SERIAL NO.: 19-184

Enclosure 2

ATTACHMENTS FOR RAI MBH-1

Virginia Electric and Power Company
(Dominion Energy Virginia or Dominion)
Surry Power Station Units 1 and 2

From: Kenneth Roller (Services - 6)
Sent: Wednesday, March 27, 2019 12:55 PM
To: Degen, Marcia
Cc: Tony Banks (Generation - 6)
Subject: Dominion Energy's Surry Power Station: Request for VDH Response

Dear Dr. Degan:

Thank you for your time and guidance during our call March 26, 2019. As Tony Banks and I discussed with you, Dominion Energy is seeking a response from VDH concerning the potential existence and perceived health risks associated with thermophilic organisms that may be present in the portion of the James River that receives the cooling water discharge from our Surry Power Station (SPS). Information concerning the reason for this request and specific microorganisms of concern is presented below. Additional supporting information is included in the attachments to this email.

Reason for this Request and Microorganisms of Concern

On October 16, 2018, Virginia Electric and Power Company d/b/a Dominion Energy Virginia (Dominion) filed an application with the U.S. Nuclear Regulatory Commission (NRC) to renew the operating licenses for Surry Power Station Units 1 and 2 (SPS) for an additional 20 years. For SPS Unit 1, this requested renewal would extend the license expiration date from May 25, 2032, to May 25, 2052. For SPS Unit 2, this requested renewal would extend the license expiration date from January 29, 2033, to January 29, 2053.

The license renewal process requires that Dominion Energy develop an environmental report (ER) that assesses the potential for environmental impacts from continued operation of the facility for an additional 20 years. One area of potential environmental impact concerns microorganisms that might be associated with the SPS once-through cooling water discharge (see below). NRC has provided guidance (Reference) that Dominion Energy should consult with VDH concerning potential health concerns associated with the following microorganisms in the portion of the James River that receives the station's cooling water discharge:

- The enteric pathogens *Salmonella* spp. and *Shigella* spp., as well as *Pseudomonas aeruginosa* and thermophilic fungi.
- The bacteria *Legionella* spp., which causes Legionnaires' disease, and
- Free-living amoebae of the genera *Naegleria* (*Naegleria fowleri*) and *Acanthamoeba*

Dominion Energy Conclusions

Given the size of the river, the saline and tidal influence of the estuary, the documented reduction in water temperatures surrounding the effluent discharge point, positioning of the cooling water intake and discharge to minimize thermal impacts to oyster grounds and regulatory restrictions placed on public access to the waters adjacent to the discharge structures, Dominion Energy does not anticipate the continued operation of SPS to adversely affect the environment or public health as a result of microbiological hazards.

We are seeking VDH concurrence with Dominion Energy’s conclusion that the continued operation of SPS for the extended license term would not be expected to adversely affect the environment or public health from exposure to thermophilic pathogens in the James River. We appreciate your consideration of this request, and look forward to a response preferably within a couple weeks, if possible. Please contact me or Tony Banks (see contact information below) should you have any questions concerning this transmittal.

Sincerely,

Ken Roller
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Tony Banks, MPH
Generation Project Manager, Nuclear
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Reference: NRC Regulatory Guide 4.1, Supplement 1, Revision 1, 2013

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Dominion Energy Surry Power Station
Information to Support VDH Consultation on Thermophilic Microorganisms

This document provides information to support Dominion Energy's request for a response from VDH concerning the potential existence and perceived health risks associated with thermophilic organisms that may be present in the portion of the James River that receives the cooling water discharge from the Surry Power Station.

SPS Operation and Thermal Discharge

During the process of generating electricity at SPS, cooling water is withdrawn from the James River on the east end of the site and, following use, is returned to the James River at a higher temperature via VPDES-permitted Outfall 001 located on the west end of the site. Figures depicting the station site and the vicinity within a 6-mile radius of the station and a thermal modelling report, which evaluated temperature distribution in the James River Estuary as a result of the operation of SPS, are attached to this document. A brief discussion of the station and its operations during the extended period of operation is provided below.

SPS is an 840-acre facility located on Gravel Neck Peninsula in Surry County, Virginia, on the south side of the James River, approximately 25 miles upstream of the point where the river enters the Chesapeake Bay.

SPS uses a once-through cooling system designed to take water from the James River on the east end of the site and discharge to the James River on the west end of the site. SPS discharges to surface waters are regulated by and permissible under Virginia Pollutant Discharge Elimination System (VPDES) Permit Number VA0004090. The permit has been in place for decades and has been regularly renewed. The current permit was issued with an effective date of March 1, 2016.

In the vicinity of SPS, the James River is approximately 2.5 miles wide and is a tidally influenced freshwater river upstream of the Gravel Neck peninsula and a saline estuary downstream. Outfall 001 is located approximately six miles upstream of the SPS low-level intake canal. This design was implemented specifically to protect oyster beds, located downstream from the low-level intake structure and in more saline water, from being affected by the thermal plume.

The station discharges once-through cooling water (~2.3 billion gallons per day) through permitted Outfall 001 to the James River. The station operates under a 316(a) thermal variance that was approved in 1978 and has been carried forth since. There is a heat rejection limit on Outfall 001 of 12.6×10^9 Btu/hour that effectively restricts the amount of heat that can be discharged under the 316(a) variance. The station has never exceeded the heat rejection limit and there are no plans to increase the amount of heat rejection during the extend license period.

Modeling of the thermal plume at a heat rejection rate of 12×10^9 was undertaken in 1967 and documented in the attached report, *Temperature Distribution in the James River Estuary which* *will result from the Discharge of Waste heat from the Surry Nuclear Power Station*. The report concluded that only a small portion of the estuarine water in the tidal segment adjacent to the plant site is subjected to excess temperatures which might have biological significance. Averaged over a tidal cycle, the area having excess temperatures exceeding 5°C occupies less than 7% of the width of the estuary.

In addition, Dominion conducted extensive pre- and post-operational studies on thermal effects of SPS on the James River over a seven-year period, which included computer modeling, field investigations of water quality and aquatic biota, field measurements of water temperatures, and electronic measurements of water temperatures in the SPS intake and discharge canals. Temperatures greater than 90°F at the discharge normally occur only in June, July, August, and September when SPS is operating at or near full capacity. Once discharged into the estuary, the thermal effluent dispersion rapidly reduces outfall temperatures to or near ambient levels. Effluent temperatures immediately outside the discharge canal decrease 1-2° F with every 1,000 feet from the mouth of the discharge canal. Temperatures were rarely more than 5° F above ambient river temperatures at a distance of 3,000 feet from the outfall.

