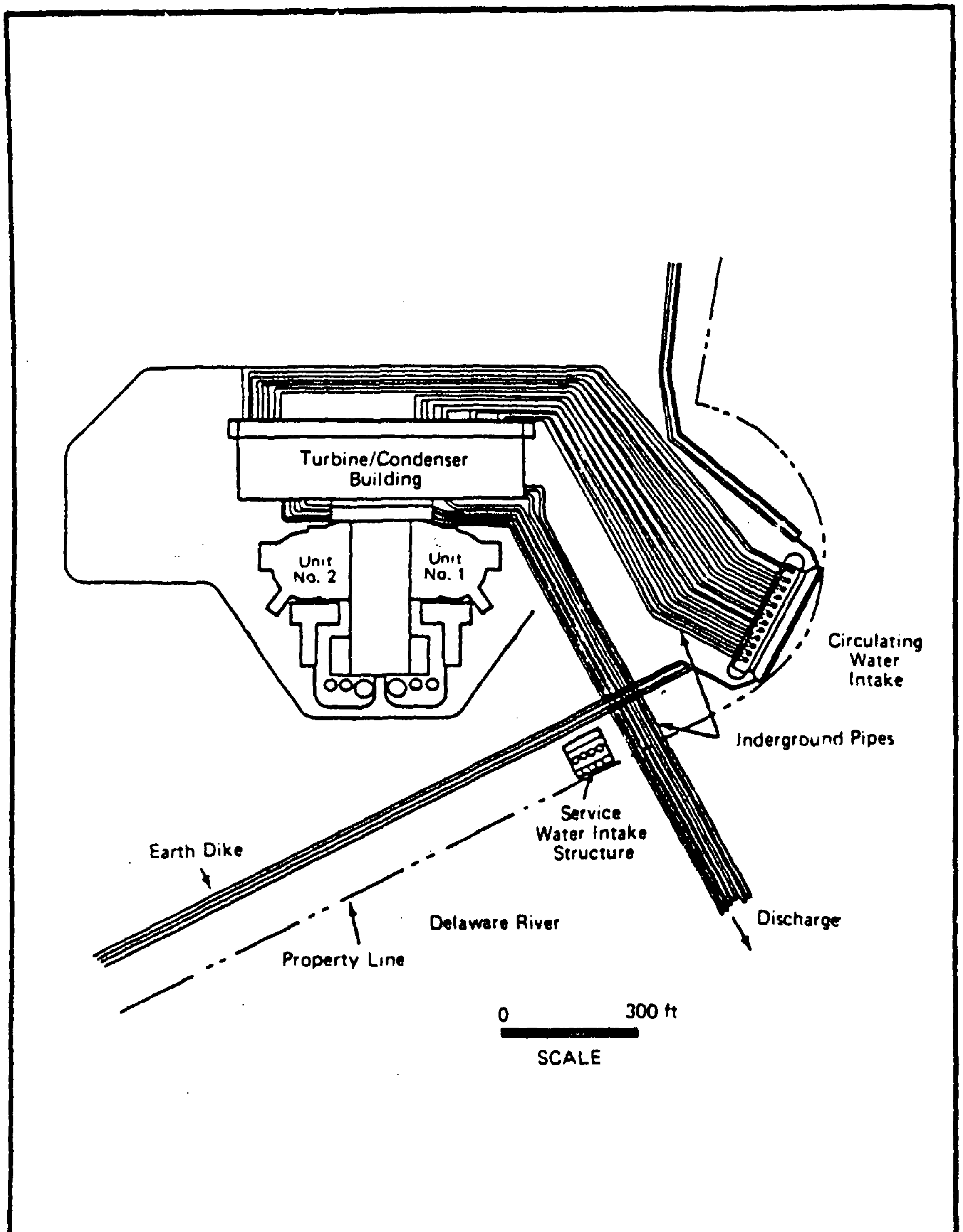


Figure 4-1. Salem Generating Station Layout with Cooling Water Piping Arrangement