The discharge outfall is surrounded by rock jetties projecting perpendicularly from the shoreline 1,100 feet into the James River estuary. Virginia Code 20-1060-10 ET SEQ §28.2-106.2 delineates a restricted access area encompassing the entire discharge canal from the jetties at its discharge pipe outlet back to the plant canal. No one may enter this restricted area without prior authorization from the marine police.

During the license renewal term, Dominion proposes to continue operating the units as currently operated. Currently, Dominion anticipates no license renewal-related refurbishment for SPS.

Given the size of the river, the saline and tidal influence of the estuary, the documented reduction in water temperatures surrounding the effluent discharge point, positioning of the cooling water intake and discharge to minimize thermal impacts to oyster grounds and regulatory restrictions placed on public access to the waters adjacent to the discharge structures, Dominion Energy does not anticipate the continued operation of SPS to adversely affect the environment or public health as a result of potential microbiological hazards.

We are seeking VDH concurrence with Dominion Energy's conclusion that the continued operation of SPS for the extended license term would not be expected to adversely affect the environment or public health from exposure to thermophilic pathogens on the James River. We appreciate your consideration of this request. Please contact me or Tony Banks should you have any questions concerning this transmittal.

<u>Attachments:</u>

Figure SPS Site
Figure 6-mile Vicinity
Temperature Distribution in the James River Estuary which will result from the Discharge of Waste heat from the Surry Nuclear Power Station, Dominion, 1967.

Figure SPS Site

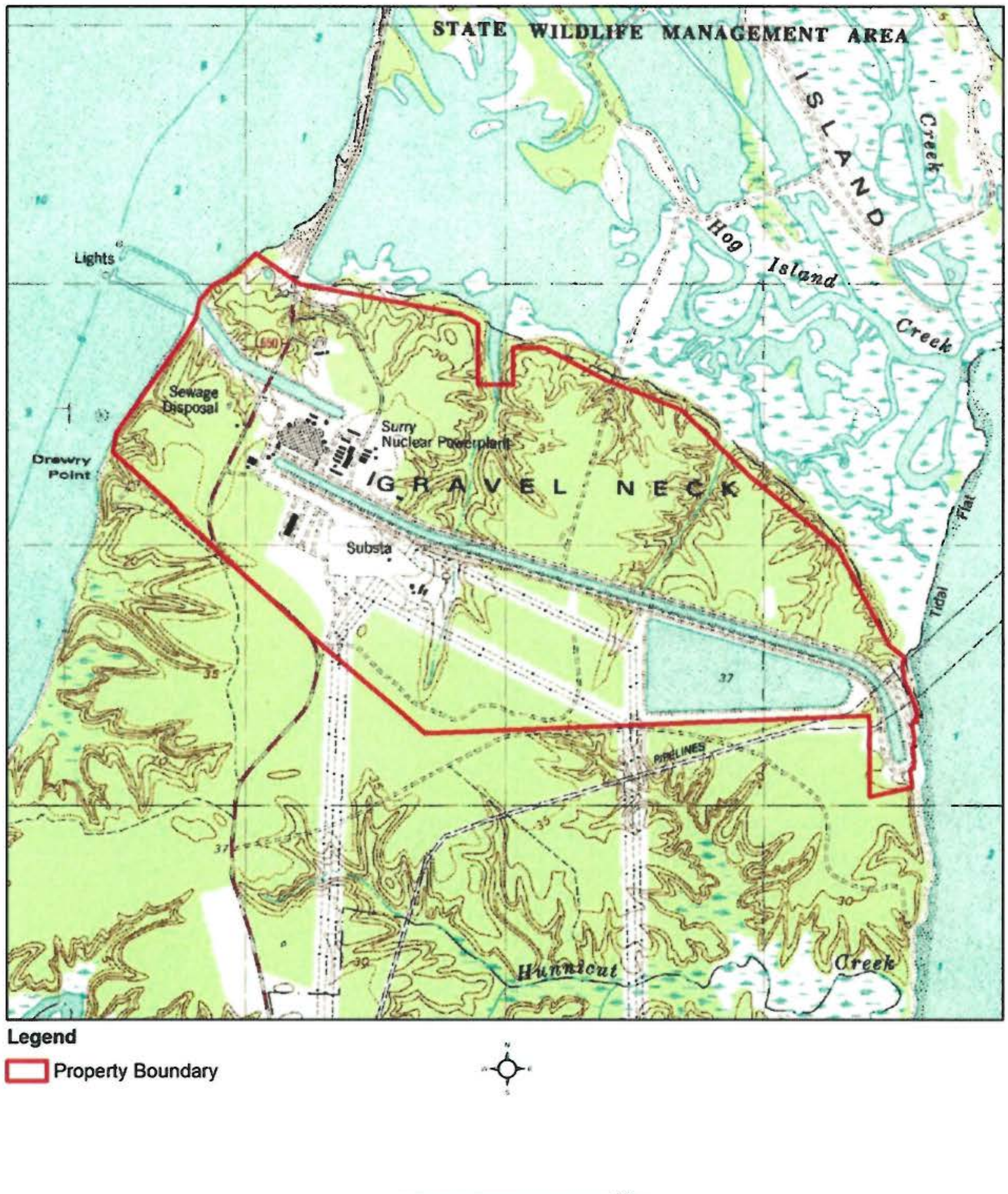
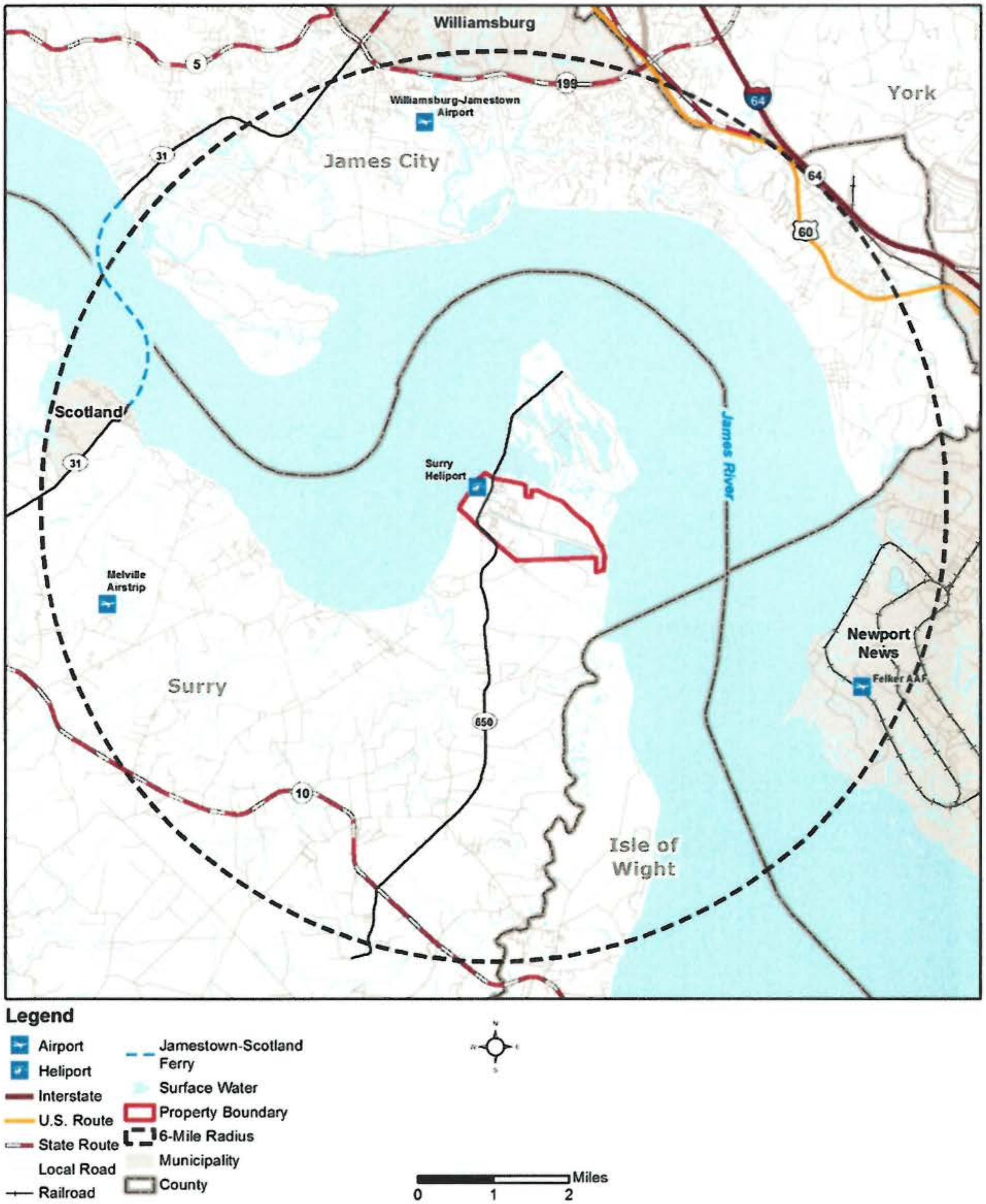