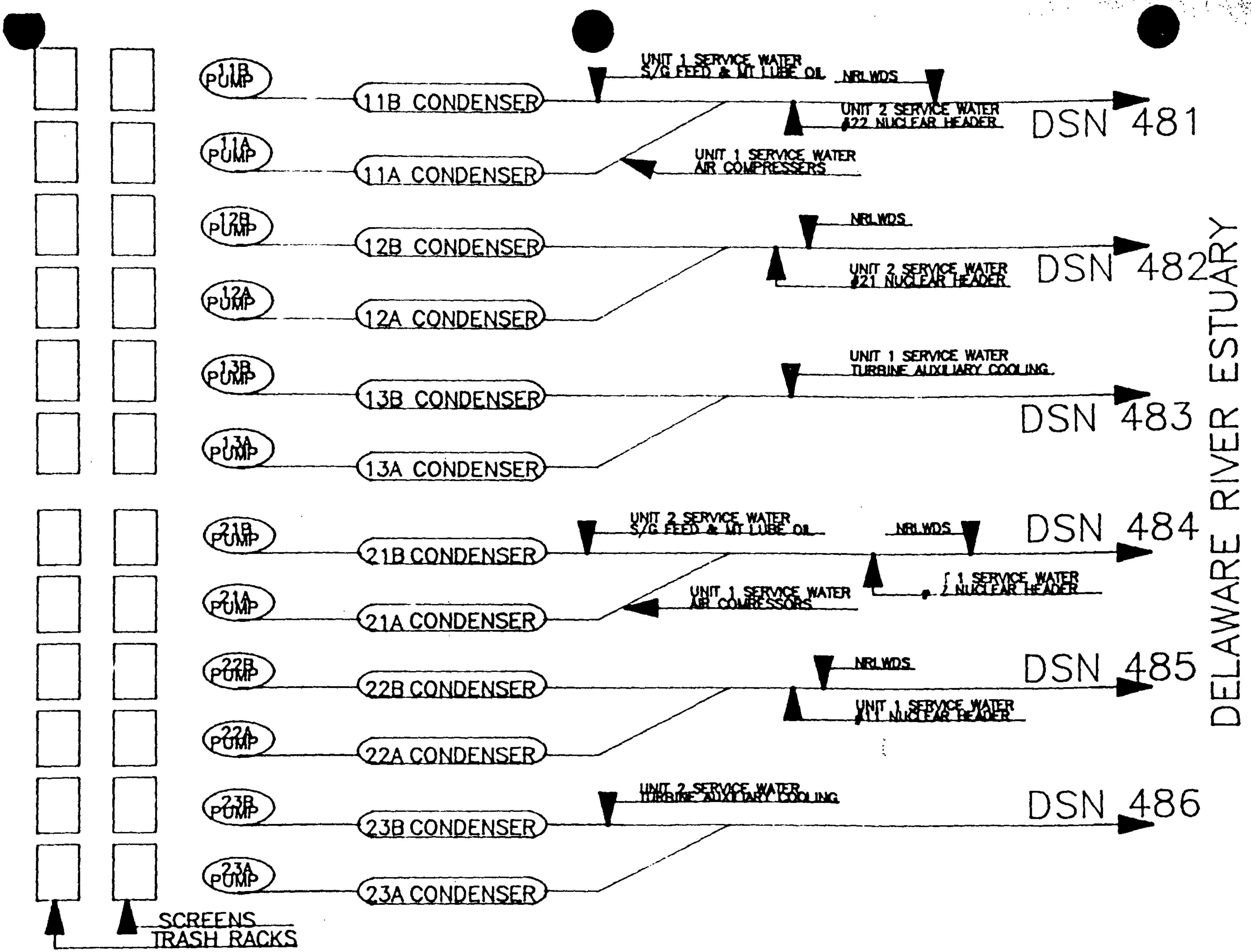


Figure 4-2. Schematic of Salem Generating Station Circulation Water System

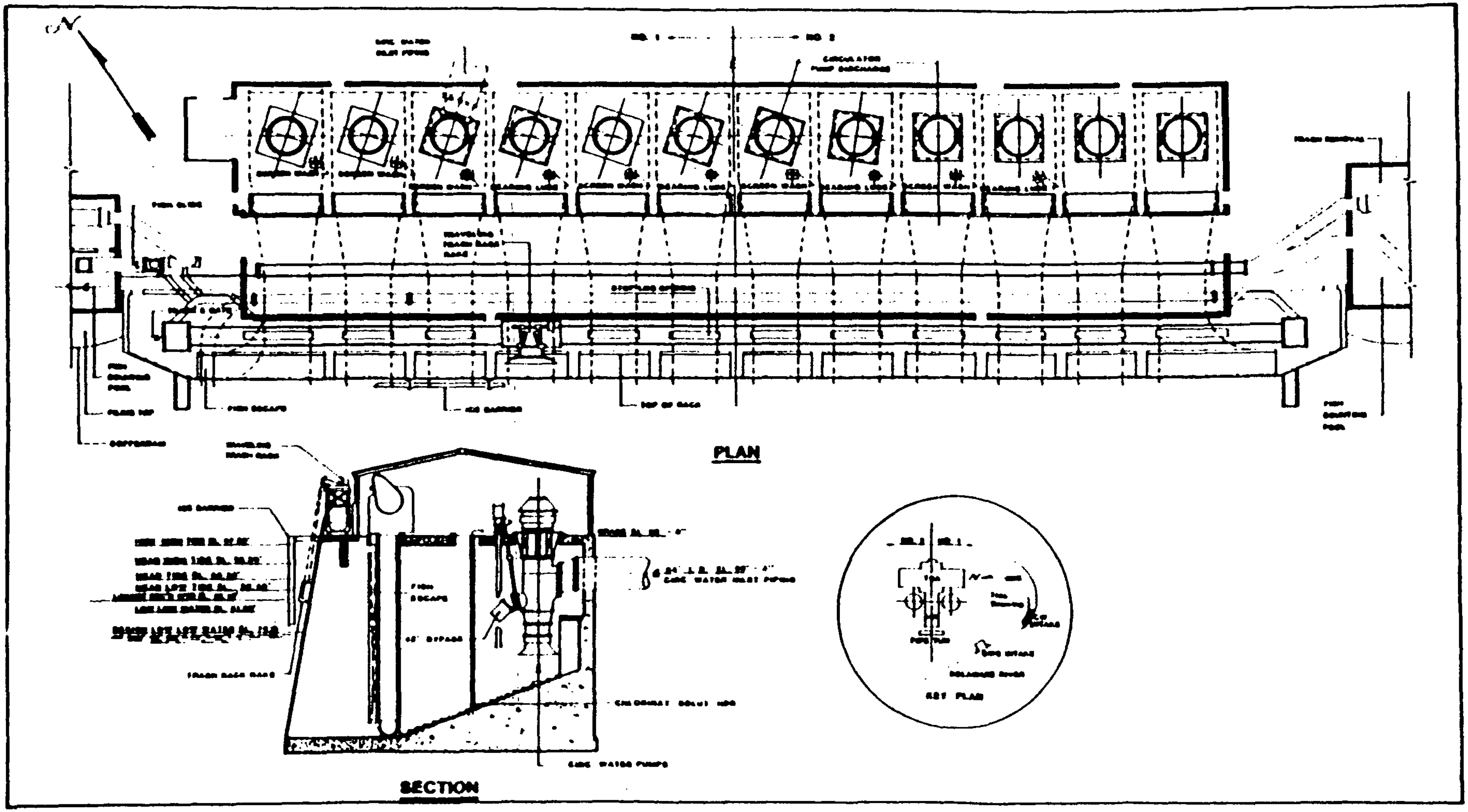


Figure 4-3. Salem Generating Station Circulating Water System Intake

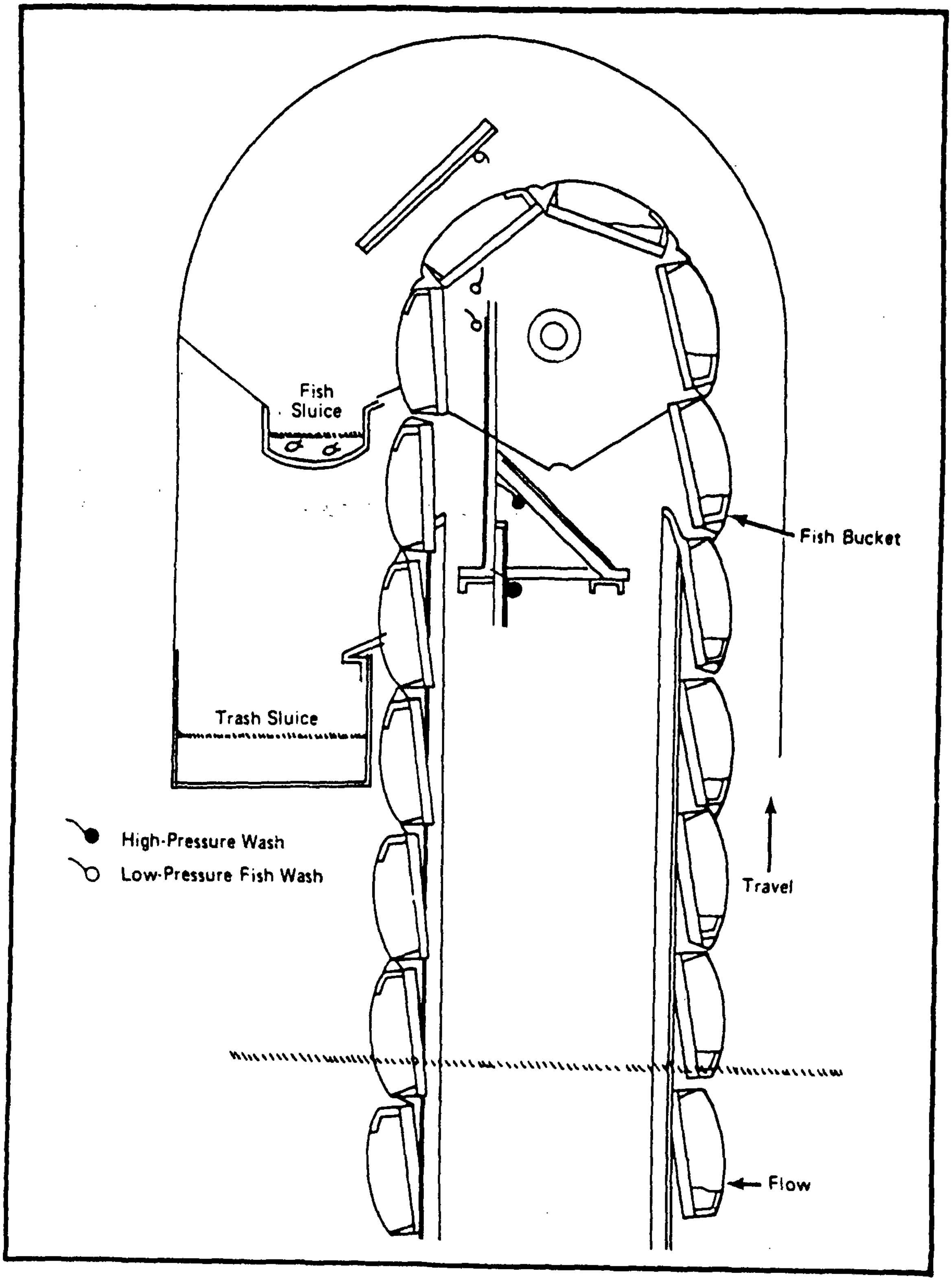


Figure 4-4. Modified Vertical Traveling Water Screen

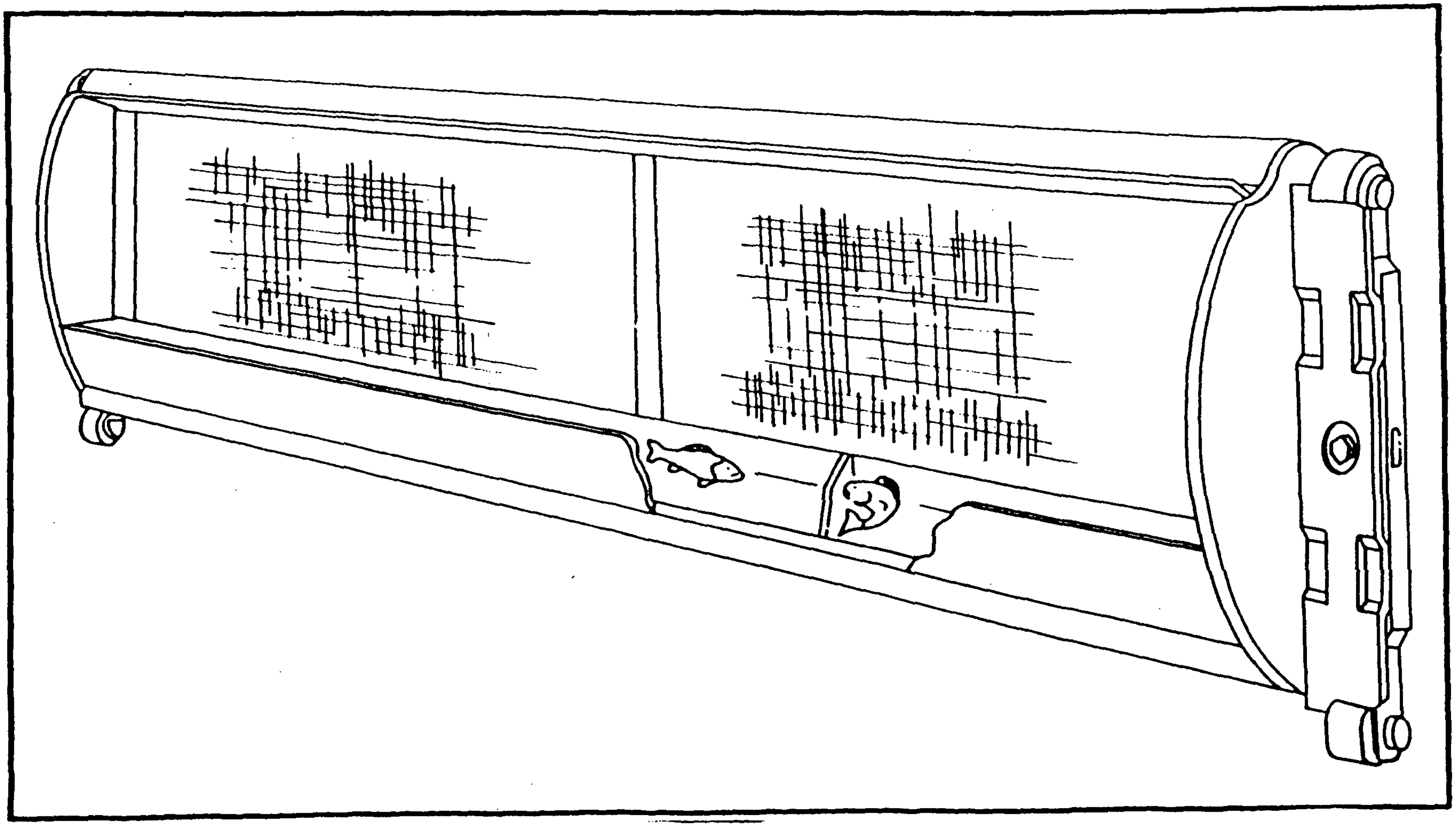


Figure 4-5. Fish Bucket-Type Screen Basket Assembly

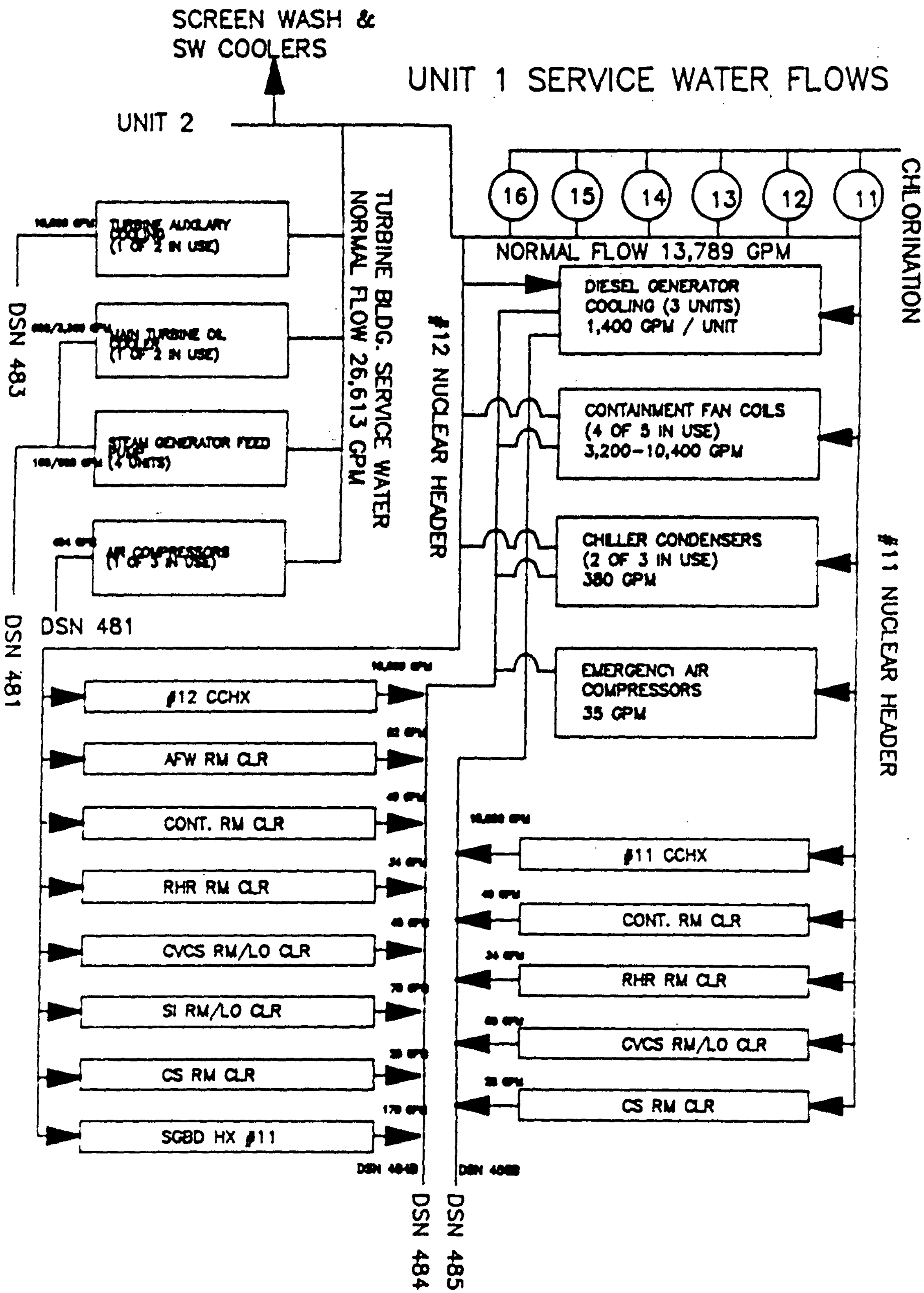


Figure 4-6. Salem Generating Station Service Water System

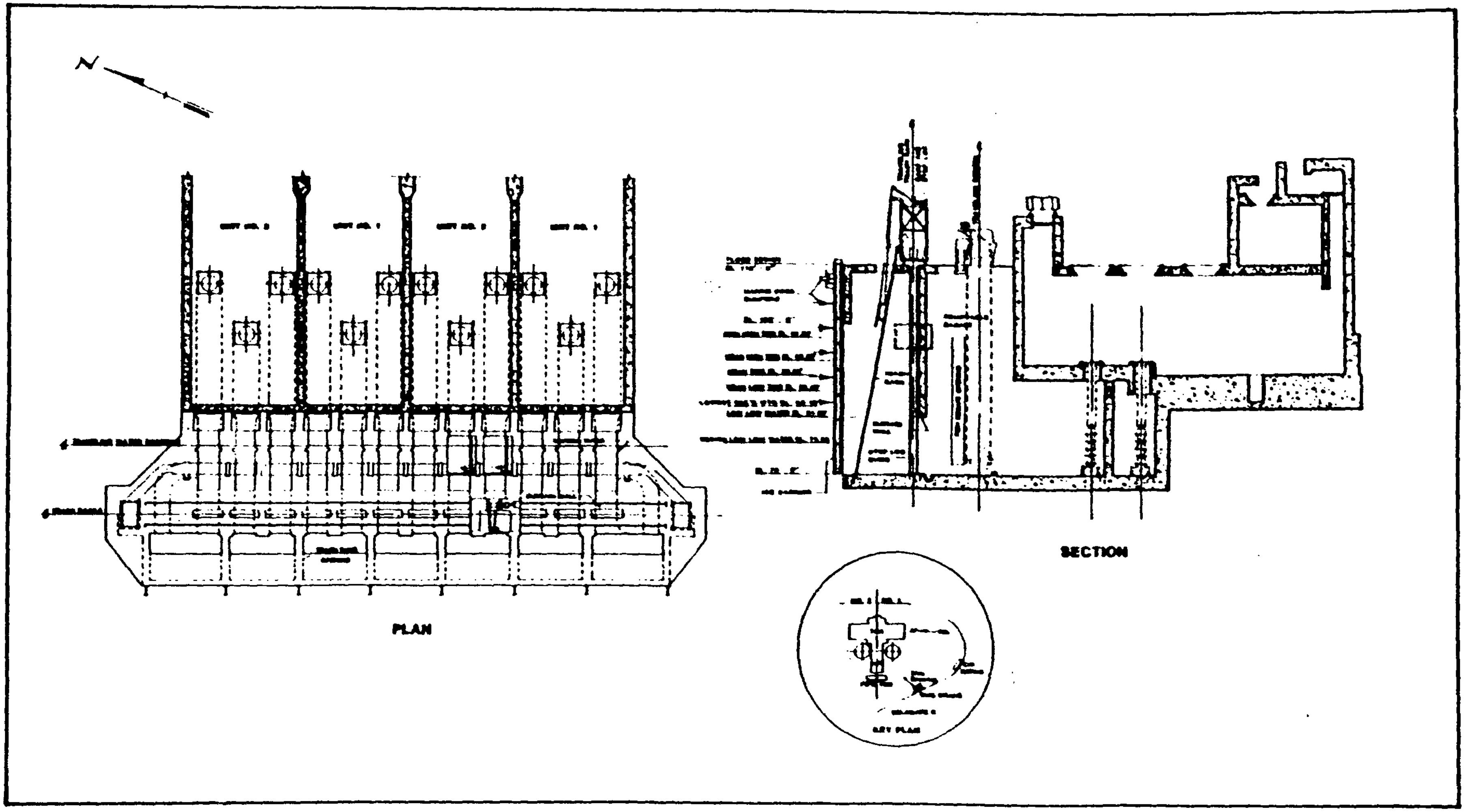


Figure 4-7. Salem Generating Station Service Water System Intake

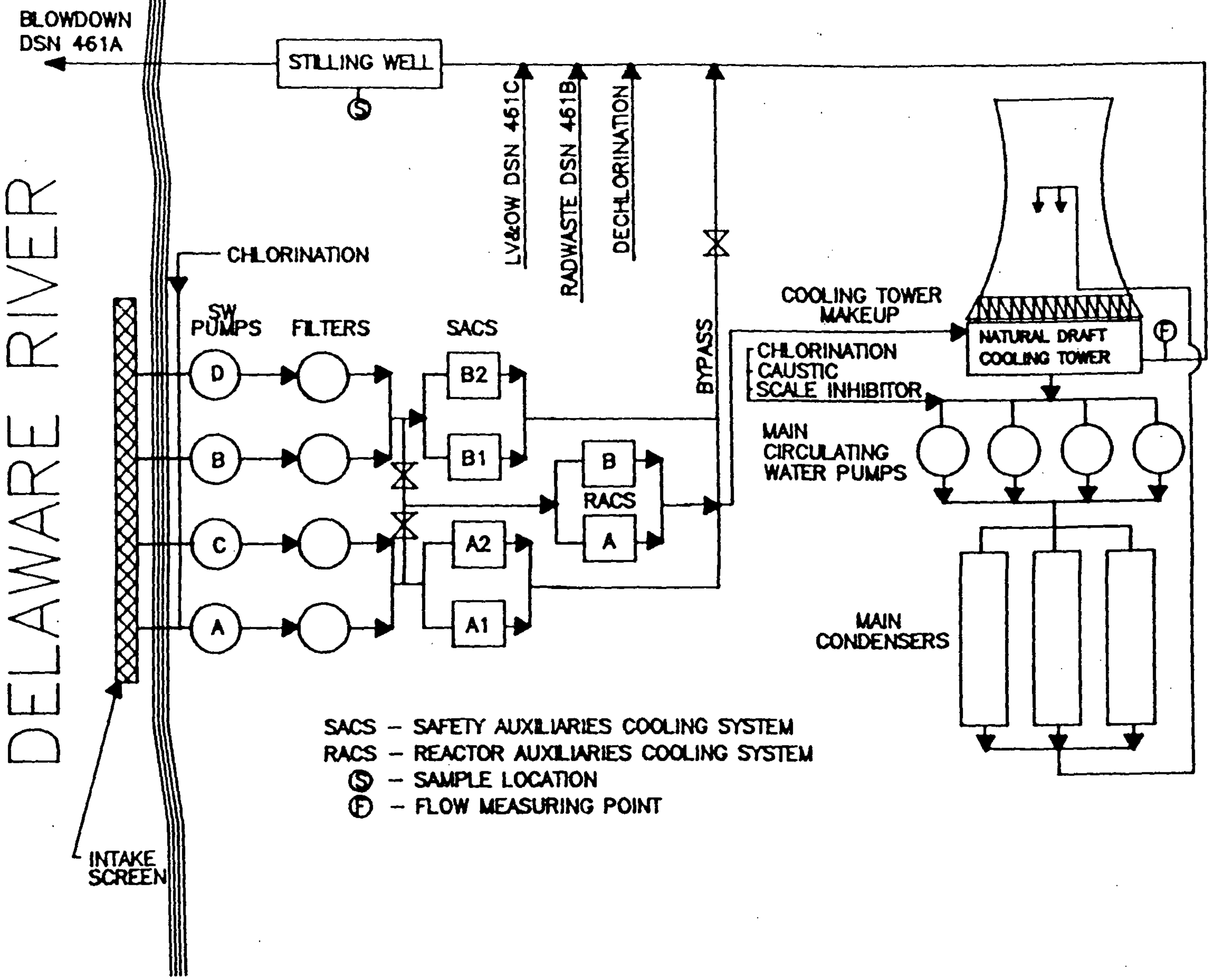


Figure 4-8. Hope Creek Service and Circulating Water Systems Schematic

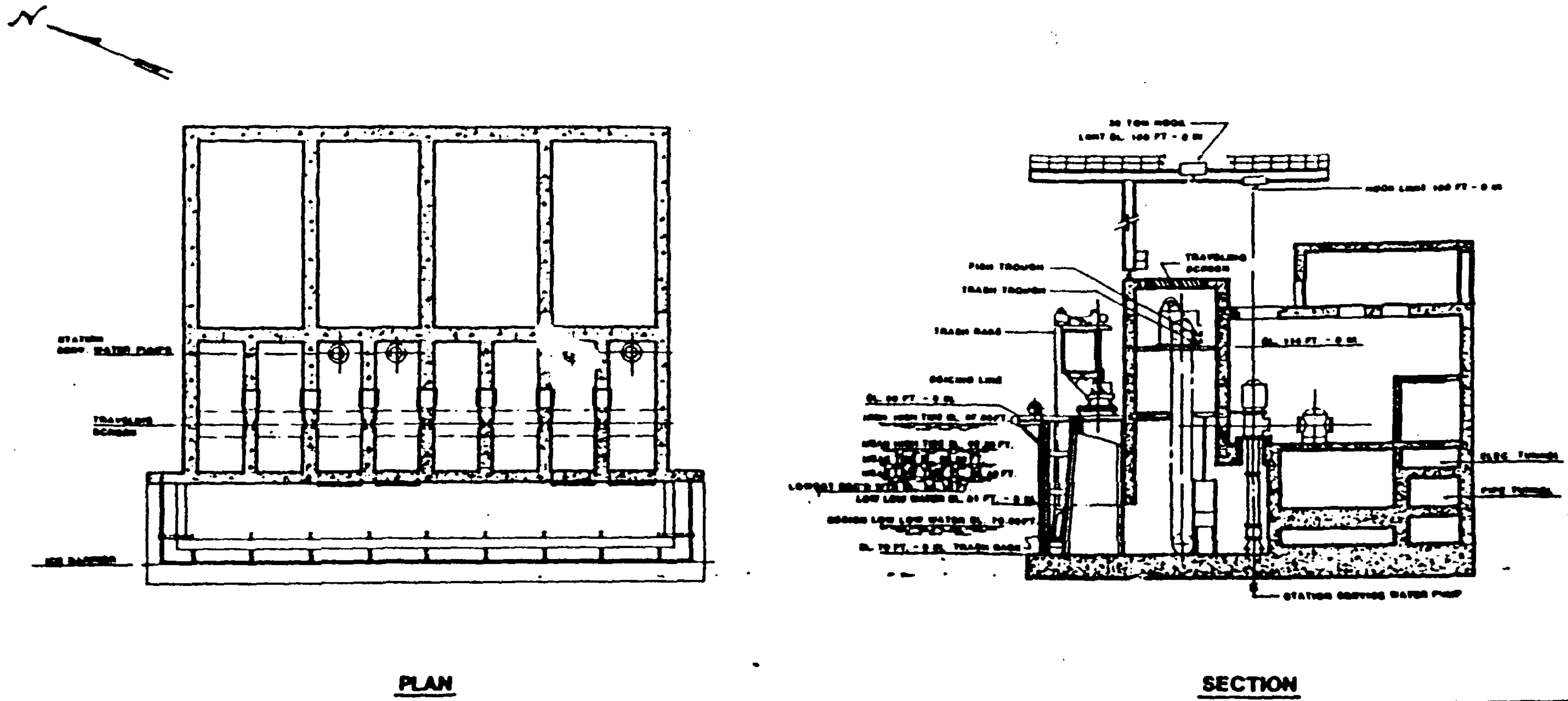


Figure 4-9. Hope Creek Generating Station Service Water System Intake

SECTION 5.0
SPECIES

5.1 GENERAL SEA TURTLE INFORMATION

Living sea turtles are taxonomically represented by two families, five genera, and seven species (Hopkins and Richardson 1984, Carr 1952). The family Cheloniidae is comprised of five genera and six distinct species. These species are Caretta caretta (loggerhead), Chelonia mydas (green turtle), C. depressa (flatback), Eretomochelys imbricata (hawksbill), Lepidochelys kempi (Kemp's ridley), and L. olivacea (olive ridley). The family Dermochelyidae is comprised of only one genus and species, Dermochelys coriacea, commonly referred to as the leatherback sea turtle.

Most of these seven sea turtle species are distributed throughout all of the tropical oceans. However, the loggerhead occurs primarily in temperate latitudes, and the leatherback, although nesting in the tropics, frequently migrates into cold waters at higher latitudes because of its unique physiology (Mager 1985).

Sea turtles are believed to be descended from species known from the late Jurassic and Cretaceous periods that were included in the extinct family Thallassemyidae (Carr 1952, Hopkins and Richardson 1984). Modern sea turtles have short, thick, incompletely retractile necks, and legs which have been modified to become flippers (Bustard 1972, Carr 1952). All species, except the leatherback, have a hard, bony carapace modified for marine existence by streamlining and weight reduction (Bustard 1972). Chelonians have only a thin layer of bone covered by overlaying scutes and Dermochelys has a smooth scaleless black skin and soft carapace with seven longitudinal keels (Carr 1952). These differences in structure are the principal reason for their designation as the only species in the monotypic family Dermochelidae (Carr 1952)

Sea turtles spend most of their lives in an aquatic environment and males of many species may never leave the water (Hopkins and Richardson 1984, Nelson 1988). The recognized life stages for these turtles are egg, hatchling, juvenile/subadult, and adult (Hirth 1971). A generalized sea turtle life cycle is presented in Figure 5-1.

Reproductive cycles in adults of all species involve some degree of migration in which the animals return to nest at the same beach year after year (Hopkins and Richardson 1984). Nesting generally begins about the middle of April and continues into September (Hopkins and Richarson 1984, Nelson 1988, Carr 1952). Mating and copulation occur just off the nesting beach and it is theorized that sperm from one nesting season may be stored by the female and thus fertilize a later season's eggs (Carr and Hirth 1962; Ehrhart 1980). A nesting female moved shoreward by the surf lands on the beach, and if suitable crawls to a point above the high water mark (Carr 1952). She then proceeds to excavate a shallow body pit by twisting her body in the sand (Bustard 1972). After digging the body pit she proceeds to excavate an egg chamber using her rear flipper (Carr 1952). Clutch size, egg size, and egg shape is species specific (Bustard 1972). Incubation periods for loggerheads and green turtles average 55 days but range from 45 to 65 days depending on local conditions (Nelson 1988).

Hatchlings emerge from the nest at night, breaking the egg shell and digging their way out of the nest (Carr 1952). They find their way across the beach to the surf by orienting to light reflecting off the breaking surf (Hopkins and Richardson 1984). Once in the surf, hatchlings exhibit behavior known as "swim frenzy," during which they swim in a straight line for many hours (Carr 1986). Once into the waters off the nesting beach, hatchlings enter a period known as the "lost year." It is not known where this time is spent, what habitat this age prefers, or mortality rates during this period. It is currently believed the period encompassed by the "lost year" may actually turn out to be several years. Various hypothesis have been put forth about the "lost year." One is that hatchlings may become associated with floating sargassum rafts offshore. These rafts provide shelter and are dispersed randomly by the currents (Carr 1986). Another hypothesis is that the "lost year" of some species may be spent in a salt marsh/estuarine system (Garmon 1981).

The functional ecology of sea turtles in the marine and/or estuarine ecosystem is varied. The loggerhead is primarily carnivorous and has jaws well-adapted to crushing molluscs and crustaceans and grazing on encrusted organisms attached to reefs, pilings and wrecks; the Kemp's ridley is omnivorous and feeds on swimming crabs and crustaceans; the green turtle is a herbivore and grazes on marine grasses and algae; and, the leatherback is a specialized feeder preying primarily upon jellyfish. Until recently, sea turtle populations were large and subsequently played a significant role in the marine ecosystem. This role has been greatly reduced in most locations as a result of declining turtle populations. These population declines are a result of natural factors such as disease and predation, habitat loss, commercial overutilization, and inadequate regulatory mechanisms for their protection. This has led to several species being in danger of or threatened with extinction.

However, due to changes in habitat use during different life history stages and seasons, sea turtle populations are difficult to census (Meylan 1982). Because of these problems estimates of population numbers have been derived from various indices such as numbers of nesting females, numbers of hatchlings per kilometer of nesting beach and number of subadult carcasses (strandings) washed ashore (Hopkins and Richardson 1984).

Six of the seven extant species of sea turtles are protected under the Endangered Species Act. Three of the turtles, Kemp's ridley, hawksbill and leatherback, were listed as endangered. The Florida nesting population of green turtle and Mexican west coast population of olive ridley are also endangered. All of the remaining populations of green turtle, olive ridley and loggerhead are threatened. The only unlisted species is the locally protected Australian flatback turtle (Hopkins and Richardson 1984). Only two species of sea turtles, loggerheads and Kemp's ridleys, occur in the Delaware estuary near the Salem and Hope Creek Generating Stations. Leatherbacks do occur in coastal New Jersey and Delaware and the mouth of Delaware Bay. Green turtles have only been sporadically reported from downbay areas and along the coast. Regional sea turtle distribution will be discussed in more detail later in the section.

5.2 LOGGERHEAD (*Caretta caretta*)

5.2.1 DESCRIPTION

The adult loggerhead turtle has a slightly elongated, heart-shaped carapace that tapers towards the posterior and has a broad triangular head (Pritchard et al. 1983). Loggerheads normally weigh up to 450 pounds (200 kilograms) and attain a carapace length (straight line) up to 48 inches (120 centimeters)(Pritchard et al. 1983). Their general coloration is reddish-brown dorsally and cream-yellow ventrally (Hopkins and Richardson 1984). Morphologically, the loggerhead is distinguishable from other sea turtle species by the following characteristics: 1) a hard shell; 2) two pairs of scutes on the front of the head, 3) five pairs of lateral scales on the carapace; 4) plastron with three pairs of enlarged scutes connecting the carapace; 5) two claws on each flipper; and, 6) reddish-brown coloration (Nelson 1988, Dodd 1988, Wolke and George 1981).

Loggerhead hatchlings are brown above with light margins below and have five pairs of lateral scales (Pritchard et al. 1983)

5.2.2 DISTRIBUTION

Loggerhead turtles are circumglobal, inhabiting continental shelves, bays, lagoons, and estuaries in the temperate, subtropical and tropical waters of the Atlantic, Pacific and Indian Oceans (Dodd 1988, Mager 1985).

In the western Atlantic Ocean, loggerhead turtles occur from Argentina northward to Nova Scotia including the Gulf of Mexico and the Caribbean Sea (Carr 1952, Dodd 1988, Mager 1985, Nelson 1988). Sporadic nesting is reported throughout the tropical and warmer temperate range of distribution, but the most important nesting areas are the Atlantic coast of Florida, Georgia and

South Carolina (Hopkins and Richardson 1984). The Florida nesting population of loggerheads has been estimated to be the second largest in the world (Ross 1982).

The foraging range of the loggerhead sea turtle extends throughout the warm waters of the U.S. continental shelf (Shoop et al. 1981). On a seasonal basis, loggerhead turtles are common as far north as the Canadian portions of the Gulf of Maine (Lazell 1980), but during cooler months of the year, distributions shift to the south (Shoop et al. 1981). Loggerheads frequently forage around coral reefs, rocky places and old boat wrecks; they commonly enter bays, lagoons and estuaries (Dodd 1988). Aerial surveys of loggerhead turtles at sea indicate that they are most common in waters less than 50-meters in depth (Shoop et al. 1981), but they occur pelagically as well (Carr 1986).

5.2.3 FOOD

Loggerheads are primarily carnivorous (Mortimer 1982). They eat a variety of benthic organisms including molluscs, crabs, shrimp, jellyfish, sea urchins, sponges, squids, and fishes (Nelson 1988). Adult loggerheads have been observed feeding in reef and hard bottom areas (Mortimer 1982). In the seagrass lagoons of Mosquito Lagoon, Florida, subadult loggerheads fed almost exclusively on horseshoe crab (Mendonca and Ehrhart 1982). Loggerheads may also eat animals discarded by commercial trawlers (Shoop and Ruckdeschel 1982). This benthic feeding characteristic may contribute to the capture of these turtles in trawls.

5.2.4 NESTING

The nesting season of the loggerhead is confined to the warmer months of the year in the temperate zones of the northern hemisphere. In south Florida nesting may occur from April through September but usually peaks in late June and July (Dodd 1988, Florida Power & Light Company 1983).

Loggerhead females generally nest every other year or every third year (Hopkins and Richardson 1984). When a loggerhead nests, it usually will lay 2 to 3 clutches of eggs per season and will lay 35 to 180 eggs per clutch (Hopkins and Richardson 1984). The eggs hatch in 46 to 65 days and hatchling emerge 2 or 3 days later (Hopkins and Richardson 1984).

Hatchling loggerheads are a little less than 2 inches (5 centimeters) in length when they emerge from the nest (Hopkins and Richardson 1984, Florida Power & Light Company 1983). They emerge from the nest as a group at night, orient themselves seaward and rapidly move towards the water (Hopkins and Richardson 1984). Many hatchlings fall prey to sea birds and other predators following emergence. Those hatchlings that reach the water quickly move offshore and exist pelagically (Carr 1986).

5.2.5 POPULATION SIZE

Loggerhead sea turtles are the most common sea turtle in the coastal waters of the United States. Based on numbers of nesting females, numbers of hatchlings per kilometer of nesting beach and number of subadult carcasses (strandings) washed ashore, the total number of mature loggerhead females in the southeastern United States have been estimated to be from 35,375 to 72,520 (Hopkins and Richarson 1984; Gordon 1983).

Adult and sub-adult (shell length greater than 60 centimeters) population estimates have also been based on aerial surveys of pelagic animals observed by NMFS during 1982 to 1984. Based on these studies the current estimated number of adult and sub-adult loggerhead sea turtles from Cape Hatteras, North Carolina to Key West, Florida is 387,594 (NMFS 1987). This number was arrived at by taking the number of observed turtles and converting it to a population abundance estimate using information on the amount of time loggerheads typically spend at the surface.

Some sea turtles which die at sea wash ashore and are found stranded. NMFS, Sea Turtle Salvage and Stranding Network collects stranded sea turtles along both the Atlantic and Gulf Coasts (NMFS 1988). Based on 1987 data, over 2,300 loggerhead turtles were reported by the network (Figures 5-2 and 5-3). The largest portion was collected from the southeast Atlantic Coast (1,414 turles) followed by the Gulf Coast (593 turtles) and northeast Atlantic Coast (347 turtles).

Onboard observation of offshore shrimp trawling by NMFS in the southeast Atlantic estimated that over 43,000 loggerheads are captured in shrimp trawls annually. The estimated number of loggerhead mortalities from this activity was estimated to be 9,874 turtles annually (NMFS 1987).

Based on these data, it is evident that a large population of loggerhead sea turtles does exist in the southeast Atlantic and Gulf of Mexico. Various populations estimates suggest that the number of adult and sub-adult turtles is probably in the hundreds of thousands in the southeastern United States alone. This plus the fact that other populations of loggerheads occur in many other parts of the world suggest that although this species needs to be conserved it is not in any immediate danger of becoming endangered. However, the continued development of coastal foraging areas and population mortalities due to offshore trawling is likely to have a negative impact on population numbers if continued. In fact, one researcher has suggested that loggerhead turtle nesting populations in the U.S. has been declining (Frazer 1986).

5.3 KEMPS RIDLEY (*Lepidochelys kempi*)

5.3.1 DESCRIPTION

The adult Kemp's ridley has a circular-shaped carapace and a medium sized pointed head (Pritchard et al. 1983). Ridleys normally weigh up to 90 pounds (42 kilograms) and attain a carapace length (straight line) up to 27 inches (70 centimeters)(Pritchard et al. 1983). Their general coloration is olive-green dorsally and yellow ventrally (Hopkins and Richardson 1984). Morphologically, the Kemp's ridley is distinguishable from other sea turtle species by the following characteristics: 1) a hard shell; 2) two pairs of scutes on the front of the head, 3) five pairs of lateral scutes on the carapace; 4) plastron with four pairs of scutes, with pores, connecting the carapace; 5) one claw on each front flipper and two on each back flipper; and, 6) olive-green coloration (Pritchard et al. 1983, Pritchard and Marquez 1973).

Kemp's ridley hatchlings are dark grey-black above and white below (Pritchard et al. 1983, Pritchard and Marquez 1973).

5.3.2 DISTRIBUTION

Kemp's ridley turtles inhabit sheltered coastal areas and frequent larger estuaries, bays and lagoons in the temperate, subtropical and tropical waters of the Atlantic Ocean and Gulf of Mexico (Mager 1985).

The foraging range of adult Kemp's ridley sea turtle appears to be restricted to the Gulf of Mexico. However, juveniles and subadult occur throughout the warm coastal waters of the U.S. Atlantic coast (Hopkins and Richardson 1984, Pritchard and Marquez 1973). On a seasonal basis ridleys are common as far north as the Canadian portions of the Gulf of Maine (Lazell 1980), but during cooler months of the year, they shift to the south (Morreale et al. 1988).

5.3.3 FOOD

Kemp's ridleys are omnivorous and feeds on crustaceans, swimming crabs, fish, jellyfish and molluscs (Pritchard and Marquez 1973).

5.3.4 NESTING

Kemp's ridley nesting is mainly restricted to a stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Pritchard and Marquez 1973, Hopkins and Richardson 1984). Occasional nesting has been reported in Padre Island, Texas and Veracruz, Mexico (Mager 1985).

The nesting season of the Kemp's ridley is confined to the warmer months of the year primarily from April through July.

Kemp's ridley females generally nest every other year or every third year (Pritchard et al. 1983). They will lay 2 to 3 clutches of eggs per season and will lay 50 to 185 eggs per clutch (Hopkins and Richardson 1984). The eggs hatch in 45 to 70 days and hatchling emerge 2 or 3 days later (Hopkins and Richardson 1984).

Hatchling ridleys are a little less than 2 inches (4.2 centimeters) in length when they emerge from the nest (Hopkins and Richardson 1984). They emerge from the nest as a group at night, orient themselves seaward and rapidly move towards the water (Hopkins and Richardson 1984). Following emergence, many hatchlings fall prey to sea birds, raccoons and crabs. Those hatchlings that reach the water quickly move offshore. Their existence after emerging is not well understood but is probably pelagic (Carr 1986).

5.3.5 POPULATION SIZE

Kemp's ridley sea turtles are the most endangered of the sea turtle species. There is only a single known colony of this species, almost all of which nest near Rancho Nuevo, Tamaulipas, Mexico. An estimated 40,000 females nested on a single day in 1947, but since 1978 there have been less than 1,000 nests per season (Figure 5-4). Based on nesting information from Rancho Nuevo, it appears that the population is declining at a rate of approximately 3 percent per year (Ross, 1989). Also based on the numbers of nest produced at Rancho Nuevo, this species nesting cycle, male-female ratios and fecundity, the adult Kemp's ridley population has been estimated to be approximately 2,200 adults (Marquez 1989).

Kemp's ridleys also die at sea and wash ashore. NMFS, Sea Turtle Salvage and Stranding Network collects stranded sea turtles along both the Atlantic and Gulf Coasts (NMFS 1988). Based on 1987 data, 767 ridleys were reported by the network (Figures 5-2 and 5-3). The largest portion was collected from the Gulf Coast (103 turtles) and mostly the western portion of the Gulf. Nearly equal numbers of ridleys were reported from the northeast and southeast Atlantic Coasts (64 and 50 respectively).

Onboard observation of offshore shrimp trawling by NMFS in the southeast Atlantic indicated that over 2,800 ridleys are captured in shrimp trawls annually. The estimated number of ridley mortalities from this activity was estimated to be 767 turtles annually and most of these (65 percent) occurred in the western portion of the Gulf of Mexico (NMFS 1987).

Based on these data it is evident the this population is in danger of extinction.

5.4 GREEN TURTLE (*Chelonia mydas*)

5.4.1 DESCRIPTION

The green turtle is a medium to large sea turtle with a nearly oval carapace and a small rounded head (Pritchard et al. 1983). Its carapace is smooth and olive-brown in color with darker streaks and spots. Its plastron is yellow. Greens normally weigh up to 220 pounds (100 kilograms) and attain a carapace length (straight line) up to 35 inches (90 centimeters) (Pritchard et al. 1983, Hopkins and Richardson 1984). Morphologically this species can be distinguished from the other sea turtles by the following characteristics: 1) a relatively smooth shell with no overlapping scutes; 2) one pair of scutes on the front of the head, 3) four pairs of lateral scutes on the carapace; 4) plastron with four pairs of enlarged scutes connecting the carapace; 5) one claw on each flipper; and, 6) olive, dark-brown mottled coloration (Nelson 1988, Pritchard et al. 1983, Carr 1952).

5.4.2 DISTRIBUTION

Green turtles are circumglobally distributed mainly in waters between the northern and southern 20°C isotherm (Mager 1985). In the western Atlantic, several major assemblages have been identified and studied (Parsons 1962, Pritchard 1969, Schulz 1975, Carr et al. 1978). In the continental U.S., however, the only known green turtle nesting occurs on the Atlantic coast of Florida (Mager 1985).

5.4.3 FOOD

Green sea turtles are primarily herbivores that eat sea grasses and algae. Other organisms living on sea grass blades and algae add to the diet (Mager 1985).

5.4.4 NESTING

Green turtle nesting occurs on the Atlantic coast of Florida from June to September (Hopkins and Richardson 1984). Mature females may nest three to seven times per season at about 10 to 18 day intervals. Average clutch sizes vary between 100 and 200 eggs that hatch usually within 45 to 60 days (Hopkins and Richardson 1984). Hatchlings emerge, mostly at night, travel quickly to the water, and swim out to sea. At this point, they enter a period which is poorly understood but is likely spent pelagically in areas where currents concentrate debris and floating vegetation such as sargassum (Carr 1986).

5.4.5 POPULATION SIZE

The number of green sea turtles that existed before commercial exploitation and the total number that now exists are not known.

Records show drastic declines in the Florida catch during the 1800's and similar declines occurred in other areas (Hopkins and Richardson 1984).
The decline and elimination of many nesting beaches and less frequent encounters with green turtles provide inferential evidence that stocks are generally declining (Mayer 1985, Hopkins and Richardson 1984).

5.5 LEATHERBACK TURTLE (*Dermochelys coriacea*)

5.5.1 DESCRIPTION

The leatherback turtle is the largest of the sea turtles. It has an elongated, somewhat triangularly shaped body with longitudinal ridges or keels. It has a leathery blue-black shell composed of a thick layer of oily, vascularized cartilaginous material, strengthened by a mosaic of thousands of small bones. This blue-black shell which may also have variable white spotting (Pritchard et al. 1983). Its plastron is white. Leatherbacks normally weigh up to 660 pounds (300 kilograms) and attain a carapace length (straight line) of 55 inches (140 centimeters) (Pritchard et al. 1983, Hopkins and Richardson 1984). Specimens as large as 910 kilograms (2,000 pounds) have been observed.

Morphologically this species can be easily distinguished from the other sea turtles by the following characteristics: 1) its smooth unscaled carapace; 2) carapace with seven longitudinal ridges; 3) head and flippers covered with unscaled skin; and, 4) no claws on the flippers (Nelson 1988, Pritchard et al. 1983, Pritchard 1971, Carr 1952).

5.5.2 DISTRIBUTION

Leatherbacks have a circumglobal distribution and occur in the Atlantic, Indian and Pacific Oceans. They range as far north as Labrador and Alaska to as far south as Chile and the Cape of Good Hope, farther north than other sea turtle species, probably because of their ability to maintain a warmer body temperature over longer period of time (NMFS 1985).

5.5.3 FOOD

The diet of the leatherback consists primarily of soft-bodied animals such as jellyfish and tunicates, together with juvenile fishes, amphipods and other organisms (Hopkins and Richardson 1984).

5.5.4 NESTING

Leatherback turtle nesting occurs on the mid-Atlantic coast of Florida from March to September (Hopkins and Richardson 1984). Mature females may nest one to nine times per season at about 9 to 17 day intervals. Average clutch sizes vary between 50 and

170 eggs that hatch usually within 50 to 70 days (Hopkins and Richardson 1984). Hatchlings emerge, mostly at night, travel quickly to the water, and swim out to sea. The life history of the leatherback is poorly understood since juvenile turtles are rarely observed.

5.5.5 POPULATION SIZE

The world population estimates for the leatherback have been revised upward to over 100,000 females in recent years due the discovery of nesting beaches in Mexico (Pritchard 1983).

5.6 SEA TURTLES IN THE DELAWARE RIVER ESTUARY

Five species of sea turtles have recently been reported to occur in the Delaware River Estuary and coastal New Jersey and Delaware. This information was obtained by the Marine Mammal Stranding Center (MMSC), Brigantine, New Jersey (Schoelkopf 1989) and the Delaware Department of Natural Resources (Thomas 1988) both of which are members of the Northeast Turtle Salvage and Stranding Network supported by NMFS. The five species which have been observed in the estuary by these organizations are the loggerhead, Kemp's ridley, leatherback, green turtle and hawksbill.

Loggerheads were the most common sea turtle species observed by DEDNR. They reported sixty-five loggerhead strandings and/or sightings in the estuary from 1976 to 1988 and three from coastal Delaware (Table 5-1). The strandings/sightings in the bay were reported primarily from areas south of Liston Point. Kemp's ridleys were not common as loggerheads but eleven turtles were reported in the bay by DEDNR during the same time period. Leatherbacks were observed by DEDNR in the bay proper on one occasion but were more commonly observed along the Delaware coast (four turtles) between Rehoboth Beach and the Indian River Inlet just south of the mouth of the bay. DEDNR also reported one green turtle near Kitts Hummock and one hawksbill near Port Mahon.

The Marine Mammal Stranding Center has reported over 242 sea turtle strandings in coastal New Jersey and Delaware Bay since 1980. Of these, thirty-one were strandings (Table 5-2) from the bay (excludes turtles from Salem Generating Station). They have reported sea turtle strandings and/or sightings from Burlington, New Jersey to the Capes. In the bay, loggerheads were the most commonly stranded turtle (26 stranding reports). Kemp's ridleys and leatherback were less common (1 and 4 strandings respectively). No green or hawksbill sea turtles were reported by MMSC from 1980 to 1988.

PSE&G has also incidentally captured several sea turtles in sample trawls being used to collect fish for station related environmental studies. Three turtles were collected during these trawls including two loggerheads and one green turtle. The green turtle was captured at an unspecified location near the Mispillion River and loggerheads were captured near Egg Island Point.

Seasonally, most of the strandings and/or sightings reported by DEDNR and MMSC occur in the spring and summer (Tables 5-1 and 5-2). September appears to be the most common month for strandings although they occur virtually all year.
Based on stomach content analyses from dead turtles, it appears that the primary food for loggerheads from the bay is blue crab and horseshoe crab. Blue crab occur year round in the lower bay and move up bay in the spring as the saltfront moves. This, in conjunction with the northward migratory movements observed in loggerheads, could account for their occurrence in the bay. Horseshoe crab move upbay to lay eggs in the spring and also occur at a time which coincides with the movement of loggerheads along the coast. Kemp's ridley stomachs which have been examined have contained primarily blue crab. From a functional ecological viewpoint, loggerhead and Kemp's ridleys would be secondary consumers (Figure 5-5). Their significance in the bay, however, is not clear since population information is not available for either species in the bay.

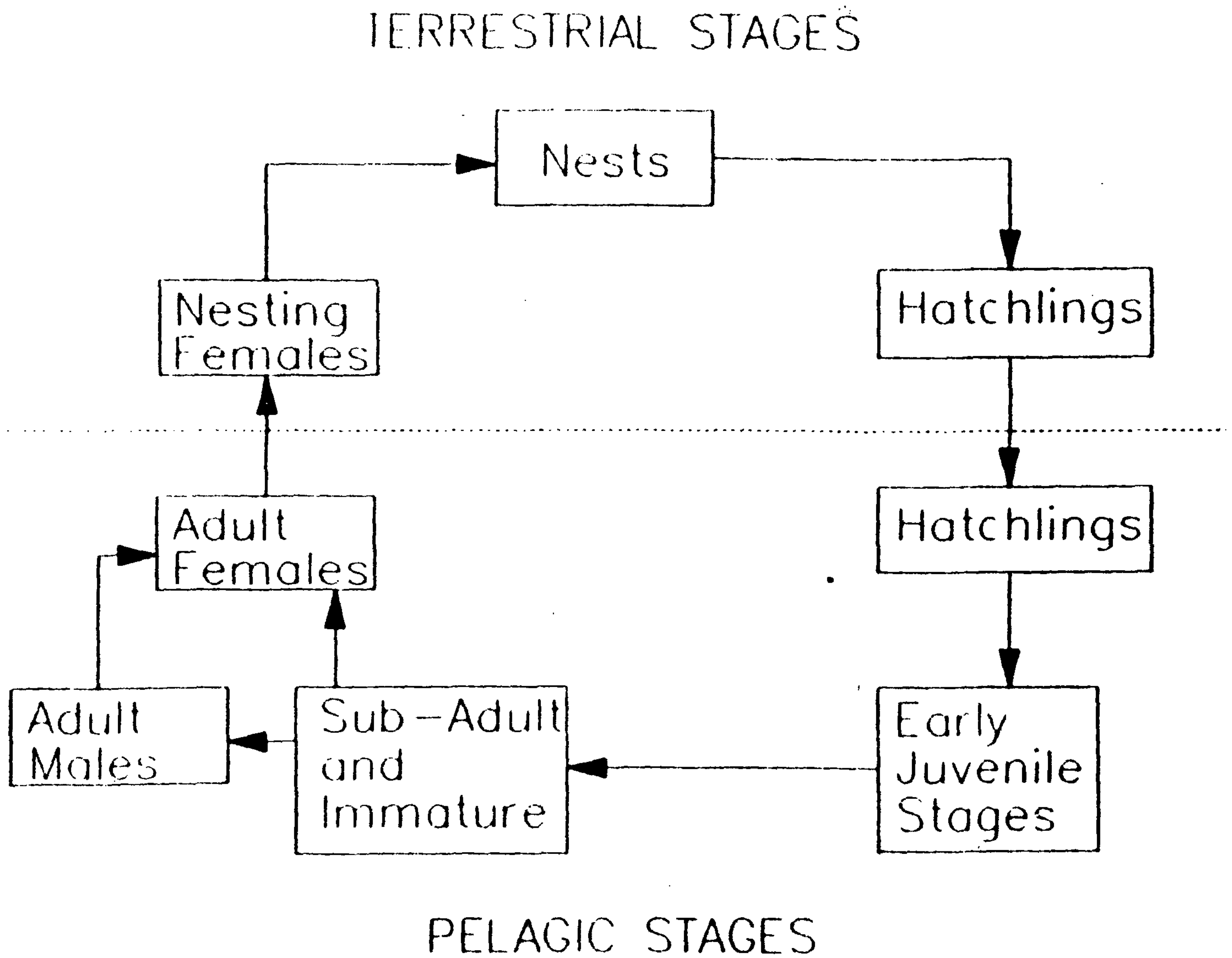


Figure 5-1. Generalized Sea Turtle Life Cycle

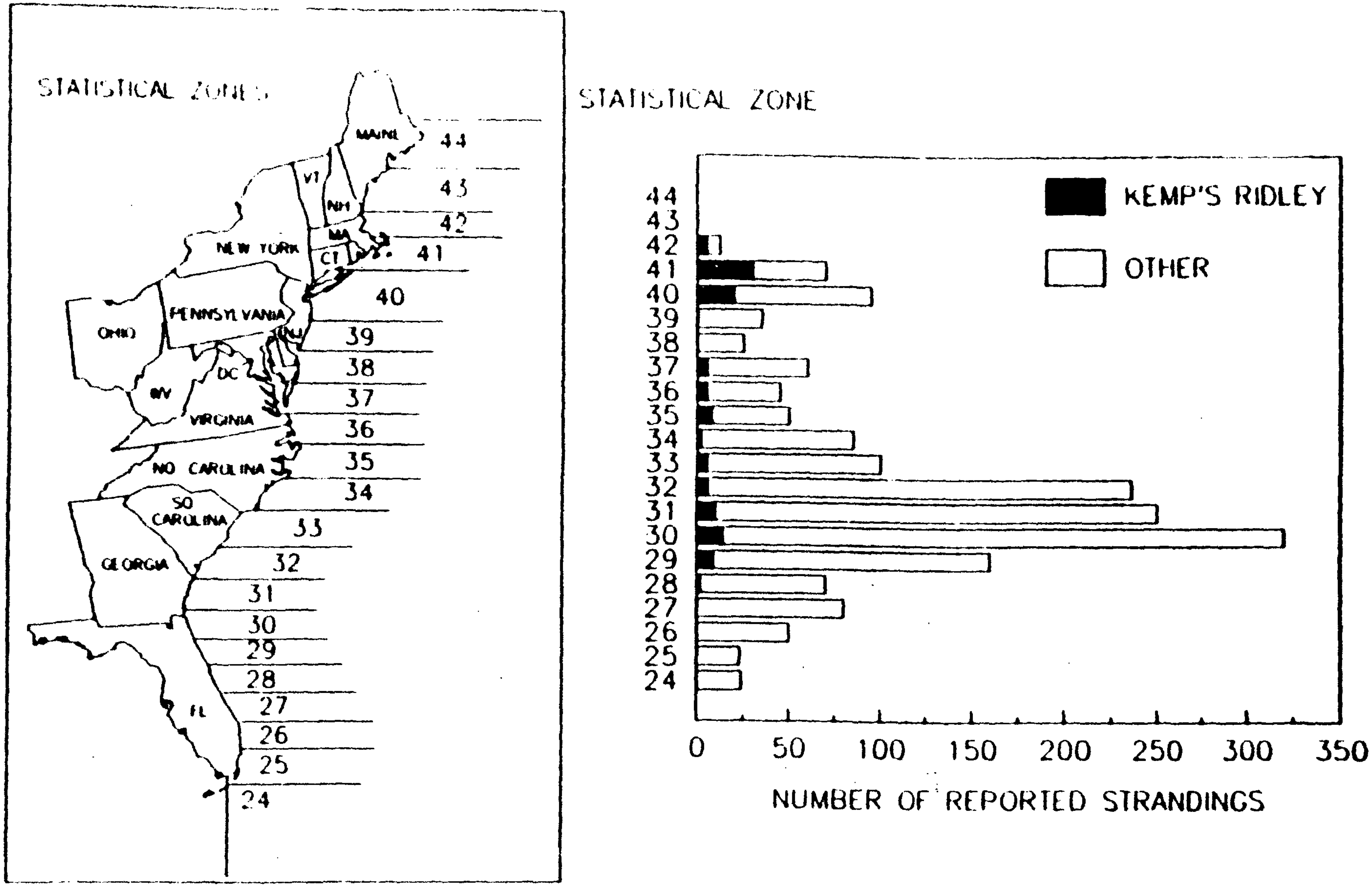
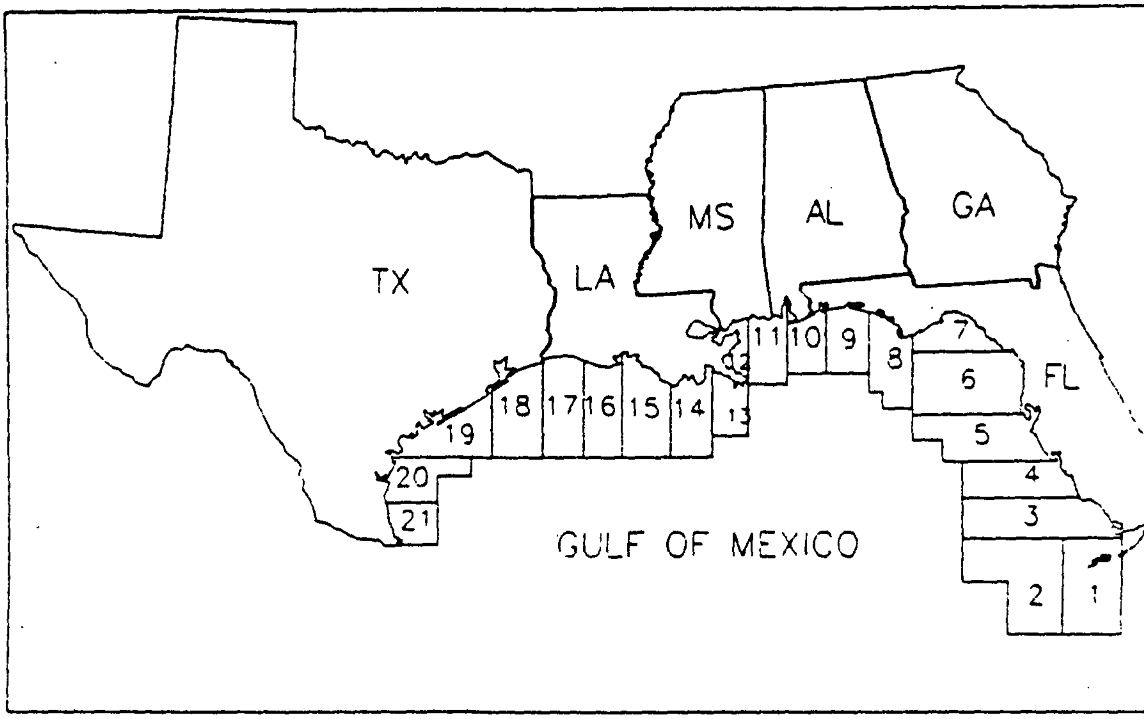


Figure 5-2. Sea Turtle Strandings,
U. S. Atlantic Coast 1987 (NMFS 1987)