Figure 6-mile Vicinity



SURRY
ENV 50
WATER QUALITY
TEMP./MIXING ZONE/HEAT REJECT.

8-30-67

ENV 50-16

Temperature Distribution in the James River Estuary Which Will Result From the Discharge of Waste Heat From the Surry Nuclear Power Station

A Report Prepared for

Virginia Electric and Power Company
Richmond, Virginia

As Part of the

Surry Nuclear Power Station Site Study

Prepared by
Pritchard-Carpenter, Consultants
208 MacAlpine Road
Ellicott City, Maryland

Background

The Virginia Electric and Power Company is constructing a nuclear power station on the James River estuary. The site of this station, called the Surry Nuclear Power Station, is located approximately 30 miles above the mouth of the James River at Old Point Comfort and 55 miles below Richmond, Virginia. This 85-mile stretch of the river is subjected to tidal motion, and hence is a tidal estuary. It is usual to designate that part of the tidal waterway between the mouth and the point of most upstream intrusion of measurable ocean salt as the estuary proper, while the fresh water segment above that point up to the head of tide is called the tidal river.

Hog Point is the northernmost point of a peninsula formed by a large bend in the James River estuary, as shown in Figure 1. The Surry Nuclear Power Station site extends across the central portion of the peninsula, the river forming both the eastern and western boundaries of the site. The peninsula to the north of the site is a low lying area of tidal marshes, tidal channels, and islands which serve as a wild fowl refuge, and terminates at Hog Point.

The eastern boundary of the site, which borders the river along the downstream side of the peninsula, is approximately opposite Deep Water Shoals. The western boundary borders the river on the upstream side of the peninsula at the northeastern end of Cobham Bay. In the following frequent reference will be made to Deep Water Shoals, or downstream, side, and to Cobham Bay, or upstream, side of the site.

The purpose of this report is to present the results of studies made to determine the probable effect of the discharge of waste heat in the condenser cooling water from the Surry Nuclear Power Station on the distribution of temperature in the adjacent James River estuary. It will aid the discussion of the results of the thermal studies, however, to first briefly consider the pertinent features of the hydrography of the estuary.

Hog Point is in the region of transition between the fresh tidal river and the estuary proper. Under conditions of very high river flow fresh water extends downstream of Deep Water Shoals. During periods of moderately high river flow, brackish water extends past Deep Water Shoals to the vicinity of Hog Point, while the Cobham Bay side of the site remains in the fresh water tidal river. Under flow conditions characteristic of most of the year the upper boundary of the estuary proper is located upstream from the Cobham Bay side of the site.

Under all but the most extreme river flow conditions, the oscillatory ebb and flood of the tide constitute the dominant motion in both estuary proper and the tidal river. The net downstream flow required to discharge the fresh water seaward through any cross section represents but a small fraction of the tidal flows.

The James River estuary has been classified in the literature as a partially mixed estuary. In such an estuary the salinity decreases in a more or less regular manner from the mouth toward the head. The salinity also increases with depth at any location. There usually occurs a layer near mid-depth in which the salinity increases more rapidly with depth than is the case in the overlying fresher layer or in the deeper, more saline layer. In spring and summer this intermediate layer is also a region of relatively rapid decrease in temperature with depth.

The upper, less saline, layer has a net non-tidal motion directed toward the mouth of the estuary, while the lower, more saline, layer has a net non-tidal motion directed toward the head of the estuary. The boundary between these layers is generally sloped across the estuary so that the seaward moving surface layer extends to greater depths on the right side of the estuary (looking seaward) than on the left. Under some conditions, particularly in the wider sections of the estuary, the boundary between the counter-flowing layers intercepts the surface, so that there is a net seaward flow surface to bottom on the right side of the estuary (looking seaward) and a net flow toward the head of the estuary on the left side of the estuary.