GULF OF MEXICO

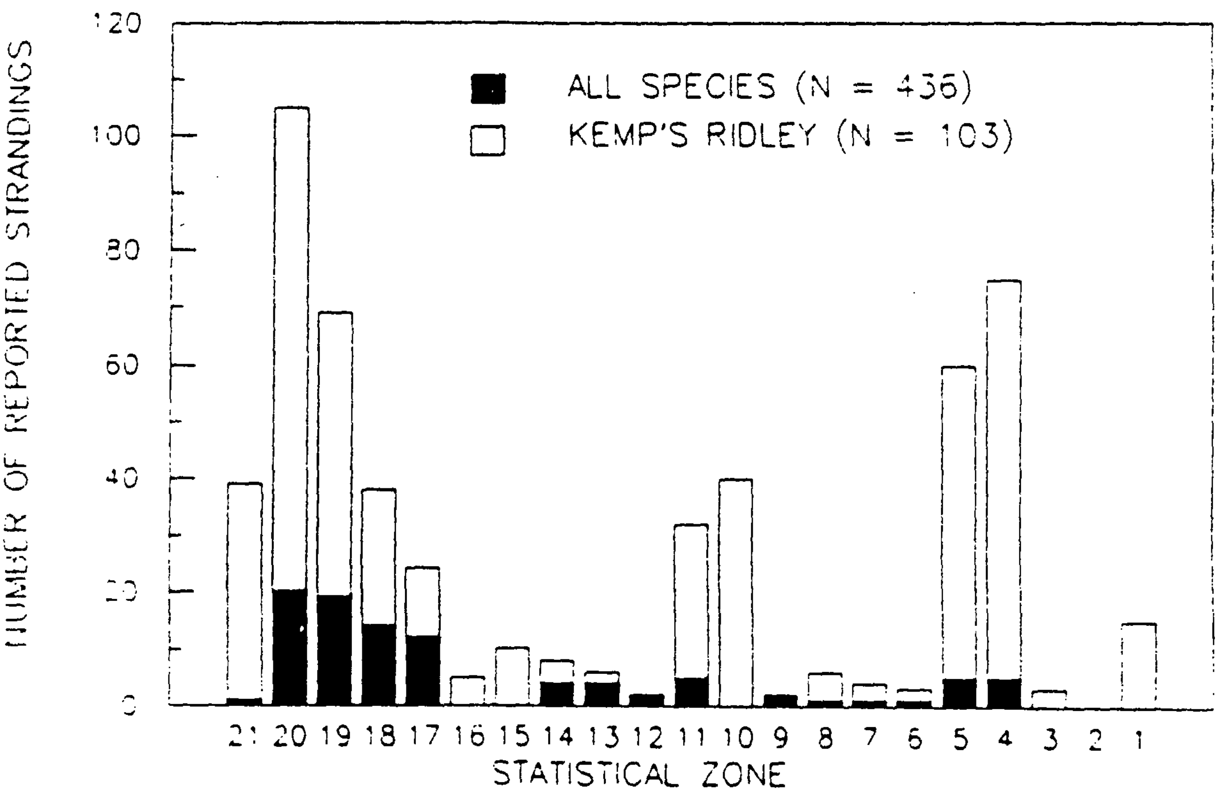


Figure 5-3. Sea Turtle Strandings, U.S. Gulf of Mexico 1987 (NMFS 1988)

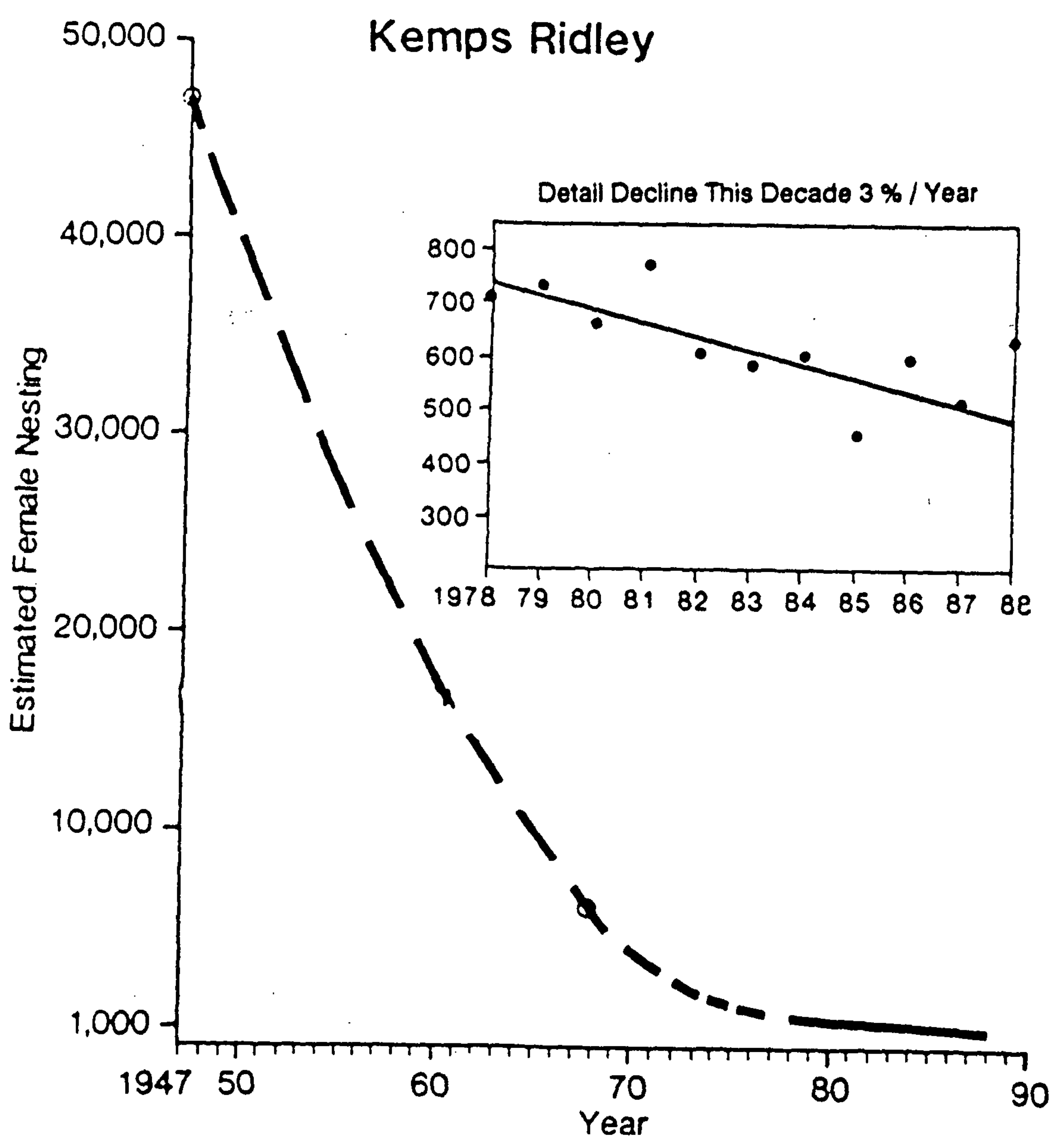


Figure 5-4. Estimated Annual Number of Nesting Female Kemp's Ridley Sea Turtles (Ross 1989)

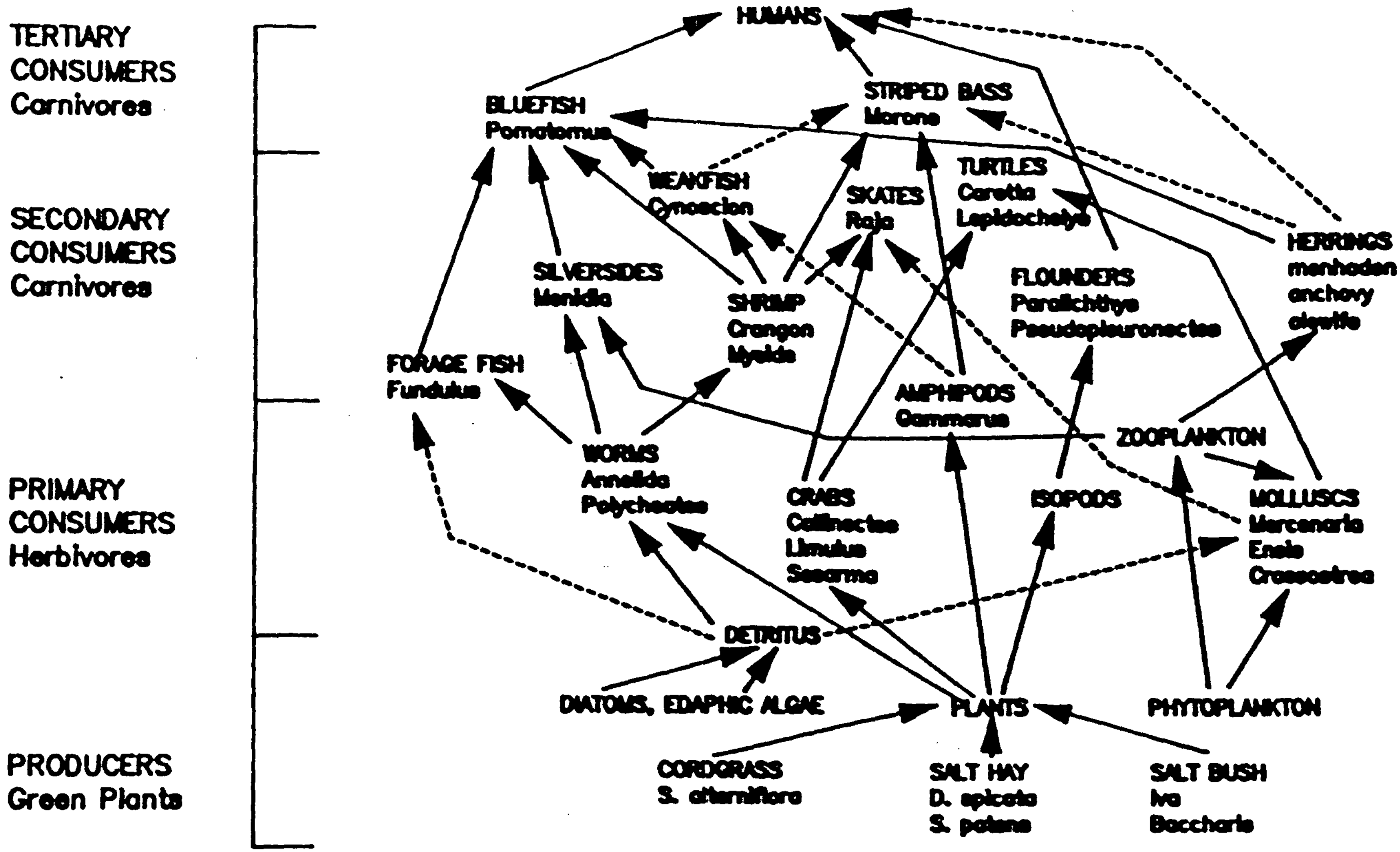


Figure 5-5. Generalized Food Web for Upper Delaware Bay

TABLE 5-1

SEA TURTLE STRANDINGS IN COASTAL DELAWARE AND DELAWARE BAY REPORTED BY DELAWARE DEPARTMENT OF NATURAL RESOURCES (Thomas 1988)

ANNUAL DISTRIBUTION*

Year	Loggerhead	Ridley	Leatherback	Green	Hawksbill
1976	1	0	0	0	0
1977	0(4)	0	0	0	0
1978	1(3)	0	0	0	0
1979	0(4)	0(5)	0	0	0
1980	0	0(3)	0	0	0
1981	0(9)	0(1)	4	0	0
1982	0(1)	0	0	0	0
1983	0(3)	0	0	0	0
1984	0(5)	0(1)	0	0	0
1985	0(17)	0	0	0(1)	0
1986	1(10)	0(1)	0	0	0(1)
1987	0(8)	0	0	0	0
1988	0(1)	0	0(1)	0	0
Totals	3(65)	0(11)	4(1)	0(1)	0(1)

* Number for Delaware Bay in parenthesis.

MONTHLY DISTRIBUTION

Month	Loggerhead	Ridley	Leatherback	Green	Hawksbill
Jan	2	0	0	0	0
Feb	1	0	0	0	0
Mar	1	0	0	0	0
Apr	0	0	0	0	0
May	0	1	0	0	1
Jun	6	0	0	0	0
Jul	11	0	5	0	0
Aug	11	2	0	1	0
Sep	14	4	0	0	0
Oct	20	4	0	0	0
Nov	0	0	0	0	0
Dec	2	0	0	0	0
Totals	68	11	5	1	1

TABLE 5-2

SEA TURTLE STRANDINGS IN COASTAL NEW JERSEY AND DELAWARE BAY REPORTED BY MARINE MAMMAL STRANDING CENTER (Schoelkopf 1989)

ANNUAL DISTRIBUTION*

Year	Loggerhead	Ridley	Leatherback
1980	9(1)	0	2(1)
1981	4(4)	0	13(1)
1982	2(2)	0	13(0)
1983	8(5)	4(0)	9(0)
1984	8(1)	0	2(0)
1985	22(4)	1(0)	7(0)
1986	15(1)	0(1)	2(0)
1987	37(2)	1(0)	33(1)
1988	13(6)	0	6(1)
Totals	118(26)	6(1)	87(4)

* Number for Delaware Bay in parenthesis.

MONTHLY DISTRIBUTION

Month	Loggerhead	Ridley	Leatherback
Jan	1	0	2
Feb	0	0	1
Mar	0	0	1
Apr	0	0	0
May	0	0	2
Jun	8	0	2
Jul	25	0	8
Aug	36	1	11
Sep	46	0	34
Oct	24	0	24
Nov	4	0	6
Dec	0	0	0
Totals	144	1	91

SECTION 6.0
ONSITE INFORMATION

6.1 OCCURRENCE OF SEA TURTLES AT SALEM GENERATING STATION

Sea turtles have been observed at Salem Generating Station and during field sampling associated with the station since 1977. A total of 44 sea turtles have been reported since 1979 (Table 6-1 and Appendix A, Tables A-1 and A-2). The majority of these turtles (38) have been collected from the Salem Generating Station circulating water intake (38 turtles). The remaining six turtles were collected during station related environmental sampling (trawling) or were stranded on other areas of Artificial Island. No strandings have been reported from either the Salem or the Hope Creek service water intakes.

6.1.1 ANNUAL COMPARISON

Table 6-2 summarizes the total number of turtles of each type reported to occur on the Salem circulating water intake. Direct annual comparisons of these data are complicated by the variations in effort between and/or within years. During any particular year the number of sea turtles collected at the intake ranged from zero prior to 1980 to ten in 1988. The actual number of loggerheads incidentally captured on the intake ranged between zero and eight animals annually. The actual number of Kemp's ridleys incidentally captured on the intake ranged between zero and three animals annually.

Based on the levels of incidental capture observed at the intake, it is estimated that zero to nine loggerheads (mean = 3) and zero to three Kemp's ridleys (mean = 1) could be expected to be taken from the intake during any given year (95 percent confidence limits). However, a portion of the turtles captured died of causes unrelated to the station and were just part of the river debris drawn into the station. Also a portion of the turtles captured were alive and released back into the wild. If we exclude animals which were moderately and severely decomposed from this calculation, zero to eight loggerheads (mean = 2) and zero to three Kemp's ridleys (mean < 1) with no evidence of previous damage would be expected to be taken from the intake during a given year.

6.1.2 SPECIES COMPOSITION

Twenty-six loggerhead sea turtles (Caretta caretta) and twelve Kemp's ridleys (Lepidochelys kempi) were captured from the circulating water intake from 1980 to 1988 (Table 6-2).

The loggerheads were all juveniles or subadults. Carapace lengths (straight length) ranged from 29 to 33 centimeters with a mean of 53.9 centimeters (Figure 6-1).

The ridleys were also all juveniles or subadults. There carapace lengths (straight length) ranged from 19 to 33 centimeters with a mean of 25.9 centimeters (Figure 6-1).

6.1.3 MONTHLY DISTRIBUTION OF OCCURRENCES

Table 6-3 summarizes the months during which sea turtles were captured at the Salem circulating water intake from 1980 to 1988. Approximately, 58 percent of all strandings were reported during July, 21 percent in September, 13 percent in August, and 8 percent in June. No turtles were collected during the winter months.

Based on aerial surveys of pelagic turtles (Shoop et al. 1981), sea turtles and loggerheads in particular migrate up the coast from the southeast in the spring and summer months. They move into the bays and coastal waters as water temperatures reach suitable levels and forage on crabs and other preferred foods (Keinath et al. 1987; Morreale 1989). As the temperatures of the bays and coastal waters start to decline, these animals move southward to the warmer water of the southeast Atlantic Coast. Recapture information from tagged animals supports these movements in loggerheads and ridleys (Shoop et al. 1981; Henwood 1987; Schoelkopf 1988).

6.1.4 CONDITION OF TURTLES CAPTURED AT INTAKE STRUCTURE

Of the 38 stranded turtles captured at the circulating water intake, twenty-four were dead and and 14 were alive and subsequently released (Table 6-4).

Eight of the twenty-six loggerheads were alive and successfully released into the Atlantic Ocean by the Marine Mammal Stranding Center after feeding and observing their behavior for several days. Among the eighteen dead loggerheads, eight appeared to be fresh dead. Among the fresh dead animals, five had collapsed lungs and three had evidence of other internal problems which may have contributed to their deaths. Collapsed lungs suggest prolonged submergence but whether or not the submergence was attributable to the station can not be concluded with certainty. Of the remaining ten dead loggerheads, no necropsy information was available for five, three had probable boat propellor cuts, one had a perforated intestine and peritonitus, and, one had apparently been partially frozen. From this information it is apparent that both man-related and natural causes of death contributed to loggerhead mortality in the estuary.

Six of the twelve ridleys were alive when captured and five were successfully released into the Atlantic Ocean by the Marine Mammal Stranding Center after feeding and observing their behavior for several days. One turtle died during this observation period. Among the six dead ridleys, three appeared to be fresh dead and all three had collapsed lungs. The remaining three dead ridleys, were moderately or severely decomposed and two of the three had probable boat propellor cuts on their carapace. From this information man-related causes of death contributed to ridley mortality in the estuary.

Based on other necropsy information available from the Marine Mammal Stranding Center, boat-related injuries appear to be common occurrences in both stranded loggerheads and ridleys in Delaware Bay and coastal New Jersey (MMSC 1988). This is consistent with NMFS findings which show boat-related injuries as a common carcass anomaly (NMFS 1988).

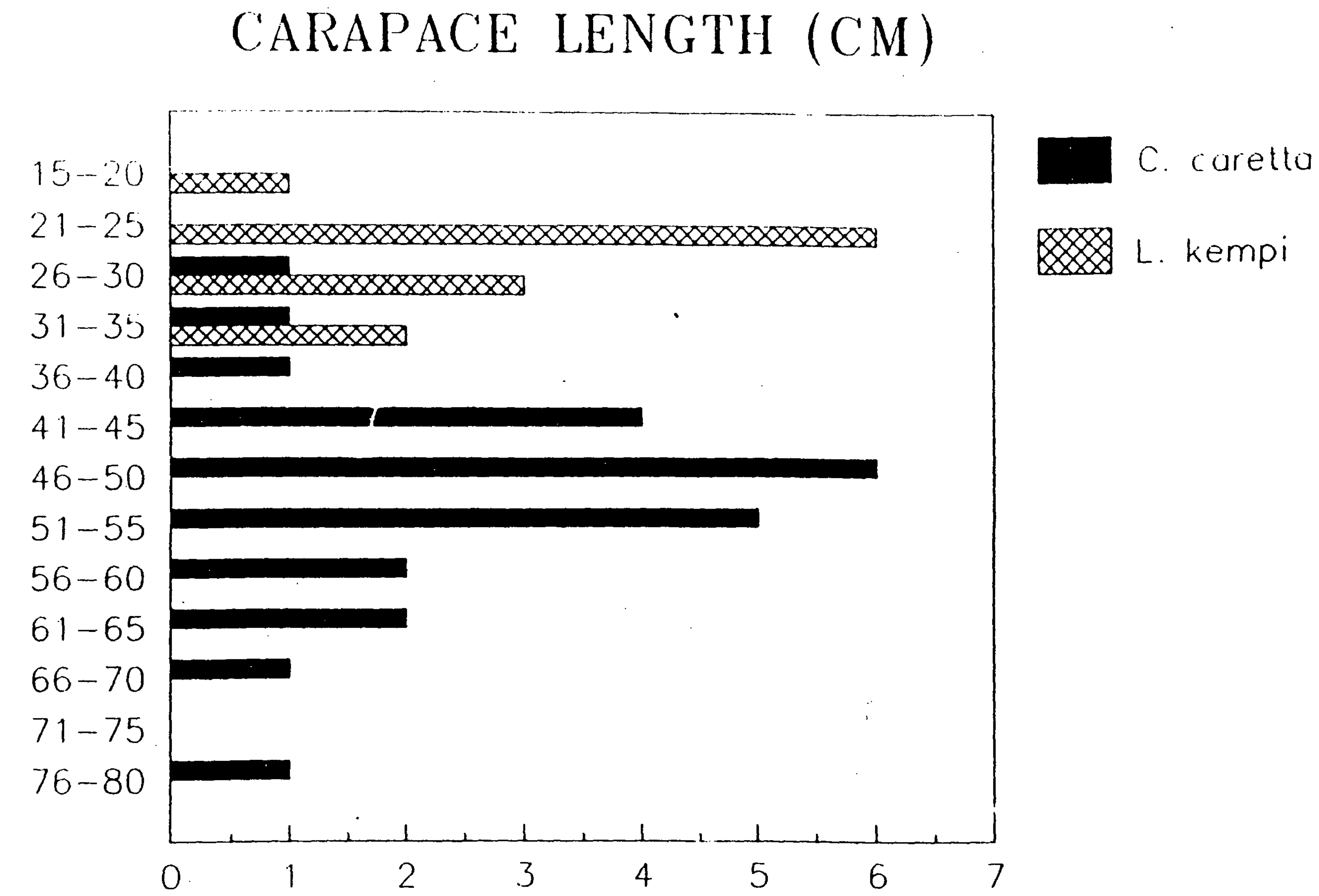


Figure 6-1. Frequency Distribution of Carapace Lengths for Loggerhead and Kemp's Ridley Sea Turtles Captured From Circulating Water System Intake at Salem Generating Station

TABLE 6-1

SEA TURTLES CAPTURED AT OR NEAR THE SALEM GENERATING STATION

Year	Loggerhead	Ridley	Green	Totals
1977	0	0	0	0
1978	0	0	0	0
1979	1	0	0	1
1980	2	1	1	4
1981	4	1	0	5
1982	1	0	0	1
1983	2	1	0	3
1984	2	1	0	3
1985	6	2	0	8
1986	0	1	0	1
1987	5	3	0	8
1988	8	2	0	10
Totals	31	12	1	44

TABLE 6-2

TOTAL NUMBER OF SEA TURTLES CAPTURED FROM CIRCULATING WATER INTAKE TRASH BARS AT SALEM GENERATING STATION

Year	Loggerhead	Ridley	Green	Totals
1977	0	0	0	0
1978	0	0	0	0
1979	0	0	0	0
1980	1	1	0	2
1981	3	1	0	4
1982	1	0	0	1
1983	2	1	0	3
1984	2	1	0	3
1985	6	2	0	8
1986	0	1	0	1
1987	3	3	0	6
1988	8	2	0	10
Totals	26	12	0	38

TABLE 6-3

SEASONAL OCCURRENCE OF SEA TURTLES AT SALEM GENERATING STATION CIRCULATION WATER INTAKE

Months	Loggerhead	Ridley	Totals
January	0	0	0
February	0	0	0
March	0	0	0
April	0	0	0
May	0	0	0
June	1	2	3
July	18	4	22
August	3	2	5
September	5	4	9
October	0	0	0
November	0	0	0
December	0	0	0
Totals	26	12	28

TABLE 6-4

MORTALITY OF SEA TURTLES CAPTURED FROM CIRCULATING WATER INTAKE TRASH BARS AT SALEM GENERATING STATION (LIVE/DEAD)

Year	Loggerhead	Ridley	Totals
1980	0/1	1/0	1/1
1981	1/2	0/1	1/3
1982	0/1	0/0	0/1
1983	0/2	0/1	0/3
1984	0/2	1/0	1/2
1985	2/4	1/1	3/5
1986	-	0/1	0/1
1987	3/0	2/1	5/1
1988	2/6	1/1	3/7
Totals	8/18	6/6	14/24

SECTION 7.0
ASSESSMENT OF PRESENT OPERATIONS

The primary concern with sea turtles at Salem Generating Station is whether or not the losses of these endangered or threatened sea turtle species "jeopardizes their continued existence." Federal regulation (50 CFR 402) defines "jeopardizes the continued existence" as "engaging in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing the reproduction, numbers, or distribution of that species." Therefore, the question relative to Salem Generating Station is: Do the activities associated with the operation of Salem Generating Station "appreciably reduce" the reproduction, numbers or distribution of either the loggerhead or Kemp's ridley sea turtles?

7.1 IMPACTS OF CONTINUED OPERATION OF SALEM GENERATING STATION ON SEA TURTLE POPULATIONS

7.1.1 IMPACTS DUE TO INCIDENTAL CAPTURE (IMPINGEMENT) OF TURTLES ON CWS INTAKE TRASH RACKS

Thirty-eight sea turtles have been retrieved from the circulating water intake at Salem Generating Station since 1980. Fourteen of these turtles were alive and returned to the Atlantic Ocean by MMSC near Brigantine, New Jersey. Twenty-four of the turtles removed from the intake were dead. Of these, twelve were either severely or moderately decomposed indicating that their death occurred prior to encountering the intake. The intake routinely removes river debris during its normal operation and dead and injured turtles wash ashore, buoyed by the gases of decomposition and would be expected to be part of the debris load in the river removed by the station. Therefore, it could be argued that only ten dead turtles were removed from the intake since 1980 whose cause of death was uncertain and may have been contributed to by the plant.

Based on these levels of incidental capture at the intake, it is estimated that zero to nine loggerheads (mean = 3) and zero to three Kemp's ridleys (mean = 1) would be expected to be taken from the intake during any given year (95 percent confidence limits). If we discount those animals which were moderately and severely decomposed from this calculation, zero to eight loggerheads (mean = 2) and zero to three Kemp's ridleys (mean = 1) with no evidence of previous damage would be expected to be taken from the intake during a given year.

7.1.1.1 ASSESSMENT OF IMPACT ON LOGGERHEAD SEA TURTLE POPULATIONS

At Salem Generating Station, the annual number of loggerheads incidentally captured between 1980 and 1988 has ranged from zero to nine turtles with a calculated annual average of three. Eight of the total of twenty-six loggerheads captured were alive and released back into the wild. Among the eighteen dead animals, eight appeared to be fresh dead and all the others were either moderately or severely decomposed suggesting death prior to involvement with the station. Carapace anomalies suggest damage from boat propellers contributed to the deaths of several animals and internal problems (i.e. peritinitous) in others. Therefore, if live and long dead animals are removed from the annual estimate, the annual average loss of loggerheads is two animals per year with which the station may have had some involvement.

Adult and subadult loggerhead sea turtle populations have been recently estimated to be approximately 387,000 in the southeast United States (see Section 5.0). The estimated number of mature females in this same area has been estimated to range between 35,000 and 72,000 turtles.

In order to determine if Salem Generating Station "appreciably reduces" the reproduction, numbers or distribution of loggerheads, it is necessary to compare on-site information with breeding information, population estimates, and distribution information for this species.

Loggerhead nesting in the United States primarily occurs along coastal beaches in Florida, Georgia, South Carolina and North Carolina. Only one report of nesting was reported from New Jersey in 1980. Additionally, diamondback terrapin nesting surveys have been conducted at select beaches in the vicinity of Salem Generating Station since 1978 and no evidence of sea turtle nesting has been observed during these studies. Also, all loggerheads incidentally captured from the CWS intake were juveniles or subadults.

Therefore, based on the immaturity of the specimens captured and the fact that loggerhead nesting does not typically occur in New Jersey the only loss to loggerhead reproduction would be from production forgone due to the loss of juvenile/subadult animals on the intake which could potentially be recruited into the breeding female population at some time in the future.

The observed worst case incidental catch level for loggerheads at Salem Generating Station would be nine turtles during any given year. If we compare this with the estimated population size of 387,000 animals, this mortality would represent 0.0002 percent loss in the population in the southeast U.S. It should be kept in mind that the population estimate on which this percentage is based does not include juveniles or subadults in the region or populations from areas other than the U.S. This means that the population is estimated and the percent loss from Salem Generating Station would even be less. It is unlikely that mortality at this level would "appreciably reduce" the distribution or numbers of loggerhead sea turtles along the Atlantic Coast of the United States.

7.1.1.2 ASSESSMENT OF IMPACT ON KEMP'S RIDLEY SEA TURTLE POPULATIONS

At Salem Generating Station, the annual number of Kemp's ridleys incidentally captured between 1980 and 1988 has ranged from zero to three turtles with a calculated annual average of one. Six of the total of twelve ridleys captured were alive and five were successfully released back into the wild. Among the six dead animals, three appeared to be fresh dead and all the others were either moderately or severely decomposed and two had probable boat propeller cuts suggesting death prior to involvement with the station. If live and long dead animals are removed from the annual estimate, the annual average loss of Kemp's ridleys is less than one animal per year with which the station may have had some involvement.

In order to determine if Salem Generating Station "appreciably reduces" the reproduction, numbers or distribution of ridley sea turtles, it is necessary to compare on-site information with breeding information, population estimates, and distribution information for this species. The adult Kemp's ridley sea turtle population has recently been estimated to be approximately 2,200 turtles based on breeding females observed in Mexico (see Section 5.0). Since this breeding colony is the only known colony in the world, this estimate represents the worldwide population for Kemp's ridleys.

Kemp's ridley nesting appears to occur only in Mexico. All specimens captured were juveniles or subadults. Therefore, based on the immaturity of the specimens captured and the fact that ridley nesting does not occur in New Jersey, the only loss to ridley reproduction would be from production forgone due to the mortality of juvenile/subadult animals on the intake which could potentially be recruited into the breeding female population at some time in the future.

If we assume a worst case incidental catch at Salem Generating Station of one to two turtles during any given year and compare it with the estimated population size of 2,200, they would represent 0.05 to 0.09 percent of the population. This population estimate does not include juveniles and subadults and likely underestimates the actual population size. It is unlikely that losses at this level would "appreciably reduce" the distribution or numbers of Kemp's ridley sea turtles along the Atlantic Coast of the United States.

7.2 OTHER POTENTIAL STATION IMPACTS ON SEA TURTLES

7.2.1 ACUTE THERMAL EFFECTS

The discharge from the Salem Generating Station is located 500 feet (152 meters) offshore on the bottom. The discharge velocity of approximately 10 feet per second (330 centimeter per second) is high enough to promote rapid mixing with ambient water. As discussed in Section 4.0, the temperature rise of the discharge will be approximately 18°F (9.2°C) over ambient river temperatures. Because of the high discharge velocity, a sea turtle could not remain in the heated portion of the plume for any length of time. Furthermore, turtles in the area would be able to avoid entrainment in the plume by swimming. Therefore, it is concluded that no adverse acute thermally-related impacts will be sustained by either sea turtle species.

No acute thermally related losses to sea turtles would be anticipated due to the operation of the Hope Creek Station. Hope Creek Station has a low volume discharge that is approximately 2.5 percent of the Salem Station flow. Furthermore, the discharge has a lower temperature rise, 11°F (6.2°C) in winter and 7°F (3.7°C) in the summer, than Salem Station and is rapidly assimilated by the Delaware River.

7.2.2 CHRONIC THERMAL EFFECTS

No impact from the thermal discharge from Salem and Hope Creek Generating Stations is anticipated on the reproduction, migratory behavior, interspecific relationships, and the incidence of disease in sea turtles inhabiting the Delaware River in the vicinity of Artificial Island.

The high tidal flushing of the river and the design and placement of the discharge eliminates the possibility of thermal blockage to the river. Because reproduction occurs in the southeastern United States in the case of the loggerhead and Mexico in the case of the Kemp's ridley, no reproductive impacts are expected. No thermal blockage of the river is anticipated, therefore, no impact on migratory behavior would occur. The areal extent of thermal plume from the Salem Station depends on tidal stage but has been estimated to be 19,800 feet long and 1,485 feet wide during flood tide conditions (1°C isotherm). Due to the low discharge flow rates from Hope Creek, the estimated extent of the 2.2°C isotherm is 2,230. In either case, both turtle species move freely about in the water column spending a large portion of their time foraging on the bottom. Based on the shallow nature of these plumes and relatively small area affected, it is concluded that no significant impacts would occur to sea turtles in the area due to chronic elevation of temperatures from the operation of the Salem and Hope Creek Stations. Therefore, no impact to sea turtle species within the Delaware River due to chronic thermal loading from the stations is anticipated.

7.2.3 BIOCIDES

Low level, continuous chlorination is used to control biofouling in the Salem Station service water system and Hope Creek Station service water and circulating water systems.

At Salem, NJPDES permit conditions restrict chlorine discharge levels may not exceed a monthly average of 0.3 mg/l or a daily maximum of 0.5 mg/l. Only the service water system is chlorinated at Salem and after service water passes through its heat exchangers it is mixed with the main condenser cooling water. The chlorine demand in this discharge consumes any remaining free chlorine and results in essentially no chlorine being discharged to the river.

At Hope Creek, NJPDES permit conditions also restrict chlorine discharge to no more than 2 hours per day and levels may not exceed a monthly average of 0.3 mg/l or a daily maximum of 0.5 mg/l. The dechlorination system at Hope Creek further reduces free chlorine levels to near zero levels before discharged via the blowdown line to the river.

It is concluded after reviewing operation of the chlorination systems that the total residual chlorine levels released to the Delaware River from Salem and Hope Creek will not be detrimental to sea turtles that may inhabit the discharge area. Furthermore, the high discharge flow rates and high tidal flow in the vicinity of the stations will prevent any organism from remaining in the plume for any considerable length of time.

7.2.4 COLD SHOCK

Both stations have a high velocity discharge. The discharge promotes rapid mixing of the effluent stream and prevent sea turtles from remaining in the discharge plume for time periods long enough to acclimate to high temperatures. Additionally, sea turtles only occur near the stations during the early spring and summer when cold shock is not a concern. Therefore, cold shock of sea turtles is not anticipated and mortality is not expected.

7.3 MITIGATING MEASURES

7.3.1 ADMINISTRATIVE CONTROLS

As required by Section 4.1.1 of the Salem, Unit No. 2, Environmental Technical Specifications (ETS) and by Section 4.1 of the Hope Creek Environmental Protection Plan, PSE&G must report the mortality or unusual occurrence of any species protected by the Endangered Species Act.

7.3.1.1 INCLUSION IN EVENT CLASSIFICATION GUIDES

Because several species of endangered or threatened sea turtles and fish (Shortnose sturgeon) occur in the vicinity of the generating stations, this notification requirement has been incorporated in the Event Classification Guide (ECG) for both the Salem and Hope Creek Generating Stations. These reference documents are in the control rooms of each generating station and are used by the Senior Shift Supervisors responsible for the safe operation of each plant to determine what events require reporting. The ECG also refers the Senior Shift Supervisor to specific attachments which clearly define the administrative procedures for specific events. Endangered and threatened species are specifically identified in each Event Classification Guide and make reference to administrative attachments (Salem, Attachment 33 and Hope Creek, Attachment 17) for reporting such events.

7.3.1.2 TURTLE HANDLING AND REPORTING

The trash rake procedure discussed in Subsection 7.2 is typically the way larger sea turtles are removed from the trash racks at the circulating water system intake at Salem Generating Station. Smaller turtles may be removed by a long handled dip net.

When a turtle is observed on the intake, the operator's first action is to attempt bringing the animal to the operating level of the intake using the trash rake. Once the turtle has been removed from the trash bar rakes, the operator notifies the Senior Shift Supervisor who in turn follows the administrative procedure referred to in the ECG.

One of the first contacts on this administrative procedure is the representative from Licensing and Regulation (L&R). The L&R representative will verify the identification of the turtle as being an endangered or threatened species and attempt resuscitation if necessary. If the turtle is alive, it will be transported to one of the fish pool buildings at either end of the intake and kept out of the direct sun. Once the turtle has been taken care of, the L&R representative will notify the Senior Shift Supervisor to continue the notifications outlined in his administrative procedure. The L&R representative will notify the local affiliate of the Sea Turtle Salvage and Stranding Network (Marine Mammal Stranding Center) to arrange for the removal of the turtle from the site and will also contact NMFS and NJDEP and advise them of the occurrence.

As the Senior Shift Supervisor makes his contacts, he completes a "Four-Hour Notification Report," on which he signs and dates the completion of his designated contacts. He then forwards the partially completed report to the Licensing and Regulation representative who signs and dates his contacts and then forwards the report to Emergency Planning for retention.

A separate report is also prepared by the L&R representative within 30 days of the event and submitted to the U.S. Nuclear Regulatory Commission in accordance with 4-Hour Notification reporting procedures. Copies of this report are also sent to NMFS and NJDEP.

7.3.1.3 ANNUAL NOTIFICATION

Over the last three years, it has also become standard procedure in the early summer for the Nuclear Department, Licensing and Regulation group to remind both Station Operations and Site Services, who clean the trash bars during the day, that they should be on the outlook for sea turtles. A memorandum is distributed to Station Operations which contains drawings of the threatened and endangered sea turtles and fish which can occur in the vicinity of the generating stations (Appendix B). It also provides the names and phone numbers of L&R personnel responsible for the handling of such specimens. Office, home and pager telephone numbers are provided for at least two L&R personnel.

Large color posters obtained from the NMFS depicting sea turtles have also been obtained and posted in the circulating water intake operators office.

7.3.2 OPERATIONS

7.3.2.1 TRASH BAR CLEANING PROCEDURES

The basic cleaning procedure consists of Security opening several access grates; positioning the cleaning equipment over the opened grates; and, then systematically raising and lowering the trash rake on the face of the trash rack to remove accumulated debris.

The traversing drive machinery operates through a worm-gear reducer to propel the rake unit along the face of the trash rack at a traversing speed of 30 feet per minute. Individual "dead-man" pushbutton controls enables the raking unit to randomly serve any intake cell, regardless of location, and not be subject to any sequential order. To position the trash rake, either the "forward" or the "reverse" pushbutton must be depressed and held until the desired intake cell position is reached. To manipulate the rake device the control panel features pushbuttons labeled for "open teeth", "lower rake," "close teeth," and "raise rake." To raise the trash rake, the operator must depress and hold the "raise" button in. When the rake reaches its upper limit, an automatic switch will stop the upward travel of the rake. The same procedure is required to lower the rake and again an automatic switch will stop the downward movement of the rake.

The carriage rake is designed to descend with the teeth in the open position, close or turn inward toward the bar rack at the lower limit of travel, collect accumulated debris while ascending along the inclined bars, and deposit the debris into the self-contained trash hopper at the end of its vertical travel. Ultimately the debris is emptied into large trash baskets located at either end of the intake structure which are periodically removed by a large portable crane. The crane removes these trash baskets at least once every other week depending on debris load.

The motion of the rake can be reversed at any elevation such that it is not mandatory to descend the full intake depth each time prior to performing cleaning operations. This flexibility is beneficial during heavy debris loading periods or when a sea turtle is on the trash bar racks.

Sea turtles are spotted either on the water surface when the grates are opened or when the tines of the trash rake exits the water with the debris. Sea turtles are removed from the rake just prior to the point that the debris is dumped into the hopper.

The trash racks are routinely cleaned once per day by labor provided by Nuclear Site Services. On the back shifts, trash rack cleaning, when necessary, is provided by Station Operations. Additional trash rack cleaning is performed when the debris level on the racks warrants it.

The cleaning of the entire face of the Salem circulating water intake and all its component trash racks may take several hours or an entire shift (8 hours) when debris levels are high.

7.3.2.2 OPERATIONAL AND STRUCTURAL MODIFICATIONS

The original design of the intake structure had a curtain wall in front of the traveling screens to skim floating material from the surface of the incoming water. It extended to the low low-water level (elevation 81.0 ft PSD).

The bottom of the curtain wall was removed in 1976 and 1977 due to concerns that their presence increased the approach velocities. Subsequent to the wall modification it was found that heavy ice formation occurred on the traveling screens since they were now exposed to the outside air temperature.

The use of removable wave walls allows the interior of the building and the equipment to be heated, preventing icing. The removable wave walls are only necessary during the winter.

In addition to the wave walls, the ice barriers which prevent river ice from damaging the intake equipment can be removed in the spring. This enhances the escape potential of any turtle that might approach the intake.

Bathymetric surveys in the vicinity of the CWS intake have shown that sediment accumulation above the base of the structure at elevation 50 ft PSD is a recurring and continuous process.

The net result of the sedimentation in the intake approach channel was to decrease the effective cross-sectional area through which cooling water was drawn. This adversely affected the approach velocity distribution. The Company has removed the sediment ridge that existed directly in front of the intake. A bathymetric survey program is being maintained to monitor the accretion of sediments in the vicinity of the intake and dredging of the area will occur when a large accumulation is observed.

7.4 DISCUSSION OF GENERAL IMPACTS ON SEA TURTLE POPULATIONS

Five factors have been listed as factors contributing to the decline in sea turtle populations (43 FR 146:32800-32811);

1. Destruction or modification of habitat;
2. Overutilization for commercial, scientific or educational purposes;
3. Inadequate regulatory mechanisms;
4. Disease and/or predation; and,
5. Other natural or man-made sources.

The destruction and/or modification of habitat from coastal development and losses due to incidental capture during commercial fishing are likely the two major factors impacting sea turtle populations along the Atlantic Coast of the United States. The continued development of beachfront and estuarine shoreline areas are likely to be impacting foraging grounds for several sea turtle species. Incidental capture (take) is defined as the capture of species other than those towards which a particular fishery is directed. As implied by this definition, the commercial fishing industry has been implicated in many of the carcass strandings on southeast U.S. beaches. The annual catch of sea turtles by shrimp trawlers in the southeast has been estimated to 45,000 turtles, primarily loggerheads. The average mortality rate was estimated to be about 27 percent or over 12,000 turtle deaths per year.

However, not all beach carcasses are the result of drowning in fish nets. Other human-related causes of mortality include damage from boating, plastic ingestion, etc. More research needs to be conducted to determine the precise cause of death of these animals. The unintentional capture of species during non-fishery related industrial process may also be considered to be incidental capture. In New Jersey and New York, boat damage is a commonly observed injury in stranded turtles.

The loggerhead is the most numerous turtle in U.S. coastal waters and therefore would be encountered most frequently by fishermen and recreational boaters.

East coast stranding data for 1987 reported approximately 2,500 animals for the Atlantic east coast. The greatest number of these strandings were observed along the southeastern Atlantic coast (i.e. Florida). Even though any loss of an endangered or threatened species is important, the magnitude of the losses of loggerhead and Kemp's ridley sea turtles from Salem Generating Station would not be expected to significantly impact the U.S. Atlantic coast populations of these sea turtle species.

SECTION 8.0
REFERENCES

SECTION 2.0

50 CFR 17.11; Endangered and Threatened Wildlife

50 CFR 222.23(a); Endangered Fish or Wildlife Permits, (Under National Marine Fisheries Service jurisdiction)

50 CFR 227.4(b); Threatened Fish and Wildlife, Enumeration of Threatened Species

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APPENDIX A

DETAILED LISTING OF SEA TURTLES CAPTURED AT AND IN THE VICINITY OF SALEM GENERATING STATION

TABLE A-1
HISTORICAL SUMMARY OF KEMP'S RIDLEY SEA TURTLES CAPTURED AT OR
DURING FIELD SAMPLING ACTIVITIES ASSOCIATED WITH SALEM GENERATING STATION

DATE	LOCATION	STATUS	WEIGHT* (kilograms)	CARAPACE LENGTH** (centimeters)	CARAPACE WIDTH** (centimeters)	WATER TEMPERATURE (°C)	SALINITY (ppt)	COMMENTS+
11-Aug-80	CWS trash racks	Live		29	28	30	7	
23-Sep-81	CWS trash racks	Dead	6	33	29	21		Moderate decomposition-carapace cut-probable boat hit
13-Jul-83	CWS trash racks	Dead	2	23	21			Female - lungs collapsed
29-Aug-84	CWS trash racks	Live		32	20			
11-Jun-85	CWS trash racks	Live		25	24	26	6-10	Tagged (NNK-051) and released
24-Jun-85	CWS trash racks	Dead	2	27	26	23	6-10	Female - lungs collapsed
5-Jul-86	CWS trash racks	Dead	1	19	17	25	4-7	Advanced decomposition (1 week+)
24-Sep-87	CWS trash racks	Live	1	21	19	22	1-6	Died at MMSC
24-Sep-87	CWS trash racks	Dead	2	25	22	22	1-6	
29-Sep-87	CWS trash racks	Live	2	23	22	22	4-6	Transported to Florida and released
5-Jul-88	CWS trash racks	Live	2	29	23	24	6-12	Tagged (NNK-062) and released
27-Jul-88	CWS trash racks	Dead	1	25	23	28	3-5	Female - Moderate decomposition-probable boat hit (post mortem)
Summary		6 Live 6 Dead	$\bar{x}$=2	$\bar{x}$=25.9	$\bar{x}$=22.8	21-30	1-12	

* Estimated
* Straight length and width
+ Autopsies and sex determination
done by R. Schoelkopf, Marine Mammal Stranding Center
Brigatine, NJ

TABLE A-2

HISTORICAL SUMMARY OF LOGGERHEAD SEA TURTLES CAPTURED AT OR DURING FIELD SAMPLING ACTIVITIES ASSOCIATED WITH SALEM GENERATING STATION

DATE	LOCATION	STATUS	WEIGHT* (kilograms)	CARAPACE LENGTH** (centimeters)	CARAPACE WIDTH** (centimeters)	WATER TEMPERATURE (°C)	SALINITY (ppt)	COMMENTS+
23-Aug-79	River Mile 15	Live		123				Captured in otter trawl-released unharmed
11-Jul-80	CWS trash racks	Dead						Carapace cut-probable boat hit
2-Sep-80	Egg Island Point, NJ	Live		62	54			Captured in otter trawl-released unharmed
30-Jun-81	Ray's Ditch, DE	Dead	16	51	38			Floating offshore
3-Sep-81	CWS trash racks	Live		47	42	25		
8-Sep-81	CWS trash racks	Dead	40	58	52	24		Female - perforated intestine-prev. frozen
14-Sep-81	CWS trash racks	Dead	32	54		25		Female - moderate decomposition-collapsed lung
10-Jul-82	CWS trash racks	Dead	4	29	28			Female - advanced decomposition
11-Jul-83	CWS trash racks	Dead	14	48	42			Female - moderate decomposition
19-Jul-83	CWS trash racks	Dead	22	54	34			Female - advanced decomposition
2-Jul-84	CWS discharge	Dead	42					Advanced decomposition
3-Jul-84	CWS trash racks	Dead		81		25	4-6	Female - moderate decomposition-probable boat hit (cuts on carapace)
8-Jun-85	CWS trash racks	Dead	7	46	36	24	6-10	Female - 8 inch cut on carapace-probable boat
15-Jul-85	CWS trash racks	Dead	16	53	43	23	10	Female - collapsed lungs

TABLE A-2

HISTORICAL SUMMARY OF LOGGERHEAD SEA TURTLES CAPTURED AT OR DURING FIELD SAMPLING ACTIVITIES ASSOCIATED WITH SALEM GENERATING STATION