This net non-tidal circulation pattern involves flow volumes large compared to the river discharge, but still small compared to the oscillatory tidal flow. For example, measurements made in July 1950, at a time when the fresh water discharge at Hog Point was approximately 6000 cfs, showed a net non-tidal, seaward directed flow in the surface layers at Deep Water

Shoals of 18,000 cfs, and a counter-flow in the deeper layers of approximately 12,000 cfs (note that the difference in non-tidal flow of the surface and deep layers must equal the river discharge). By comparison, the average volume rate of up-river directed flow during the flood-tide period, and of seaward directed flow during the ebb-tide period amounted to some 130,000 cfs through the Deep Water Shoals section.

At the time of the above described flow measurements, the salinity at the surface at Deep Water Shoals was about 4.2‰, and at the bottom about 6.1 ‰. At a point farther down the estuary, where the surface and bottom salinities were, respectively, about 11.0‰ and 14.5‰, the net non-tidal seaward-directed flow in the surface layers was observed to be about 24,000 cfs, or some 4 times the fresh water river discharge. In general, the volume rate of flow of the net non-tidal circulation increases toward the mouth of the estuary.

As the river flow decreases, the salinity distribution moves up the estuary, so that at any location the salinity increases with decreasing river flow. Also, in general, the higher the salinity, the larger the ratio of the net non-tidal flow to the river flow. Thus, within the estuary proper, the water available for dilution of an introduced waste material at a given section does not decrease in direct proportion to the decrease in river flow.

A more detailed description of the hydrology of the estuary is contained in the report "Hydrology of the James River Estuary with Emphasis upon the Ten-Mile Segment Centered on Hog Point, Virginia", previously submitted to the Virginia Electric and Power Company.

Condenser Cooling Water System

In order to convert the thermal energy produced by the reactors into electrical energy, a certain amount of heat must be rejected at the condensers. This waste heat, which for a nuclear power source at current practical efficiencies amounts to approximately 6.8×10^{6} $BTU \cdot hr^{-1}$ per MW produced electric power, is carried away from the condensers in the condenser cooling water. The volume rate of flow of the condenser cooling water is therefore determined by the design temperature rise at the condensers and the number of MW of electric power the plant is designed to produce.

The studies described in this report were designed to determine the probable distribution of excess temperature in the James River estuary resulting from the discharge of 12×10^{9} $BTU \cdot hr^{-1}$ of waste heat (corresponding to 1764 MW produced electric power, or two units at 882 MW each), and of 24×10^{9} $BTU \cdot hr^{-1}$ of waste heat (corresponding to 3528 MW produced electric power, or four units at 882 MW each). A temperature rise at the condensers of 15°F was used in these studies, and hence the volume rate of flow of the condenser cooling water for two units is 3530 cfs and for 4 units 7060 cfs.

The first unit now being constructed at the Surry Nuclear Power Station site is actually sized at 850 MW electrical power, and the heat rejected under full load for this unit will therefore be 5.2×10^9 BTU. Some tests were conducted on the James River estuarine hydraulic model using this heat loading; however, since it is planned that a second unit, perhaps somewhat larger than the first unit, will be added within a few years, and since it may be desirable ultimately to develop the site for 4 units, most of the results presented here are for the higher values of rejected heat given in the previous paragraph.

At the Surry Nuclear Power Station condenser cooling water is to be drawn from the estuary from one side of the Hog Point peninsula and discharged from the other side, thus the intake and discharge are separated by something over a tidal excursion. Tests were conducted both for the intake on the downstream side of the plant site and the discharge on the upstream side, and for the opposite arrangement. On the basis of these tests, it was determined that any possible influence of the heated discharge on the environment would be minimized if the condenser cooling water were withdrawn from the downstream, or Deep Water Shoals, side of the plant site and discharged from the upstream, or Cobham Bay, side. The major portion of the data presented here is therefore for this arrangement of intake and discharge.

Description of Thermal Studies

The distribution of excess temperature which will result from the discharge of waste heat from the Surry Nuclear Power Station as presented in the later sections of this report is based on studies conducted on the hydraulic model of the James River estuary located at the U. S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi. This model covers the entire tidal waterway from Richmond to the mouth, and also part of the lower Chesapeake Bay. The model has a horizontal scale of 1:1000, and a vertical scale of 1:100. The approximately 90 nautical miles of the estuary are therefore represented by a model about 550 feet long. The time scale of this model is 1:100; hence one day in the prototype occurs in about $14\frac{1}{2}$ minutes in the model.

All pertinent features of tide, current, river inflow and mixing of sea water and fresh water (and hence the distribution of salinity) are properly scaled in the model. Density, temperature and salinity are all scaled 1:1 in this model, and it has been shown that for models of this relative size, the thermal exchange processes at the water surface are also properly scaled.

A model thermal plant was constructed which consisted of a pump, a flow control system, an accurate volume rate of flow gage, electric heaters to simulate the condensers, a temperature sensing and control system to maintain a constant temperature rise of 15°F between intake and discharge. This model plant was set up on the hydraulic model of the James River estuary at the location corresponding to the Surry Nuclear Power Station site.

Tests were conducted during two different periods. The first set of tests were made during the period 29 July through 1 August 1966, and the second series during the period 19 October through 23 October 1966. During the July-August studies, the model was run for a total of 475 tidal cycles, corresponding to approximately 246 days of prototype time. The river inflow at Richmond was maintained throughout this series at a simulated 2000 cfs. One of the main purposes of this first series of tests was to determine the degree of mixing produced by discharging the condenser cooling water as a jet having an initial velocity equal to or larger than the tidal velocity in the estuary. Tests were run with the velocity of the condenser cooling water, at the point of discharge into the waterway, of 2 $ft \cdot sec^{-1}$, 4 $ft \cdot sec^{-1}$, 4.56 $ft \cdot sec^{-1}$, 6 $ft \cdot sec^{-1}$ and 9.15 $ft \cdot sec^{-1}$. On the basis of these studies, it was determined that a discharge velocity of 6 feet per second would be most suitable for design of the condenser discharge structure.

Tests were conducted during this July-August series with a simulated heat rejection at the condensers of $5.2 \times 10^9 BTU \cdot hr^{-1}$, corresponding to a single 850 MW unit, and at $12 \times 10^9 BTU \cdot hr^{-1}$, corresponding to a total of 1764 MW electrical power production. Temperatures in the model were measured using a rapid response thermistor bead mounted on a motor driven trolley structure which ran across the model on a 16-foot long aluminum beam. A single run consisted of setting the beam across the model at a designated cross-section, and running the thermistor sensor across the model to obtain a plot of temperature vs lateral distance made on a strip chart recorder. At each location runs were made each $1\frac{1}{2}$ hours throughout a tidal cycle. During the July-August test series a total of 496 such temperature runs was made.

For the October series improvements were made in the temperature measuring system, so that two thermistor bead sensors were towed across the model on each run. The sensors were placed 18 inches apart, representing a prototype distance of 1500 feet. Thus near the discharge structure one run provided data for two adjacent temperature cross sections. Farther away from the discharge, where the horizontal temperature gradients were small, the two simultaneous sections provided a check on the consistency of the data. During the October studies the model was run for a total of 784 tidal cycles, corresponding to about 379 days of prototype time. Some 489 temperature runs were made, each consisting of at least one and in many cases two records of surface temperature across a section of the estuary. The locations of the sections at which temperature runs were made are shown in Figure 2. Again, as in the earlier series of tests, runs were repeated at each section for each $1\frac{1}{2}$ hours of the tidal cycle, for each set of test conditions.

Tests were conducted for river inflows at Richmond of 2000 cfs and 6000 cfs, and for heat rejected at the condensers of 12×10^9 BTU·hr^{-1}, corresponding to two 882 MW units, and of 24×10^9 BTU·hr^{-1}, corresponding to 4 such units. Most of the tests were run with the intake on the Deep Water Shoals side of the plant site, and the discharge on the Cobham Bay side, as marked in Figure 2. One set of tests were, however, run with the intake and discharge reversed.

During the October studies a special test was made to determine the surface heat exchange coefficient for the model. For this test Cobham Bay was blocked off from the rest of the model using a long rubber dam. Motor driven paddle wheels were mounted in the enclosed area to circulate the water at a speed corresponding to the mean tidal current. Thermistor bead temperature sensors were placed at several locations in the enclosed water area. Water from this area was circulated through the heaters until the temperature in the enclosed area was 20°F above the ambient water temperature in the adjacent model. A temperature-time record was then made as the water in the enclosed basin cooled. The rate of cooling provided a measure of the surface heat exchange coefficient.

With the tests in the model running over several days during each series, the base or ambient temperature of the water in the model varied during the tests. It was therefore necessary to monitor the water temperature in the model in areas which were sufficiently removed from the plant site so that the temperature of these areas represented the ambient water temperature. During both series of tests, fixed thermistor bead temperature sensors were therefore placed in the model at positions well upstream and well downstream from the plant site.

Treatment of Temperature Data; Some Theoretical and Empirical Relationships

In the following the term excess temperature is used to designate the incremental increase in temperature of the water at a given point in the estuary over that which would occur if there were no discharge of waste heat to the estuary. Thus, if T_h represents the temperature of the water at a given position in the estuary under conditions of waste heat discharge, and T_n represents the temperature which would occur under natural conditions, then

(1) $\Theta = T_h - T_n$

defines the excess temperature, Θ.

Designating Q_h as the rate of introduction of waste heat into the condenser cooling water, Q_c as the volume rate of flow of the condenser cooling water, and Θ_o as the temperature rise at the condensers, then

(2) $Q_h = \rho C_p \Theta_o Q_c$

where ρ is the density of the water and C_p is the specific heat at constant pressure. Further, if H_n designates the heat content per unit volume of a water parcel under natural conditions, and H_h designates the heat content per unit volume of that water parcel under conditions of discharge of waste heat to the waterway, then

(3) $h = H_h - H_n$

defines the excess heat content, h. Also,

(4) $h = \rho C_p \Theta$.

Consider a small parcel of water at the surface, having a vertical thickness D_h. This parcel will gain or lose heat through the sides and bottom due to exchange of water with adjacent parcels of different heat content (i.e., the processes of advection and turbulent diffusion). The parcel will also gain and lose heat across the water surface due to radiation processes and to exchange processes with the atmosphere. Under steady state conditions, all these gains and losses must be in balance. Hence, for natural conditions, the heat budget of the parcel can be written

(5) $(Q_s)_n - (Q_r)_n + (Q_a)_n - (Q_b)_n - (Q_e)_n - (Q_t)_n + (Q_v)_n + (Q_d)_n = 0$

where: Q_s = incident solar radiation on the water surface

Q_r = reflected solar radiation at the water surface

Q_a = long wave atmospheric radiation adsorbed by the water

Q_b = long wave radiation emitted by the water surface

Q_e = heat carried away from the surface by evaporation

Q_t = heat loss from water surface to atmosphere by conduction

Q_v = heat gained by advective processes

Q_d = heat gained by processes of turbulent diffusion

A similar expression can be written for the case of introduction of waste heat to the waterway. Thus:

(6) $(Q_s)_h - (Q_r)_h + (Q_a)_h - (Q_b)_h - (Q_e)_h - (Q_t)_h + (Q_v)_h + (Q_d)_h = 0$

Now the incoming solar radiation, the reflected radiation and the radiation from the atmosphere will be the same for both cases; that is

$$(Q_s)_n = (Q_s)_h$$

$$(Q_r)_n = (Q_r)_h$$

and $$(Q_a)_n = (Q_a)_h$$

Hence, when equation (5) is subtracted from equation (6), we have

(7) $q_v + q_d - q_b - q_e - q_t = 0$

where

$$q_v = (Q_v)_h - (Q_v)_n \qquad \text{etc.}$$

Equation (7) can be considered to express the budget for the excess heat. Note that this budget is independent of solar and atmospheric radiation.

The last three terms in (7) represent the exchange of excess heat from the water to the atmosphere. The long wave radiation emitted by the surface of a parcel of water is proportional to the fourth power of the absolute temperature of the parcel. Because the difference in absolute temperature between the heated and natural conditions is relatively small, it can be shown that

(8) $q_b \doteq F_1 \cdot \Theta$

where F_1 is a slowly varying function of the ambient temperature, T_n.

The amount of heat lost by evaporation from a parcel of water is given by

$$Q_e = \rho L (a + bW)(e_s - e_a)$$

where L is the latent heat of vaporization, W is the wind speed, e_s the saturated vapor pressure, and e_a the vapor pressure of the air over the water (which in turn is given by $R \cdot e_s$ where R is the relative humidity). Now, since

$$q_e = (Q_e)_h - (Q_e)_n$$

then

(9) $q_e = \rho L (a + bW) \left\{(e_s)_h - (e_s)_n\right\}$

since e_a will be the same for both natural and heated conditions. Thus the rate of excess heat loss by evaporation is dependent on the wind speed, and on the difference between the saturated vapor pressure for the heated and natural conditions. It is not dependent on the relative humidity. Now the saturated vapor pressure over a water surface is dependent only on the temperature of the water surface, and it can therefore be shown that

(10) $(e_s)_h - (e_s)_n \doteq F_2 \Theta$

where F_2 is a slowly varying function of the ambient temperature, T_n, and to a lesser degree, of the excess temperature, Θ.