DATE	LOCATION	STATUS	WEIGHT* (kilograms)	CARAPACE LENGTH** (centimeters)	CARAPACE WIDTH** (centimeters)	WATER TEMPERATURE (°C)	SALINITY (ppt)	COMMENTS+
5-Aug-85	CWS trash racks	Dead	27	59	50	25	6-10	Female - collapsed lungs
7-Aug-85	CWS trash racks	Dead	29	50	40	25	8-10	Female - perforated intestine-peritonitus-horseshoe crab in gut
10-Aug-85	CWS trash racks	Live	15	53	43	26	6	Released by MMSC
30-Sep-85	CWS trash racks	Live	20	52	43	22	11-15	Released by MMSC
15-Jun-87		Live		70	61	24	5-8	Captured in otter trawl-released unharmed
14-Jul-87	CWS trash racks	Live	14	41	38	27	4-8	Released by MMSC
16-Jul-87		Live	11	41	36	26	4-6	Released by MMSC
20-Jul-87		Live	36	69	54	27	6	Released by MMSC
14-Oct-87		Dead		44	40	16	5-8	Advanced decomposition
5-Jul-88	CWS trash racks	Live	35	61	43	24	6-12	Tagged (NNK-063) and released by MMSC
-Jul-88	CWS trash racks	Live	16	35	32	26	6-10	Tagged (NNK-064 and NNK-066) and released by MMSC
2-Jul-88	CWS trash racks	Dead	14	43	38	25	6-8	Female - massive internal hemorraging-numerous fractures of carapace
2-Jul-88	CWS trash racks	Dead	14	43	39	25	6-8	Female - abcecess lower right lung and intestine-partial impaction by crab
2-Jul-88	CWS trash racks	Dead	7	37	32	25	6-8	Female - fresh dead-lungs collapsed-blue crab in gut

TABLE A-2

HISTORICAL SUMMARY OF LOGGERHEAD SEA TURTLES CAPTURED AT OR DURING FIELD SAMPLING ACTIVITIES ASSOCIATED WITH SALEM GENERATING STATION

DATE	LOCATION	STATUS	WEIGHT* (kilograms)	CARAPACE LENGTH** (centimeters)	CARAPACE WIDTH** (centimeters)	WATER TEMPERATURE (°C)	SALINITY (ppt)	COMMENTS+
12-Jul-88	CWS trash racks	Dead	16	48	39	25	6-8	Female - fresh dead-lungs collapsed-blue crab in gut
15-Jul-88	CWS trash racks	Dead	36	61	46	25	7-10	Female - long dead-blue crab in gut
15-Jul-88	CWS trash racks	Dead	20	49	41	25	7-10	Male - fresh dead-lungs collapsed-blockage in gut (clay balls)
SUMMARY		11 Live 20 Dead	$\bar{x}$=21 kg range 4-42	$\bar{x}$=53.9 range 29-123	$\bar{x}$=41.7 range 16-46	16-26	4-15	

* Estimated

** Straight length and width

\+ Autopsies and sex determination done by R. Schoelkopf, Marine Mammal Stranding Center, Brigatine, NJ

APPENDIX B

PSE&G MEMORANDUM PREPARED FOR SALEM AND HOPE CREEK OPERATIONS PERTAINING TO SEA TURTLE HANDLING/REPORTING PROCEDURES

PSEG

Public Service Electric and Gas Company P O Box 236 Hancocks Bridge, New Jersey 08038

Nuclear Department

JUN 0 8 1989
NLR-I89226

To the General Manager - Salem Operations
- Hope Creek Operations

ENDANGERED SPECIES REPORTING
SEA TURTLES/STURGEON IMPINGEMENT

As required by Section 4.1.1 of the Salem, Unit No. 2, Environmental Technical Specification (ETS) and by Section 4.1 of the Hope Creek Environmental Protection Plan, PSE&G must report the mortality or unusual occurrence of any species protected by the Endangered Species Act of 1973 to the NRC within 4 hours. Also, under the Endangered Species Act, inappropriate handling of endangered or threatened species can result in legal action.

Because several species of endangered and threatened sea turtles (Figure 1) and fish (Figure 2) have in the past been impinged on the Salem CWS trash bars during the summer months and because similar problems could occur at the Salem and Hope Creek SWS intakes, Licensing and Regulation requests that all Operations personnel be reminded of the importance of proper handling of impinged sea turtles and sturgeon. In addition, we request that the following procedures be implemented:

1. Circulating water system trash bars should be inspected a minimum of once per shift and cleaned a minimum of once per day from June through September, regardless of debris load. This will increase the probability of recovering live sea turtles. A high-powered spotlight will be needed on backshifts in order to inspect the trash bars properly.

2. Service water system trash bars only need to be inspected on a daily basis and only cleaned as needed.

3. Sea turtles observed on the trash bars must be recovered immediately. Upon recovery, Licensing and Regulation must be notified by calling either Tom Warren (Salem extension 5015/home number 678-7808), Ken Strait (Salem extension 5074/home number 451-4027),

or John Balletto (Salem extension 4748/home number 581-3643) of my staff. Diamondback Terrapin (Figure 3) can be returned directly to the river. The diamondback terrapin is distinguished from the other species of sea turtles by the presence of claws on both the forelimbs and hindlimbs (sea turtles have flippers).

4. Recovered turtles that are alive should be kept cool and wet until positive identification can be made by Licensing. Upon recovery, elevation of the hindquarters of turtles will help promote resuscitation. Licensing and Regulation should also be notified of sturgeon occurrence. Live sturgeon should be kept immersed in Delaware River water for release by Licensing personnel. Dead turtles and sturgeon should be placed in a plastic bag with ice to prevent decomposition and retard odor.

5. Environmental Consulting Services, Inc. (Impingement Crew) can be contacted (when on site) at extension 3135 for assistance with turtles or sturgeon.

Please contact Tom Warren or Ken Strait if you have any questions concerning this matter.

BA Preston

B. A. Preston
Manager -
Licensing and Regulation

TAW/spk
Attachments

C Manager - Site Services
C. L. Adams
J. H. Balletto
K. A. Strait
T. A. Warren
Environmental Consulting Services, Inc. (S. J. Beck)
File 4.7.1 SGS

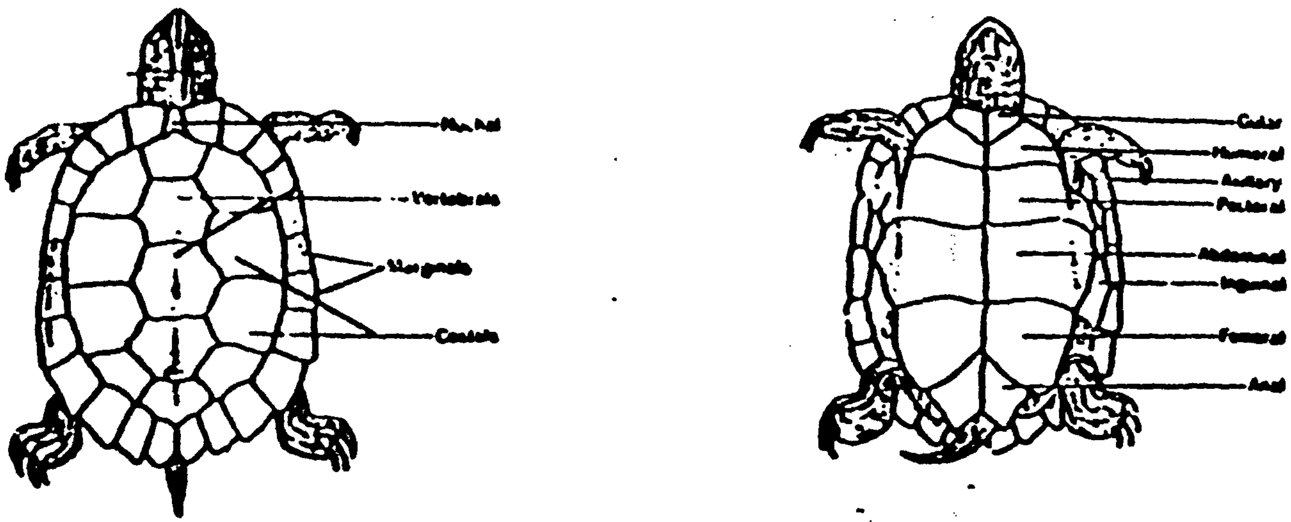


Figure 3. Commonly encountered Diamondback terrapin (not threatened or endangered - return to river).

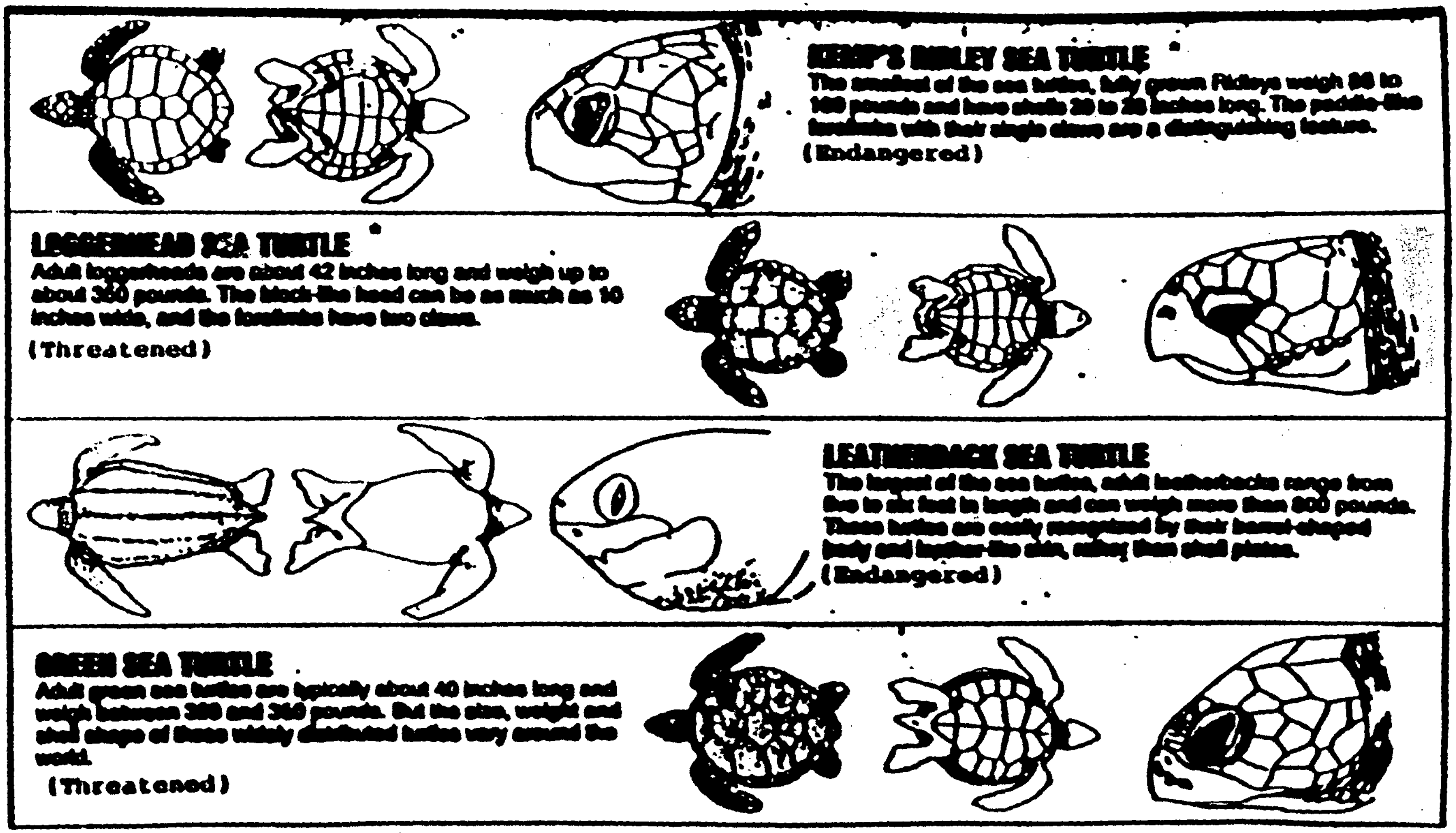
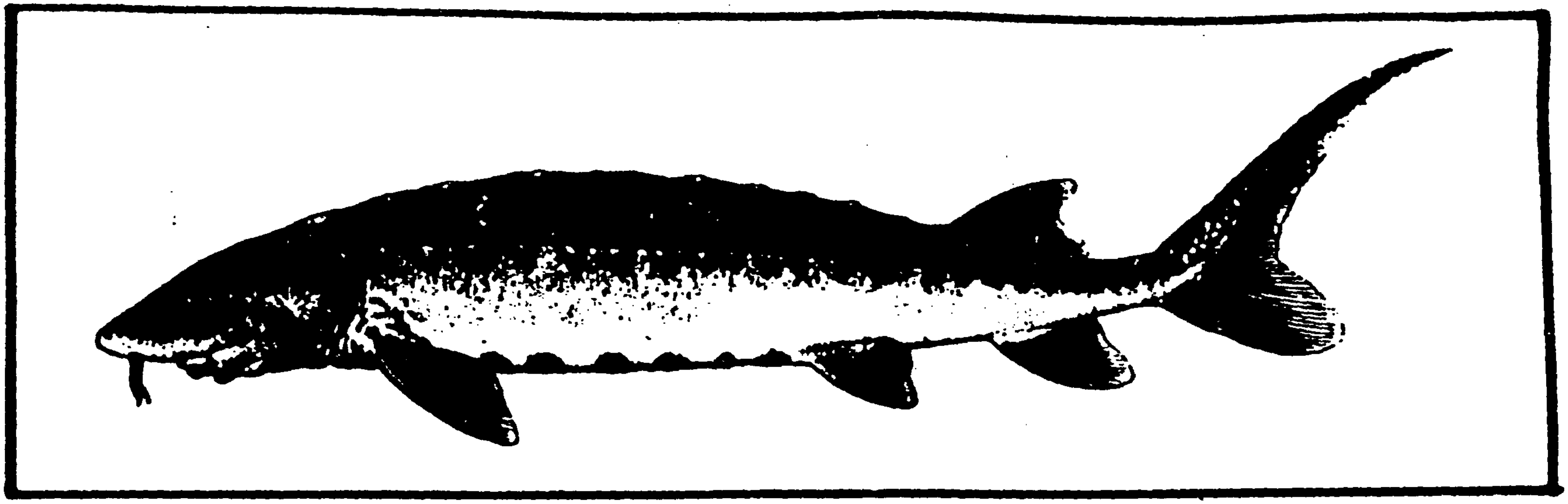
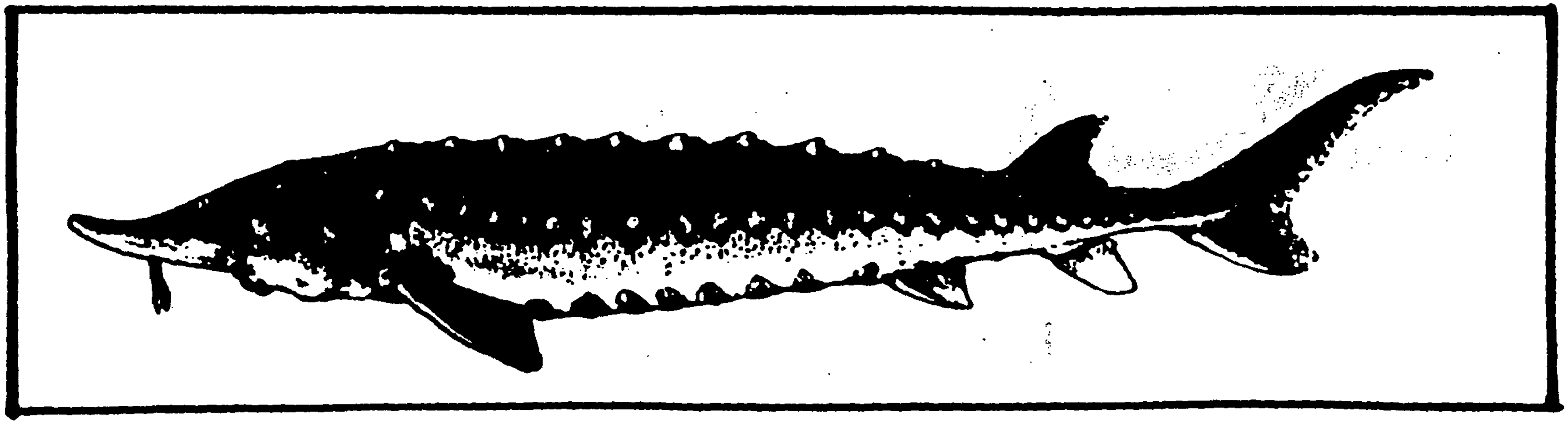


Figure 1. Threatened and Endangered Sea Turtle Species
collected from Salem Generating Station Circulating Water Intake (*).



Shortnose Sturgeon (Endangered)



Atlantic Sturgeon

Figure 2. Sturgeon collected from Salem Generating Station Circulating Water Intake.

SECTION 6.0
ONSITE INFORMATION

6.1 OCCURRENCE OF SEA TURTLES AT SALEM GENERATING STATION

Sea turtles have been observed at Salem Generating Station and during field sampling associated with the station since 1977. A total of 44 sea turtles have been reported since 1979 (Table 6-1 and Appendix A, Tables A-1 and A-2). The majority of these turtles (38) have been collected from the Salem Generating Station circulating water intake (38 turtles). The remaining six turtles were collected during station related environmental sampling (trawling) or were stranded on other areas of Artificial Island. No strandings have been reported from either the Salem or the Hope Creek service water intakes.

6.1.1 ANNUAL COMPARISON

Table 6-2 summarizes the total number of turtles of each type reported to occur on the Salem circulating water intake. Direct annual comparisons of these data are complicated by the variations in effort between and/or within years. During any particular year the number of sea turtles collected at the intake ranged from zero prior to 1980 to ten in 1988. The actual number of loggerheads incidentally captured on the intake ranged between zero and eight animals annually. The actual number of Kemp's ridleys incidentally captured on the intake ranged between zero and three animals annually.

Based on the levels of incidental capture observed at the intake, it is estimated that zero to nine loggerheads (mean = 3) and zero to three Kemp's ridleys (mean = 1) could be expected to be taken from the intake during any given year (95 percent confidence limits). However, a portion of the turtles captured died of causes unrelated to the station and were just part of the river debris drawn into the station. Also a portion of the turtles captured were alive and released back into the wild. If we exclude animals which were moderately and severely decomposed from this calculation, zero to eight loggerheads (mean = 2) and zero to three Kemp's ridleys (mean < 1) with no evidence of previous damage would be expected to be taken from the intake during a given year.

6.1.2 SPECIES COMPOSITION

Twenty-six loggerhead sea turtles (<u>Caretta caretta</u>) and twelve Kemp's ridleys (<u>Lepidochelys kempi</u>) were captured from the circulating water intake from 1980 to 1988 (Table 6-2).

The loggerheads were all juveniles or subadults. Carapace lengths (straight length) ranged from 29 to 33 centimeters with a mean of 53.9 centimeters (Figure 6-1).

The ridleys were also all juveniles or subadults. There carapace lengths (straight length) ranged from 19 to 33 centimeters with a mean of 25.9 centimeters (Figure 6-1).

6.1.3 MONTHLY DISTRIBUTION OF OCCURRENCES

Table 6-3 summarizes the months during which sea turtles were captured at the Salem circulating water intake from 1980 to 1988. Approximately, 58 percent of all strandings were reported during July, 21 percent in September, 13 percent in August, and 8 percent in June. No turtles were collected during the winter months.

Based on aerial surveys of pelagic turtles (Shoop et al. 1981), sea turtles and loggerheads in particular migrate up the coast from the southeast in the spring and summer months. They move into the bays and coastal waters as water temperatures reach suitable levels and forage on crabs and other preferred foods (Keinath et al. 1987; Morreale 1989). As the temperatures of the bays and coastal waters start to decline, these animals move southward to the warmer water of the southeast Atlantic Coast. Recapture information from tagged animals supports these movements in loggerheads and ridleys (Shoop et al. 1981; Henwood 1987; Schoelkopf 1988).

6.1.4 CONDITION OF TURTLES CAPTURED AT INTAKE STRUCTURE

Of the 38 stranded turtles captured at the circulating water intake, twenty-four were dead and and 14 were alive and subsequently released (Table 6-4).

Eight of the twenty-six loggerheads were alive and successfully released into the Atlantic Ocean by the Marine Mammal Stranding Center after feeding and observing their behavior for several days. Among the eighteen dead loggerheads, eight appeared to be fresh dead. Among the fresh dead animals, five had collapsed lungs and three had evidence of other internal problems which may have contributed to their deaths. Collapsed lungs suggest prolonged submergence but whether or not the submergence was attributable to the station can not be concluded with certainty. Of the remaining ten dead loggerheads, no necropsy information was available for five, three had probable boat propellor cuts, one had a perforated intestine and peritonitus, and, one had apparently been partially frozen. From this information it is apparent that both man-related and natural causes of death contributed to loggerhead mortality in the estuary.

Six of the twelve ridleys were alive when captured and five were successfully released into the Atlantic Ocean by the Marine Mammal Stranding Center after feeding and observing their behavior for several days. One turtle died during this observation period. Among the six dead ridleys, three appeared to be fresh dead and all three had collapsed lungs. The remaining three dead ridleys, were moderately or severely decomposed and two of the three had probable boat propellor cuts on their carapace. From this information man-related causes of death contributed to ridley mortality in the estuary.

Based on other necropsy information available from the Marine Mammal Stranding Center, boat-related injuries appear to be common occurrences in both stranded loggerheads and ridleys in Delaware Bay and coastal New Jersey (MMSC 1988). This is consistent with NMFS findings which show boat-related injuries as a common carcass anomaly (NMFS 1988).