The sensible heat loss term is related to the evaporative heat loss through the Bowen ratio. It can therefore be shown that

(11) $q_t = F_3(a + bW) \cdot \Theta$

where F_3 is a slowly varying function of the ambient temperature, T_n, and to a lesser degree of the excess temperature, Θ.

Combining these expressions, we have

(12) $q_b + q_e + q_t = \rho C_p \gamma \Theta$

where γ, the surface heat exchange coefficient, is primarily a function of wind velocity, but also varies somewhat with the ambient temperature T_n, and only slightly with the excess temperature, Θ. The various constants which enter the terms comprising γ have been determined. Table 1 is an abbreviated table of γ as a function of wind velocity, ambient temperature, and excess temperature, to show the primary dependence on wind velocity, the secondary dependence on ambient temperature, and the slight dependence on the excess temperature.

Table 1

The surface heat exchange coefficient, γ, as a function of the wind velocity W (miles per hour), the ambient temperature, T_n(°F), and the excess temperature, Θ(°F)

	For Θ = 10° F			For Θ = 2° F		
W \ T_n	40°	60°	80°	40°	60°	80°
0	0.017	0.020	0.022	0.014	0.016	0.017
5	0.040	0.052	0.074	0.034	0.045	0.064
10	0.062	0.085	0.125	0.055	0.075	0.111

Returning to equation (7), it is seen that the excess heat budget can be written

$$(13) \quad q_v + q_d + \rho C_p \gamma \Theta = 0$$

Now the advective and diffusive terms in this budget (the q_v and q_d) depend on the velocity field, the intensity of turbulence, and on the spatial gradients of the excess temperature, Θ. The hydraulic model is designed to reproduce the prototype velocity field and the intensity of turbulence. The relative pattern of the distribution of excess heat, as shown by the excess temperature isolines as observed in the model, should be applicable to the prototype. However, the model is subject to a different heat exchange coefficient than will prevail in the natural environment. It is therefore necessary to adjust the excess temperature distributions, as observed in the model, to take into account the difference in surface exchange coefficient between model conditions and prototype conditions. The correction procedure is based on the expression:

$$(14) \quad (A_\Theta)_2/(A_\Theta)_1 = f\left\{\frac{\gamma_1}{\gamma_2}, \Theta\right\}$$

where $(A_\Theta)_1$ is the area inside the isoline of excess temperature Θ for a surface exchange coefficient γ_1; and $(A_\Theta)_2$ is the area inside the isoline of excess temperature Θ for a surface exchange coefficient γ_2. In the region near the discharge, where the highest values of Θ are found, cooling has had little time to act. Hence the areas are to a first approximation independent of γ, and the ratio given in (14) is close to unity. For regions removed from the source, the area within an isotherm is inversely proportional to the surface exchange coefficient. However, since the total heat lost to the atmosphere must in all cases equal the heat rejected at the condensers, the ratio of the areas for the two cases of surface cooling must be, for small Θ, slightly less than the inverse ratio of the surface exchange coefficients. Therefore:

$$(15) \quad (A_\Theta)_2/(A_\Theta)_1 \longrightarrow \begin{cases} 1 & \text{for } \Theta \text{ large} \\ n \times \gamma_1/\gamma_2 & \text{for } \Theta \text{ small, where } \underline{n} \text{ is a number slightly less than unity} \end{cases}$$

On the basis of available data, we have used the following relationships in converting the temperature data observed in the model to the conditions expected in the prototype

$$(16) \quad \begin{cases} (A_\Theta)_p/(A_\Theta)_m = 1 \text{ for } \Theta \geq 0.5\,\Theta_o \\ (A_\Theta)_p/(A_\Theta)_m \doteq 0.9\dfrac{\gamma_m}{\gamma_p} \text{ for } \Theta \leq 0.15\,\Theta_o \end{cases}$$

and a linear variation in the ratio for intermediate temperatures.

The procedure in developing the expected distribution of excess temperature for the James River estuary from the data obtained in the model involved the use of the isothermal patterns as observed in the model, with an adjustment to the areas contained within the isotherms in accordance with equation (16).

The Results of the Thermal Studies

The results presented here are based primarily on the data collected during the October test series. A comparison of the results of the two series showed somewhat lower excess temperatures in the August tests, as compared to the October tests, than could be accounted for by the difference in ambient temperature in the two cases. During the August tests the large doors to the building containing the model were generally kept opened, and circulating fans were operating over various areas in the building (although not directly on the test area). The surface exchange coefficient increases rapidly with wind speed at wind speeds near zero. It is likely that the surface exchange coefficient applicable to the August tests corresponded to a finite but unmeasured wind speed. Further, there was an appreciable temperature gradient along the length of the model, and with time during the August series of tests not related to the introduction of waste heat. Hence the precise establishment of a base temperature was difficult for this series.

During the October series, the building was kept closed. Direct measurements of the surface exchange coefficient gave values appropriate for zero wind speeds. The ambient temperature variation in space and time was much less in this series than in the August studies, and the base temperature could be established with considerable confidence.

While the results of the August tests show somewhat better conditions (lower excess temperatures) than the results of the October series, the differences are not of large magnitude. It was felt most appropriate to restrict the presentation here to the data collected under conditions for which the greatest confidence could be placed in the results.

Figure 2 shows the locations of the sections along which temperature data were obtained. The actual observed temperature for each of the sections occupied during the October test series, expressed in terms of excess temperature, Θ, is given in the appendix.

Figures 3 through 34 present the excess temperature distribution as determined for the James River estuary, under conditions of an ambient temperature of 80°F and a wind velocity of 5 mph. The distribution is given as isolines of constant excess temperature, expressed in °C. These figures show the expected excess temperature distribution for the condenser cooling water discharge on the Cobham Bay side of the plant site, and the intake on the Deep Water Shoals side.

For each combination of river discharge and rejected heat, the excess temperature distribution is given for each $1\frac{1}{2}$ hours over a tidal cycle. The conditions of river flow and rate of heat rejection for each set of figures are as follows:

Figure No.'s	River Flow, cfs	Rate of Heat Rejection	(Power Production)
3 through 10	2000	12×10^9BTU·hr^{-1}	(1765 MW)
11 through 18	6000	12×10^9BTU·hr^{-1}	(1765 MW)
19 through 26	2000	24×10^9BTU·hr^{-1}	(3530 MW)
27 through 34	6000	24×10^9BTU·hr^{-1}	(3530 MW)

As stated earlier in this report, tests were also conducted with the intake located on the upstream side of the plant site and the discharge on the downstream side. The distributions of excess temperature for this intake-discharge arrangement, and for a river flow of 2000 cfs and a rate of heat rejection of 12×10^9BTU·hr^{-1} are given for each $1\frac{1}{2}$ tidal hours in Figures 35 through 42. Commercial oyster leases occur just downstream of the discharge on the west side of the river, and also just across the river from the discharge. It is evident that these oyster bars would be subject to considerably higher excess temperatures with the discharge on the downstream side than for the case of the discharge on the upstream side. Discharge of the condenser cooling water to the upstream, or Cobham Bay, side of the plant site has been shown by these studies to provide less possibility of harm to the environment, and further discussion is therefore limited to this discharge arrangement.

A comparison of Figures 3 through 10, which are for a river flow of 2000 cfs, and with Figures 11 through 18, which are for a river flow of 6000 cfs, shows that there is very little difference in the distribution of excess temperature under different river flows. The following factors contribute to this lack of significant dependence on river discharge:

(a) The initial mechanical mixing produced by the jet discharge, which provides for a rapid decrease in the maximum excess temperatures, functions independent of river flow.

(b) Mixing provided by the oscillatory ebb and flood of the tide, which on a single flood tide passes an average of 190,000 cfs past the plant site, is not significantly influenced by river discharge except for very high river flows.

(c) The net new water made available to the tidal segment adjacent to the plant site, as a result of tidal mixing, is relatively constant over a wide range of river discharges. The net flow of new water to the tidal segment is related to the vertical salinity distribution by the following relationship:

$$(17) \quad Q_i = R\left[1 + \frac{S_u}{S_\ell - S_u}\right]$$

where Q_i is the volume rate of inflow of net new water, R is the volume rate of inflow of fresh water (the river discharge), S_u is the mean salinity in the upper layers of the estuary and S_ℓ is the mean salinity of the lower layers of the estuary. Salinity data taken in the model during these thermal studies showed that at the Deep Water Shoals section, for a river discharge of 2000 cfs, $S_u = 11.60‰$ and $S_\ell = 12.52‰$. Hence:

$$Q_i = 2000 + 2000 \times \frac{11.60}{0.92} = 2000 + 25,220 = 27,220 \text{ cfs}$$

For the river discharge of 6000 cfs, the salinity data at Deep Water Shoals gave $S_u = 5.02‰$ and $S_\ell = 6.46‰$. Hence for this river flow

$$Q_i = 6000 + 6000 \times \frac{5.02}{1.44} = 6000 + 20,940 = 26,940 \text{ cfs} .$$

Thus it is clear that the water available for dilution is relatively independent of river flow except perhaps at high river discharges.

An inspection of Figures 3 through 18, which are for a rate of heat rejection of $12 \times 10^9 \text{BTU}\cdot\text{hr}^{-1}$, reveals that the area of the estuary having excess temperatures greater than 5°C is quite small compared to the area of the tidal segment into which the discharge is being made. The size of this area of warmest water is largest at tidal hour $4\frac{1}{2}$ for a river flow of 2000 cfs (Figure 6), when it comprises a plume 3500 yards long with an average width of less than 300 yards. On the average over the tidal cycle, water having surface excess temperatures of 2°C or greater occupies less than one-third of the width of the estuary.

The warmest water is confined primarily to the upper 10 feet of the water column. Only when the excess temperatures are less than 2°C is there likely to be penetration of excess heat to greater depths.

Inspection of Figures 19 through 34, which are for a rate of heat rejection of 24×10^9BTU, corresponding to 3530 MW produced electric power, reveals that while the areas within given isolines of excess temperature are greater for this heat loading than in the case of a rate of heat rejection of 12×10^9BTU, the area of the estuary subjected to warm water is still not excessive. Averaged over the tidal cycle, the area having excess temperatures greater than 5°C occupies less than 14% of the width of the estuary, while the area having excess temperatures greater than 2°C occupies less than half of the width of the estuary.

As discussed earlier in this report, the distribution of excess temperature in the estuary results from a combination of mixing and cooling. The mixing produced by the jet discharge and by the tidal flow is very important in reducing to a minimum the area having excess temperatures which might be of biological significance. Surface cooling alone could not accomplish this rapid reduction in excess temperatures. To see this consider the data given in Table 2. Here the area having excess temperatures greater than a given value, Θ, as determined for the James River estuary for a rate of heat rejection at the condensers of $12 \times 10^9 BTU \cdot hr^{-1}$, is compared to the area of a flow through cooling pond required to reduce the excess temperatures to the given value, Θ, by surface cooling alone. The cooling pond areas are based on the relationship

$$(18) \quad A_{\Theta} = \frac{Q_c}{\gamma} \ln \frac{\Theta_o}{\Theta}$$

where A_{Θ} is the area of the cooling pond required to reduce the excess temperature of the condenser cooling water from Θ_o, the temperature rise at the condensers, to the value Θ; Q_c is the volume rate of flow of the condenser cooling water; and γ is the surface heat exchange coefficient. For this comparison, the value of γ has been taken for an ambient water temperature of 80°F and a wind velocity of 5 mph, which are the conditions taken for the estuary. Θ_o in both cases is 15°F (8.33°C).

Table 2

Area (A_{Θ}) having excess temperatures greater than the given value of Θ, as determined for the James River Estuary and for a Flow Through Cooling Pond, for a Rate of Heat Rejection of $12 \times 10^9 BTU \cdot hr^{-1}$, an Ambient Temperature of 80°F (26.7°C), a Wind Speed of 5 mph, and a Temperature Rise at the Condensers of 15°F (8.33°C)

	Area, A_{Θ} (ft^2) For	
Θ°C	James River	Cooling Pond
5	0.29×10^7	0.93×10^8
4	1.63×10^7	1.33×10^8
3	2.04×10^7	1.86×10^8
2	4.91×10^7	2.59×10^8
1	1.55×10^8	3.86×10^8

This table shows that the area having excess temperatures greater than 5°C would be over 30 times as large for the case of surface cooling alone as for the case of the James River estuary where mixing and cooling are important. The area in the James River having excess temperatures for this rate of heat rejection of 2°C or greater is only about one-half of the area of a cooling pond required to reduce the excess temperatures to 5°C.