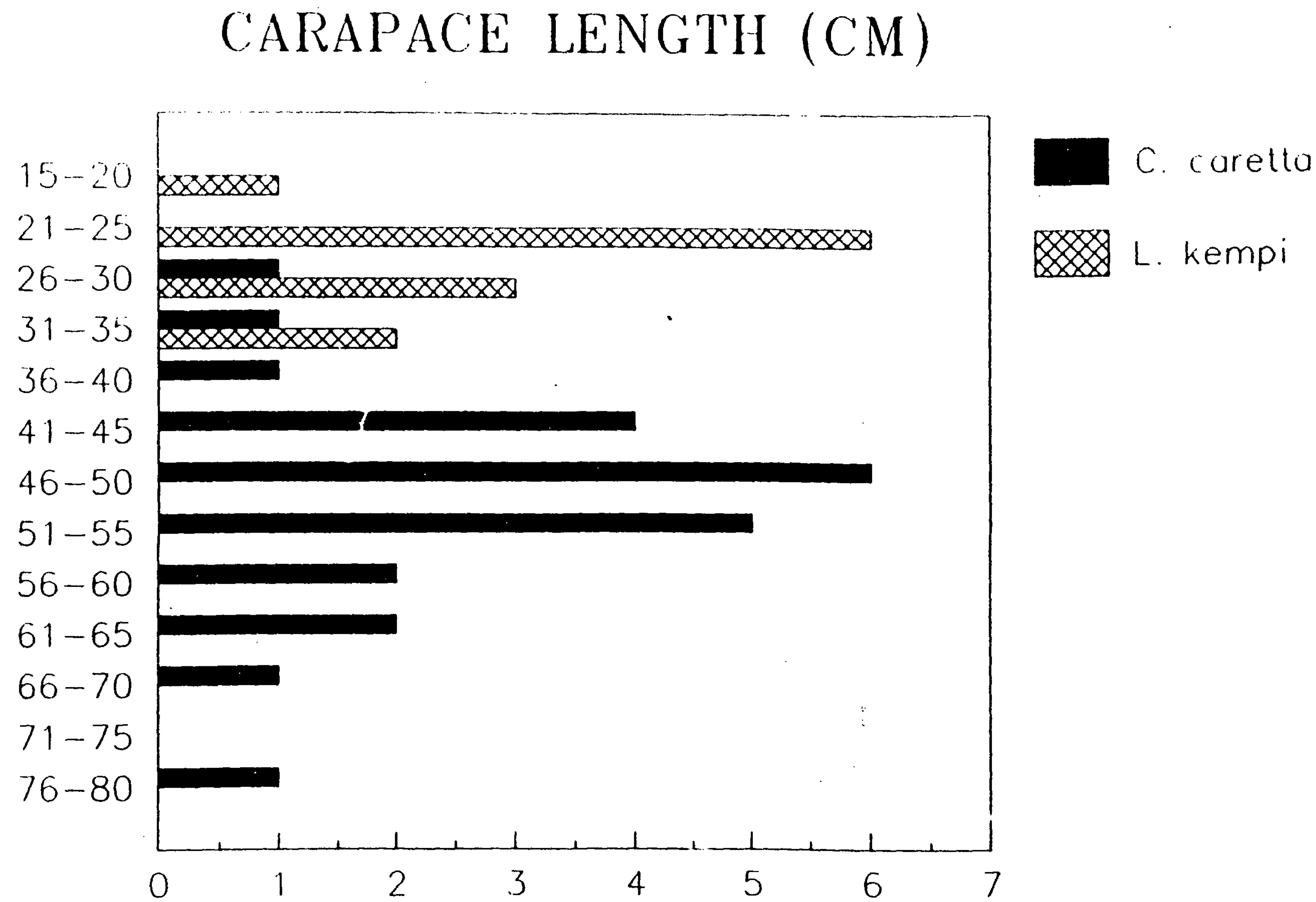


Figure 6-1. Frequency Distribution of Carapace Lengths for Loggerhead and Kemp's Ridley Sea Turtles Captured From Circulating Water System Intake at Salem Generating Station

TABLE 6-1

SEA TURTLES CAPTURED AT OR NEAR THE SALEM GENERATING STATION

Year	Loggerhead	Ridley	Green	Totals
1977	0	0	0	0
1978	0	0	0	0
1979	1	0	0	1
1980	2	1	1	4
1981	4	1	0	5
1982	1	0	0	1
1983	2	1	0	3
1984	2	1	0	3
1985	6	2	0	8
1986	0	1	0	1
1987	5	3	0	8
1988	8	2	0	10
Totals	31	12	1	44

TABLE 6-2

TOTAL NUMBER OF SEA TURTLES CAPTURED FROM CIRCULATING WATER INTAKE TRASH BARS AT SALEM GENERATING STATION

Year	Loggerhead	Ridley	Green	Totals
1977	0	0	0	0
1978	0	0	0	0
1979	0	0	0	0
1980	1	1	0	2
1981	3	1	0	4
1982	1	0	0	1
1983	2	1	0	3
1984	2	1	0	3
1985	6	2	0	8
1986	0	1	0	1
1987	3	3	0	6
1988	8	2	0	10
Totals	26	12	0	38

TABLE 6-3

SEASONAL OCCURRENCE OF SEA TURTLES AT SALEM GENERATING STATION CIRCULATION WATER INTAKE

Months	Loggerhead	Ridley	Totals
January	0	0	0
February	0	0	0
March	0	0	0
April	0	0	0
May	0	0	0
June	1	2	3
July	18	4	22
August	3	2	5
September	5	4	9
October	0	0	0
November	0	0	0
December	0	0	0
Totals	26	12	28

TABLE 6-4

MORTALITY OF SEA TURTLES CAPTURED FROM CIRCULATING WATER INTAKE TRASH BARS AT SALEM GENERATING STATION (LIVE/DEAD)

Year	Loggerhead	Ridley	Totals
1980	0/1	1/0	1/1
1981	1/2	0/1	1/3
1982	0/1	0/0	0/1
1983	0/2	0/1	0/3
1984	0/2	1/0	1/2
1985	2/4	1/1	3/5
1986	-	0/1	0/1
1987	3/0	2/1	5/1
1988	2/6	1/1	3/7
Totals	8/18	6/6	14/24

SECTION 7.0
ASSESSMENT OF PRESENT OPERATIONS

The primary concern with sea turtles at Salem Generating Station is whether or not the losses of these endangered or threatened sea turtle species "jeopardizes their continued existence." Federal regulation (50 CFR 402) defines "jeopardizes the continued existence" as "engaging in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing the reproduction, numbers, or distribution of that species." Therefore, the question relative to Salem Generating Station is: Do the activities associated with the operation of Salem Generating Station "appreciably reduce" the reproduction, numbers or distribution of either the loggerhead or Kemp's ridley sea turtles?

7.1 IMPACTS OF CONTINUED OPERATION OF SALEM GENERATING STATION ON SEA TURTLE POPULATIONS

7.1.1 IMPACTS DUE TO INCIDENTAL CAPTURE (IMPINGEMENT) OF TURTLES ON CWS INTAKE TRASH RACKS

Thirty-eight sea turtles have been retrieved from the circulating water intake at Salem Generating Station since 1980. Fourteen of these turtles were alive and returned to the Atlantic Ocean by MMSC near Brigantine, New Jersey. Twenty-four of the turtles removed from the intake were dead. Of these, twelve were either severely or moderately decomposed indicating that their death occurred prior to encountering the intake. The intake routinely removes river debris during its normal operation and dead and injured turtles wash ashore, buoyed by the gases of decomposition and would be expected to be part of the debris load in the river removed by the station. Therefore, it could be argued that only ten dead turtles were removed from the intake since 1980 whose cause of death was uncertain and may have been contributed to by the plant.

Based on these levels of incidental capture at the intake, it is estimated that zero to nine loggerheads (mean = 3) and zero to three Kemp's ridleys (mean = 1) would be expected to be taken from the intake during any given year (95 percent confidence limits). If we discount those animals which were moderately and severely decomposed from this calculation, zero to eight loggerheads (mean = 2) and zero to three Kemp's ridleys (mean = 1) with no evidence of previous damage would be expected to be taken from the intake during a given year.

7.1.1.1 ASSESSMENT OF IMPACT ON LOGGERHEAD SEA TURTLE POPULATIONS

At Salem Generating Station, the annual number of loggerheads incidentally captured between 1980 and 1988 has ranged from zero to nine turtles with a calculated annual average of three. Eight of the total of twenty-six loggerheads captured were alive and released back into the wild. Among the eighteen dead animals, eight appeared to be fresh dead and all the others were either moderately or severely decomposed suggesting death prior to involvement with the station. Carapace anomalies suggest damage from boat propellers contributed to the deaths of several animals and internal problems (i.e. peritinitous) in others. Therefore, if live and long dead animals are removed from the annual estimate, the annual average loss of loggerheads is two animals per year with which the station may have had some involvement.

Adult and subadult loggerhead sea turtle populations have been recently estimated to be approximately 387,000 in the southeast United States (see Section 5.0). The estimated number of mature females in this same area has been estimated to range between 35,000 and 72,000 turtles.

In order to determine if Salem Generating Station "appreciably reduces" the reproduction, numbers or distribution of loggerheads, it is necessary to compare on-site information with breeding information, population estimates, and distribution information for this species.

Loggerhead nesting in the United States primarily occurs along coastal beaches in Florida, Georgia, South Carolina and North Carolina. Only one report of nesting was reported from New Jersey in 1980. Additionally, diamondback terrapin nesting surveys have been conducted at select beaches in the vicinity of Salem Generating Station since 1978 and no evidence of sea turtle nesting has been observed during these studies. Also, all loggerheads incidentally captured from the CWS intake were juveniles or subadults.

Therefore, based on the immaturity of the specimens captured and the fact that loggerhead nesting does not typically occur in New Jersey the only loss to loggerhead reproduction would be from production forgone due to the loss of juvenile/subadult animals on the intake which could potentially be recruited into the breeding female population at some time in the future.

The observed worst case incidental catch level for loggerheads at Salem Generating Station would be nine turtles during any given year. If we compare this with the estimated population size of 387,000 animals, this mortality would represent 0.0002 percent loss in the population in the southeast U.S. It should be kept in mind that the population estimate on which this percentage is based does not include juveniles or subadults in the region or populations from areas other than the U.S. This means that the population is estimated and the percent loss from Salem Generating Station would even be less. It is unlikely that mortality at this level would "appreciably reduce" the distribution or numbers of loggerhead sea turtles along the Atlantic Coast of the United States.

7.1.1.2 ASSESSMENT OF IMPACT ON KEMP'S RIDLEY SEA TURTLE POPULATIONS

At Salem Generating Station, the annual number of Kemp's ridleys incidentally captured between 1980 and 1988 has ranged from zero to three turtles with a calculated annual average of one. Six of the total of twelve ridleys captured were alive and five were successfully released back into the wild. Among the six dead animals, three appeared to be fresh dead and all the others were either moderately or severely decomposed and two had probable boat propeller cuts suggesting death prior to involvement with the station. If live and long dead animals are removed from the annual estimate, the annual average loss of Kemp's ridleys is less than one animal per year with which the station may have had some involvement.

In order to determine if Salem Generating Station "appreciably reduces" the reproduction, numbers or distribution of ridley sea turtles, it is necessary to compare on-site information with breeding information, population estimates, and distribution information for this species. The adult Kemp's ridley sea turtle population has recently been estimated to be approximately 2,200 turtles based on breeding females observed in Mexico (see Section 5.0). Since this breeding colony is the only known colony in the world, this estimate represents the worldwide population for Kemp's ridleys.

Kemp's ridley nesting appears to occur only in Mexico. All specimens captured were juveniles or subadults. Therefore, based on the immaturity of the specimens captured and the fact that ridley nesting does not occur in New Jersey, the only loss to ridley reproduction would be from production forgone due to the mortality of juvenile/subadult animals on the intake which could potentially be recruited into the breeding female population at some time in the future.

If we assume a worst case incidental catch at Salem Generating Station of one to two turtles during any given year and compare it with the estimated population size of 2,200, they would represent 0.05 to 0.09 percent of the population. This population estimate does not include juveniles and subadults and likely underestimates the actual population size. It is unlikely that losses at this level would "appreciably reduce" the distribution or numbers of Kemp's ridley sea turtles along the Atlantic Coast of the United States.

7.2 OTHER POTENTIAL STATION IMPACTS ON SEA TURTLES

7.2.1 ACUTE THERMAL EFFECTS

The discharge from the Salem Generating Station is located 500 feet (152 meters) offshore on the bottom. The discharge velocity of approximately 10 feet per second (330 centimeter per second) is high enough to promote rapid mixing with ambient water. As discussed in Section 4.0, the temperature rise of the discharge will be approximately 18°F (9.2°C) over ambient river temperatures. Because of the high discharge velocity, a sea turtle could not remain in the heated portion of the plume for any length of time. Furthermore, turtles in the area would be able to avoid entrainment in the plume by swimming. Therefore, it is concluded that no adverse acute thermally-related impacts will be sustained by either sea turtle species.

No acute thermally related losses to sea turtles would be anticipated due to the operation of the Hope Creek Station. Hope Creek Station has a low volume discharge that is approximately 2.5 percent of the Salem Station flow. Furthermore, the discharge has a lower temperature rise, 11°F (6.2°C) in winter and 7°F (3.7°C) in the summer, than Salem Station and is rapidly assimilated by the Delaware River.

7.2.2 CHRONIC THERMAL EFFECTS

No impact from the thermal discharge from Salem and Hope Creek Generating Stations is anticipated on the reproduction, migratory behavior, interspecific relationships, and the incidence of disease in sea turtles inhabiting the Delaware River in the vicinity of Artificial Island.

The high tidal flushing of the river and the design and placement of the discharge eliminates the possibility of thermal blockage to the river. Because reproduction occurs in the southeastern United States in the case of the loggerhead and Mexico in the case of the Kemp's ridley, no reproductive impacts are expected. No thermal blockage of the river is anticipated, therefore, no impact on migratory behavior would occur. The areal extent of thermal plume from the Salem Station depends on tidal stage but has been estimated to be 19,800 feet long and 1,485 feet wide during flood tide conditions (1°C isotherm). Due to the low discharge flow rates from Hope Creek, the estimated extent of the 2.2°C isotherm is 2,230. In either case, both turtle species move freely about in the water column spending a large portion of their time foraging on the bottom. Based on the shallow nature of these plumes and relatively small area affected, it is concluded that no significant impacts would occur to sea turtles in the area due to chronic elevation of temperatures from the operation of the Salem and Hope Creek Stations. Therefore, no impact to sea turtle species within the Delaware River due to chronic thermal loading from the stations is anticipated.

7.2.3 BIOCIDES

Low level, continuous chlorination is used to control biofouling in the Salem Station service water system and Hope Creek Station service water and circulating water systems.

At Salem, NJPDES permit conditions restrict chlorine discharge levels may not exceed a monthly average of 0.3 mg/l or a daily maximum of 0.5 mg/l. Only the service water system is chlorinated at Salem and after service water passes through its heat exchangers it is mixed with the main condenser cooling water. The chlorine demand in this discharge consumes any remaining free chlorine and results in essentially no chlorine being discharged to the river.

At Hope Creek, NJPDES permit conditions also restrict chlorine discharge to no more than 2 hours per day and levels may not exceed a monthly average of 0.3 mg/l or a daily maximum of 0.5 mg/l. The dechlorination system at Hope Creek further reduces free chlorine levels to near zero levels before discharged via the blowdown line to the river.

It is concluded after reviewing operation of the chlorination systems that the total residual chlorine levels released to the Delaware River from Salem and Hope Creek will not be detrimental to sea turtles that may inhabit the discharge area. Furthermore, the high discharge flow rates and high tidal flow in the vicinity of the stations will prevent any organism from remaining in the plume for any considerable length of time.

7.2.4 COLD SHOCK

Both stations have a high velocity discharge. The discharge promotes rapid mixing of the effluent stream and prevent sea turtles from remaining in the discharge plume for time periods long enough to acclimate to high temperatures. Additionally, sea turtles only occur near the stations during the early spring and summer when cold shock is not a concern. Therefore, cold shock of sea turtles is not anticipated and mortality is not expected.

7.3 MITIGATING MEASURES

7.3.1 ADMINISTRATIVE CONTROLS

As required by Section 4.1.1 of the Salem, Unit No. 2, Environmental Technical Specifications (ETS) and by Section 4.1 of the Hope Creek Environmental Protection Plan, PSE&G must report the mortality or unusual occurrence of any species protected by the Endangered Species Act.

7.3.1.1 INCLUSION IN EVENT CLASSIFICATION GUIDES

Because several species of endangered or threatened sea turtles and fish (Shortnose sturgeon) occur in the vicinity of the generating stations, this notification requirement has been incorporated in the Event Classification Guide (ECG) for both the Salem and Hope Creek Generating Stations. These reference documents are in the control rooms of each generating station and are used by the Senior Shift Supervisors responsible for the safe operation of each plant to determine what events require reporting. The ECG also refers the Senior Shift Supervisor to specific attachments which clearly define the administrative procedures for specific events. Endangered and threatened species are specifically identified in each Event Classification Guide and make reference to administrative attachments (Salem, Attachment 33 and Hope Creek, Attachment 17) for reporting such events.

7.3.1.2 TURTLE HANDLING AND REPORTING

The trash rake procedure discussed in Subsection 7.2 is typically the way larger sea turtles are removed from the trash racks at the circulating water system intake at Salem Generating Station. Smaller turtles may be removed by a long handled dip net.

When a turtle is observed on the intake, the operator's first action is to attempt bringing the animal to the operating level of the intake using the trash rake. Once the turtle has been removed from the trash bar rakes, the operator notifies the Senior Shift Supervisor who in turn follows the administrative procedure referred to in the ECG.

One of the first contacts on this administrative procedure is the representative from Licensing and Regulation (L&R). The L&R representative will verify the identification of the turtle as being an endangered or threatened species and attempt resuscitation if necessary. If the turtle is alive, it will be transported to one of the fish pool buildings at either end of the intake and kept out of the direct sun. Once the turtle has been taken care of, the L&R representative will notify the Senior Shift Supervisor to continue the notifications outlined in his administrative procedure. The L&R representative will notify the local affiliate of the Sea Turtle Salvage and Stranding Network (Marine Mammal Stranding Center) to arrange for the removal of the turtle from the site and will also contact NMFS and NJDEP and advise them of the occurrence.

As the Senior Shift Supervisor makes his contacts, he completes a "Four-Hour Notification Report," on which he signs and dates the completion of his designated contacts. He then forwards the partially completed report to the Licensing and Regulation representative who signs and dates his contacts and then forwards the report to Emergency Planning for retention.

A separate report is also prepared by the L&R representative within 30 days of the event and submitted to the U.S. Nuclear Regulatory Commission in accordance with 4-Hour Notification reporting procedures. Copies of this report are also sent to NMFS and NJDEP.

7.3.1.3 ANNUAL NOTIFICATION

Over the last three years, it has also become standard procedure in the early summer for the Nuclear Department, Licensing and Regulation group to remind both Station Operations and Site Services, who clean the trash bars during the day, that they should be on the outlook for sea turtles. A memorandum is distributed to Station Operations which contains drawings of the threatened and endangered sea turtles and fish which can occur in the vicinity of the generating stations (Appendix B). It also provides the names and phone numbers of L&R personnel responsible for the handling of such specimens. Office, home and pager telephone numbers are provided for at least two L&R personnel.

Large color posters obtained from the NMFS depicting sea turtles have also been obtained and posted in the circulating water intake operators office.

7.3.2 OPERATIONS

7.3.2.1 TRASH BAR CLEANING PROCEDURES

The basic cleaning procedure consists of Security opening several access grates; positioning the cleaning equipment over the opened grates; and, then systematically raising and lowering the trash rake on the face of the trash rack to remove accumulated debris.

The traversing drive machinery operates through a worm-gear reducer to propel the rake unit along the face of the trash rack at a traversing speed of 30 feet per minute. Individual "dead-man" pushbutton controls enables the raking unit to randomly serve any intake cell, regardless of location, and not be subject to any sequential order. To position the trash rake, either the "forward" or the "reverse" pushbutton must be depressed and held until the desired intake cell position is reached. To manipulate the rake device the control panel features pushbuttons labeled for "open teeth", "lower rake," "close teeth," and "raise rake." To raise the trash rake, the operator must depress and hold the "raise" button in. When the rake reaches its upper limit, an automatic switch will stop the upward travel of the rake. The same procedure is required to lower the rake and again an automatic switch will stop the downward movement of the rake.

The carriage rake is designed to descend with the teeth in the open position, close or turn inward toward the bar rack at the lower limit of travel, collect accumulated debris while ascending along the inclined bars, and deposit the debris into the self-contained trash hopper at the end of its vertical travel. Ultimately the debris is emptied into large trash baskets located at either end of the intake structure which are periodically removed by a large portable crane. The crane removes these trash baskets at least once every other week depending on debris load.

The motion of the rake can be reversed at any elevation such that it is not mandatory to descend the full intake depth each time prior to performing cleaning operations. This flexibility is beneficial during heavy debris loading periods or when a sea turtle is on the trash bar racks.

Sea turtles are spotted either on the water surface when the grates are opened or when the tines of the trash rake exits the water with the debris. Sea turtles are removed from the rake just prior to the point that the debris is dumped into the hopper.

The trash racks are routinely cleaned once per day by labor provided by Nuclear Site Services. On the back shifts, trash rack cleaning, when necessary, is provided by Station Operations. Additional trash rack cleaning is performed when the debris level on the racks warrants it.

The cleaning of the entire face of the Salem circulating water intake and all its component trash racks may take several hours or an entire shift (8 hours) when debris levels are high.

7.3.2.2 OPERATIONAL AND STRUCTURAL MODIFICATIONS

The original design of the intake structure had a curtain wall in front of the traveling screens to skim floating material from the surface of the incoming water. It extended to the low low-water level (elevation 81.0 ft PSD).

The bottom of the curtain wall was removed in 1976 and 1977 due to concerns that their presence increased the approach velocities. Subsequent to the wall modification it was found that heavy ice formation occurred on the traveling screens since they were now exposed to the outside air temperature.

The use of removable wave walls allows the interior of the building and the equipment to be heated, preventing icing. The removable wave walls are only necessary during the winter.

In addition to the wave walls, the ice barriers which prevent river ice from damaging the intake equipment can be removed in the spring. This enhances the escape potential of any turtle that might approach the intake.

Bathymetric surveys in the vicinity of the CWS intake have shown that sediment accumulation above the base of the structure at elevation 50 ft PSD is a recurring and continuous process.

The net result of the sedimentation in the intake approach channel was to decrease the effective cross-sectional area through which cooling water was drawn. This adversely affected the approach velocity distribution. The Company has removed the sediment ridge that existed directly in front of the intake. A bathymetric survey program is being maintained to monitor the accretion of sediments in the vicinity of the intake and dredging of the area will occur when a large accumulation is observed.

7.4 DISCUSSION OF GENERAL IMPACTS ON SEA TURTLE POPULATIONS

Five factors have been listed as factors contributing to the decline in sea turtle populations (43 FR 146:32800-32811);

1. Destruction or modification of habitat;
2. Overutilization for commercial, scientific or educational purposes;
3. Inadequate regulatory mechanisms;
4. Disease and/or predation; and,
5. Other natural or man-made sources.

The destruction and/or modification of habitat from coastal development and losses due to incidental capture during commercial fishing are likely the two major factors impacting sea turtle populations along the Atlantic Coast of the United States. The continued development of beachfront and estuarine shoreline areas are likely to be impacting foraging grounds for several sea turtle species. Incidental capture (take) is defined as the capture of species other than those towards which a particular fishery is directed. As implied by this definition, the commercial fishing industry has been implicated in many of the carcass strandings on southeast U.S. beaches. The annual catch of sea turtles by shrimp trawlers in the southeast has been estimated to 45,000 turtles, primarily loggerheads. The average mortality rate was estimated to be about 27 percent or over 12,000 turtle deaths per year.

However, not all beach carcasses are the result of drowning in fish nets. Other human-related causes of mortality include damage from boating, plastic ingestion, etc. More research needs to be conducted to determine the precise cause of death of these animals. The unintentional capture of species during non-fishery related industrial process may also be considered to be incidental capture. In New Jersey and New York, boat damage is a commonly observed injury in stranded turtles.

The loggerhead is the most numerous turtle in U.S. coastal waters and therefore would be encountered most frequently by fishermen and recreational boaters.

East coast stranding data for 1987 reported approximately 2,500 animals for the Atlantic east coast. The greatest number of these strandings were observed along the southeastern Atlantic coast (i.e. Florida). Even though any loss of an endangered or threatened species is important, the magnitude of the losses of loggerhead and Kemp's ridley sea turtles from Salem Generating Station would not be expected to significantly impact the U.S. Atlantic coast populations of these sea turtle species.

SECTION 8.0
REFERENCES

SECTION 2.0

50 CFR 17.11; Endangered and Threatened Wildlife

50 CFR 222.23(a); Endangered Fish or Wildlife Permits, (Under National Marine Fisheries Service jurisdiction)

50 CFR 227.4(b); Threatened Fish and Wildlife, Enumeration of Threatened Species

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APPENDIX A

DETAILED LISTING OF SEA TURTLES CAPTURED AT AND IN THE VICINITY OF SALEM GENERATING STATION

TABLE A-1

HISTORICAL SUMMARY OF KEMP'S RIDLEY SEA TURTLES CAPTURED AT OR DURING FIELD SAMPLING ACTIVITIES ASSOCIATED WITH SALEM GENERATING STATION

DATE	LOCATION	STATUS	WEIGHT* (kilograms)	CARAPACE LENGTH** (centimeters)	CARAPACE WIDTH** (centimeters)	WATER TEMPERATURE (°C)	SALINITY (ppt)	COMMENTS+
11-Aug-80	CWS trash racks	Live		29	28	30	7	
23-Sep-81	CWS trash racks	Dead	6	33	29	21		Moderate decomposition-carapace cut-probable boat hit
13-Jul-83	CWS trash racks	Dead	2	23	21			Female - lungs collapsed
29-Aug-84	CWS trash racks	Live		32	20			
11-Jun-85	CWS trash racks	Live		25	24	26	6-10	Tagged (NNK-051) and released
24-Jun-85	CWS trash racks	Dead	2	27	26	23	6-10	Female - lungs collapsed
5-Jul-86	CWS trash racks	Dead	1	19	17	25	4-7	Advanced decomposition (1 week+)
24-Sep-87	CWS trash racks	Live	1	21	19	22	1-6	Died at MMSC
24-Sep-87	CWS trash racks	Dead	2	25	22	22	1-6	
29-Sep-87	CWS trash racks	Live	2	23	22	22	4-6	Transported to Florida and released
5-Jul-88	CWS trash racks	Live	2	29	23	24	6-12	Tagged (NNK-062) and released
27-Jul-88	CWS trash racks	Dead	1	25	23	28	3-5	Female - Moderate decomposition-probable boat hit (post mortem)
Summary		6 Live 6 Dead	$\bar{x}$=2	$\bar{x}$=25.9	$\bar{x}$=22.8	21-30	1-12	

* Estimated

** Straight length and width

+ Autopsies and sex determination done by R. Schoelkopf, Marine Mammal Stranding Center Brigatine, NJ

TABLE A-2
HISTORICAL SUMMARY OF LOGGERHEAD SEA TURTLES CAPTURED AT OR DURING FIELD
SAMPLING ACTIVITIES ASSOCIATED WITH SALEM GENERATING STATION

DATE	LOCATION	STATUS	WEIGHT* (kilograms)	CARAPACE LENGTH** (centimeters)	CARAPACE WIDTH** (centimeters)	WATER TEMPERATURE (°C)	SALINITY (ppt)	COMMENTS+
23-Aug-79	River Mile 15	Live		123				Captured in otter trawl-released unharmed
11-Jul-80	CWS trash racks	Dead						Carapace cut-probable boat hit
2-Sep-80	Egg Island Point, NJ	Live		62	54			Captured in otter trawl-released unharmed
30-Jun-81	Ray's Ditch, DE	Dead	16	51	38			Floating offshore
3-Sep-81	CWS trash racks	Live		47	42	25		
8-Sep-81	CWS trash racks	Dead	40	58	52	24		Female - perforated intestine-prev. frozen
14-Sep-81	CWS trash racks	Dead	32	54		25		Female - moderate decomposition-collapsed lung
10-Jul-82	CWS trash racks	Dead	4	29	28			Female - advanced decomposition
11-Jul-83	CWS trash racks	Dead	14	48	42			Female - moderate decomposition
19-Jul-83	CWS trash racks	Dead	22	54	34			Female - advanced decomposition
2-Jul-84	CWS discharge	Dead	42					Advanced decomposition
3-Jul-84	CWS trash racks	Dead		81		25	4-6	Female - moderate decomposition-probable boat hit (cuts on carapace)
8-Jun-85	CWS trash racks	Dead	7	46	36	24	6-10	Female - 8 inch cut on carapace-probable boat
15-Jul-85	CWS trash racks	Dead	16	53	43	23	10	Female - collapsed lungs

TABLE A-2

HISTORICAL SUMMARY OF LOGGERHEAD SEA TURTLES CAPTURED AT OR DURING FIELD SAMPLING ACTIVITIES ASSOCIATED WITH SALEM GENERATING STATION

DATE	LOCATION	STATUS	WEIGHT* (kilograms)	CARAPACE LENGTH** (centimeters)	CARAPACE WIDTH** (centimeters)	WATER TEMPERATURE (°C)	SALINITY (ppt)	COMMENTS+
5-Aug-85	CWS trash racks	Dead	27	59	50	25	6-10	Female - collapsed lungs
7-Aug-85	CWS trash racks	Dead	29	50	40	25	8-10	Female - perforated intestine-peritonitus-horseshoe crab in gut
10-Aug-85	CWS trash racks	Live	15	53	43	26	6	Released by NMSC
30-Sep-85	CWS trash racks	Live	20	52	43	22	11-15	Released by NMSC
15-Jun-87		Live		70	61	24	5-8	Captured in otter trawl-released unharmed
14-Jul-87	CWS trash racks	Live	14	41	38	27	4-8	Released by NMSC
16-Jul-87		Live	11	41	36	26	4-6	Released by NMSC
20-Jul-87		Live	36	69	54	27	6	Released by NMSC
14-Oct-87		Dead		44	40	16	5-8	Advanced decomposition
[illegible]-Jul-88	CWS trash racks	Live	35	61	43	24	6-12	Tagged (NNK-063) and released by NMSC
[illegible]-Jul-88	CWS trash racks	Live	16	35	32	26	6-10	Tagged (NNK-064 and NNK-066) and released by NMSC
2-Jul-88	CWS trash racks	Dead	14	43	38	25	6-8	Female - massive internal hemorraging-numerous fractures of carapace
2-Jul-88	CWS trash racks	Dead	14	43	39	25	6-8	Female - abscess lower right lung and intestine-partial impaction by crab
2-Jul-88	CWS trash racks	Dead	7	37	32	25	6-8	Female - fresh dead-lungs collapsed-blue crab in gut

TABLE A-2

HISTORICAL SUMMARY OF LOGGERHEAD SEA TURTLES CAPTURED AT OR DURING FIELD SAMPLING ACTIVITIES ASSOCIATED WITH SALEM GENERATING STATION

DATE	LOCATION	STATUS	WEIGHT* (kilograms)	CARAPACE LENGTH** (centimeters)	CARAPACE WIDTH** (centimeters)	WATER TEMPERATURE (°C)	SALINITY (ppt)	COMMENTS+
12-Jul-88	CWS trash racks	Dead	16	48	39	25	6-8	Female - fresh dead-lungs collapsed-blue crab in gut
15-Jul-88	CWS trash racks	Dead	36	61	46	25	7-10	Female - long dead-blue crab in gut
15-Jul-88	CWS trash racks	Dead	20	49	41	25	7-10	Male - fresh dead-lungs collapsed-blockage in gut (clay balls)
SUMMARY		11 Live 20 Dead	$\bar{x}$=21 kg range 4-42	$\bar{x}$=53.9 range 29-123	$\bar{x}$=41.7 range 16-46	16-26	4-15	

* Estimated

** Straight length and width

\+ Autopsies and sex determination done by R. Schoelkopf, Marine Mammal Stranding Center, Brigatine, NJ

APPENDIX B

PSE&G MEMORANDUM PREPARED FOR SALEM AND HOPE CREEK OPERATIONS PERTAINING TO SEA TURTLE HANDLING/REPORTING PROCEDURES

PSE&G

Public Service Electric and Gas Company P O Box 236 Hancocks Bridge, New Jersey 08038

Nuclear Department

JUN 08 1989
NLR-I89226

To the General Manager - Salem Operations
- Hope Creek Operations

ENDANGERED SPECIES REPORTING
SEA TURTLES/STURGEON IMPINGEMENT

As required by Section 4.1.1 of the Salem, Unit No. 2, Environmental Technical Specification (ETS) and by Section 4.1 of the Hope Creek Environmental Protection Plan, PSE&G must report the mortality or unusual occurrence of any species protected by the Endangered Species Act of 1973 to the NRC within 4 hours. Also, under the Endangered Species Act, inappropriate handling of endangered or threatened species can result in legal action.

Because several species of endangered and threatened sea turtles (Figure 1) and fish (Figure 2) have in the past been impinged on the Salem CWS trash bars during the summer months and because similar problems could occur at the Salem and Hope Creek SWS intakes, Licensing and Regulation requests that all Operations personnel be reminded of the importance of proper handling of impinged sea turtles and sturgeon. In addition, we request that the following procedures be implemented:

1. Circulating water system trash bars should be inspected a minimum of once per shift and cleaned a minimum of once per day from June through September, regardless of debris load. This will increase the probability of recovering live sea turtles. A high-powered spotlight will be needed on backshifts in order to inspect the trash bars properly.

2. Service water system trash bars only need to be inspected on a daily basis and only cleaned as needed.

3. Sea turtles observed on the trash bars must be recovered immediately. Upon recovery, Licensing and Regulation must be notified by calling either Tom Warren (Salem extension 5015/home number 678-7808), Ken Strait (Salem extension 5074/home number 451-4027),

or John Balletto (Salem extension 4748/home number 581-3643) of my staff. Diamondback Terrapin (Figure 3) can be returned directly to the river. The diamondback terrapin is distinguished from the other species of sea turtles by the presence of claws on both the forelimbs and hindlimbs (sea turtles have flippers).

4. Recovered turtles that are alive should be kept cool and wet until positive identification can be made by Licensing. Upon recovery, elevation of the hindquarters of turtles will help promote resuscitation. Licensing and Regulation should also be notified of sturgeon occurrence. Live sturgeon should be kept immersed in Delaware River water for release by Licensing personnel. Dead turtles and sturgeon should be placed in a plastic bag with ice to prevent decomposition and retard odor.

5. Environmental Consulting Services, Inc. (Impingement Crew) can be contacted (when on site) at extension 3135 for assistance with turtles or sturgeon.

Please contact Tom Warren or Ken Strait if you have any questions concerning this matter.

B. A. Preston
Manager -
Licensing and Regulation

TAW/spk
Attachments

C Manager - Site Services
C. L. Adams
J. H. Balletto
K. A. Strait
T. A. Warren
Environmental Consulting Services, Inc. (S. J. Beck)
File 4.7.1 SGS

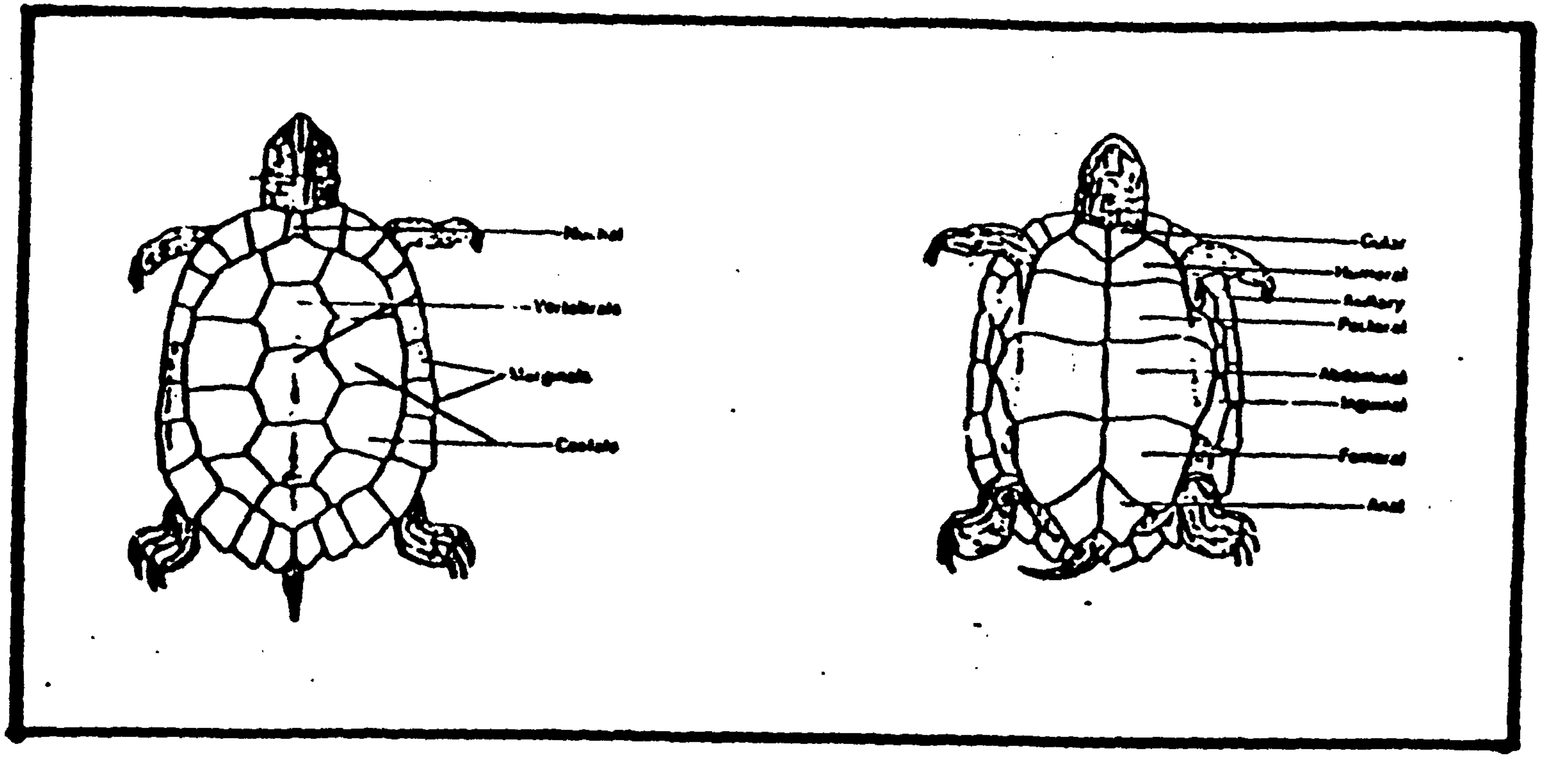


Figure 3. Commonly encountered Diamondback terrapin (not threatened or endangered - return to river).

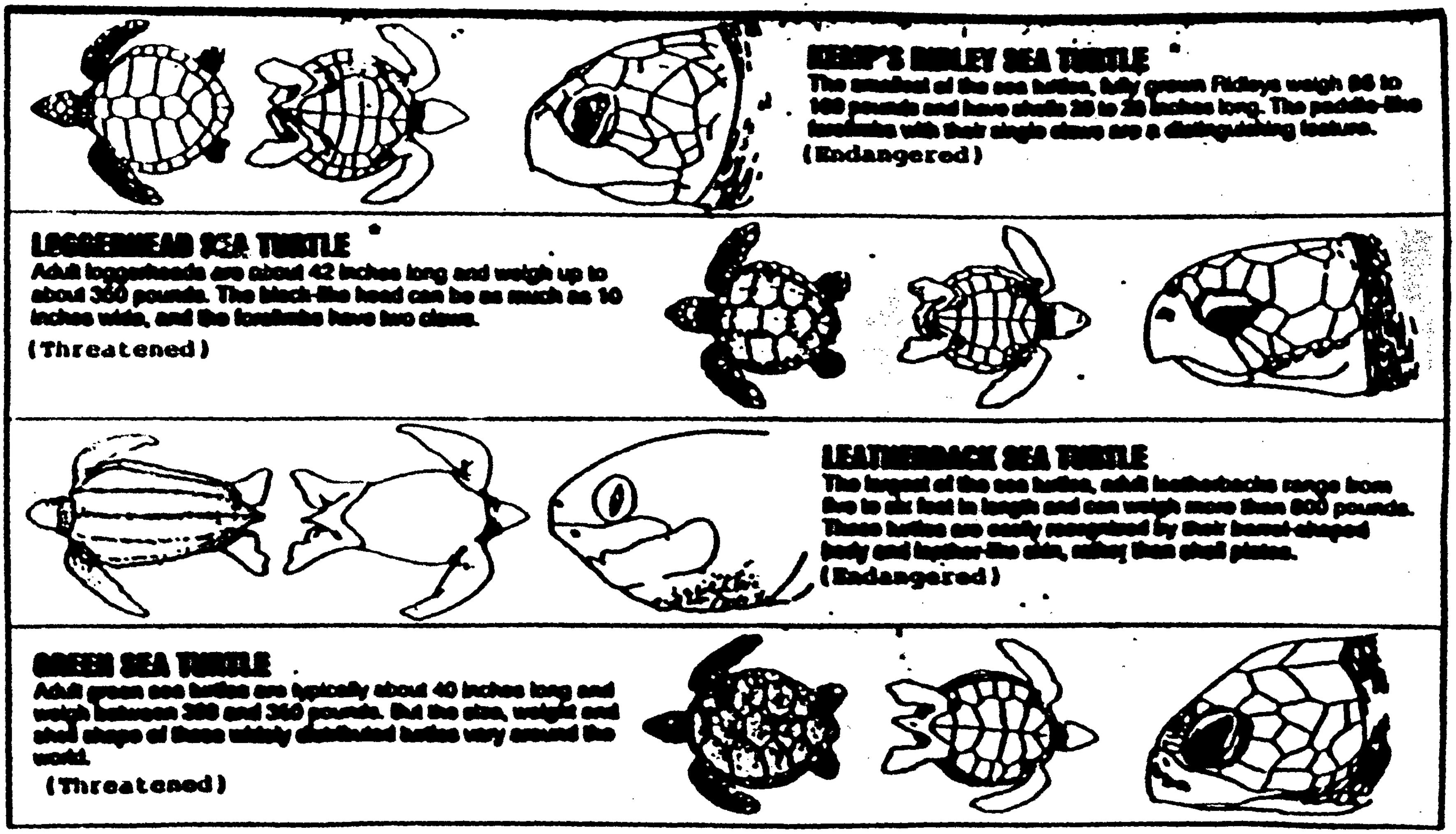
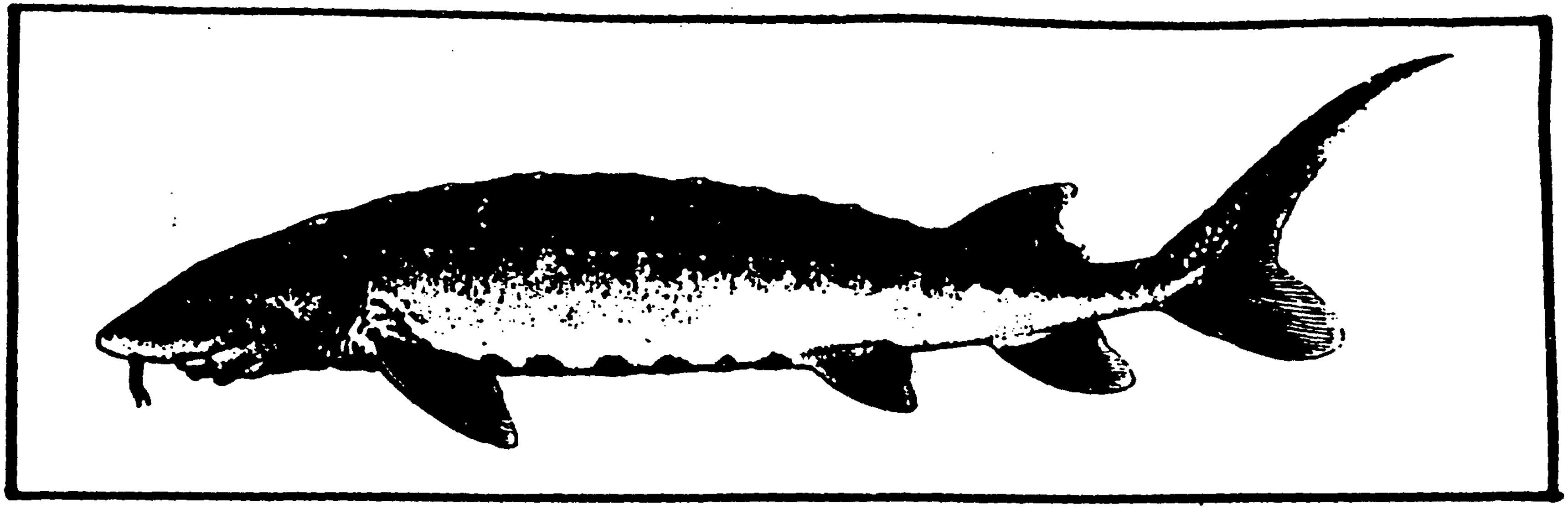
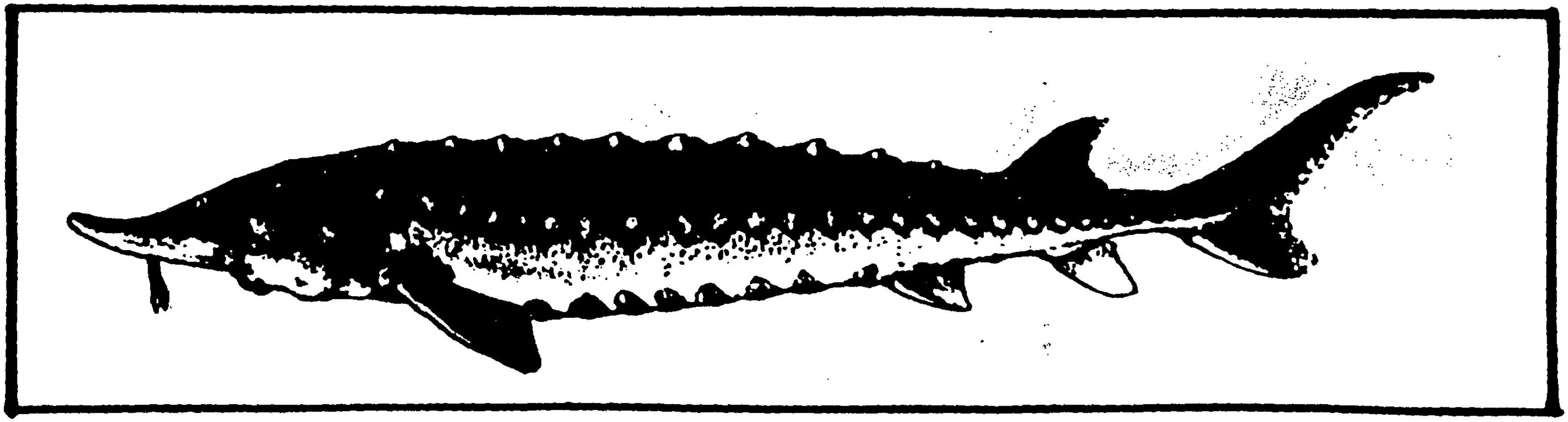


Figure 1. Threatened and Endangered Sea Turtle Species collected from Salem Generating Station Circulating Water Intake ([illegible]).



Shortnose Sturgeon (Endangered)



Atlantic Sturgeon

Figure 2. Sturgeon collected from Salem Generating Station Circulating Water Intake.