Conclusions

1. The results of the thermal studies in the James River estuarine model for a rate of heat rejection of 12 x 10^9BTU·hr^{-1}, corresponding to 1765 MW electric power production, (Figures 3 through 18) show that only a small portion of the estuarine water in the tidal segment adjacent to the plant site is subjected to excess temperatures which might have biological significance. Averaged over a tidal cycle, the area having excess temperatures exceeding 5°C occupies less than 7% of the width of the estuary. Over 2/3 of the width of the estuary in the tidal segment adjacent to the discharge would have excess temperatures less than 2°C. The highest excess temperature which completely closes a cross-section would be 0.80°C which occurs on only one of the eight distributions over the tidal cycle. The average closing excess temperature over the tidal period is 0.66°C.

2. The excess temperature distribution in the James River estuary adjacent to the Surry Nuclear Power Plant site, as determined for a rate of heat rejection of 24 x 10^9BTU, reveals that even for this loading there is not an unreasonable use of the estuarine environment as a heat sink. Averaged over a tidal cycle, the area having excess temperatures exceeding 5°C occupies less than 14% of the width of the estuary. Approximately one-half of the width of the estuary in the tidal segment adjacent to the discharge would have excess temperatures less than 2°C. The highest excess temperature which completely closes a cross-section would be 1.09°C, and this occurs on only one of the eight distributions over the tidal cycle. The average closing excess temperature over the tidal cycle is 0.82°C.

3. A condenser cooling water circulating system with the intake on the downstream side of the site and the discharge on the upstream side is more desirable, from the standpoint of the estuarine environment, than the opposite arrangement.

4. The magnitude of the river discharge has little effect on the excess temperature distribution, except perhaps at very high discharges.

5. The mechanical mixing produced by a jet discharge, and the turbulent mixing resulting from the tidal currents, contribute significantly to reducing the area occupied by the warmest water. Cooling alone would not be sufficiently effective in restricting the area subjected to the warm water to acceptable size.

The attached appendix contains the observed temperature data, as read from the strip chart records, expressed as the difference between the observed temperature in °F and the base, or ambient temperature for the time of each temperature section. These observed excess temperatures are entered along a line representing the section on which the measurements were taken, at a position on the line representing the corresponding position on the section. The section locations are shown in Figure 2.

August 30, 1967

D. W. Pritchard
Consultant

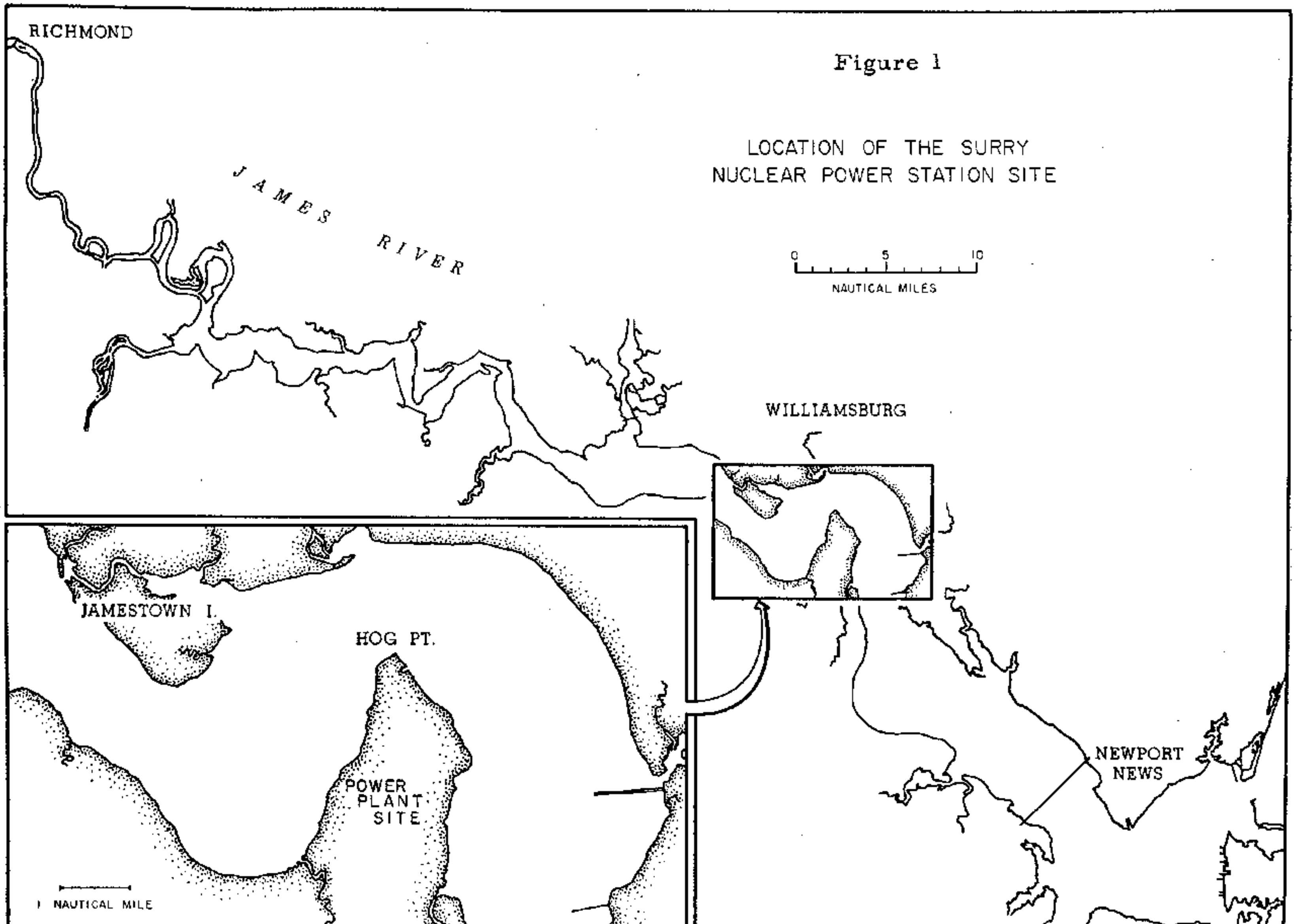


Figure 1

LOCATION OF THE SURRY NUCLEAR POWER STATION SITE

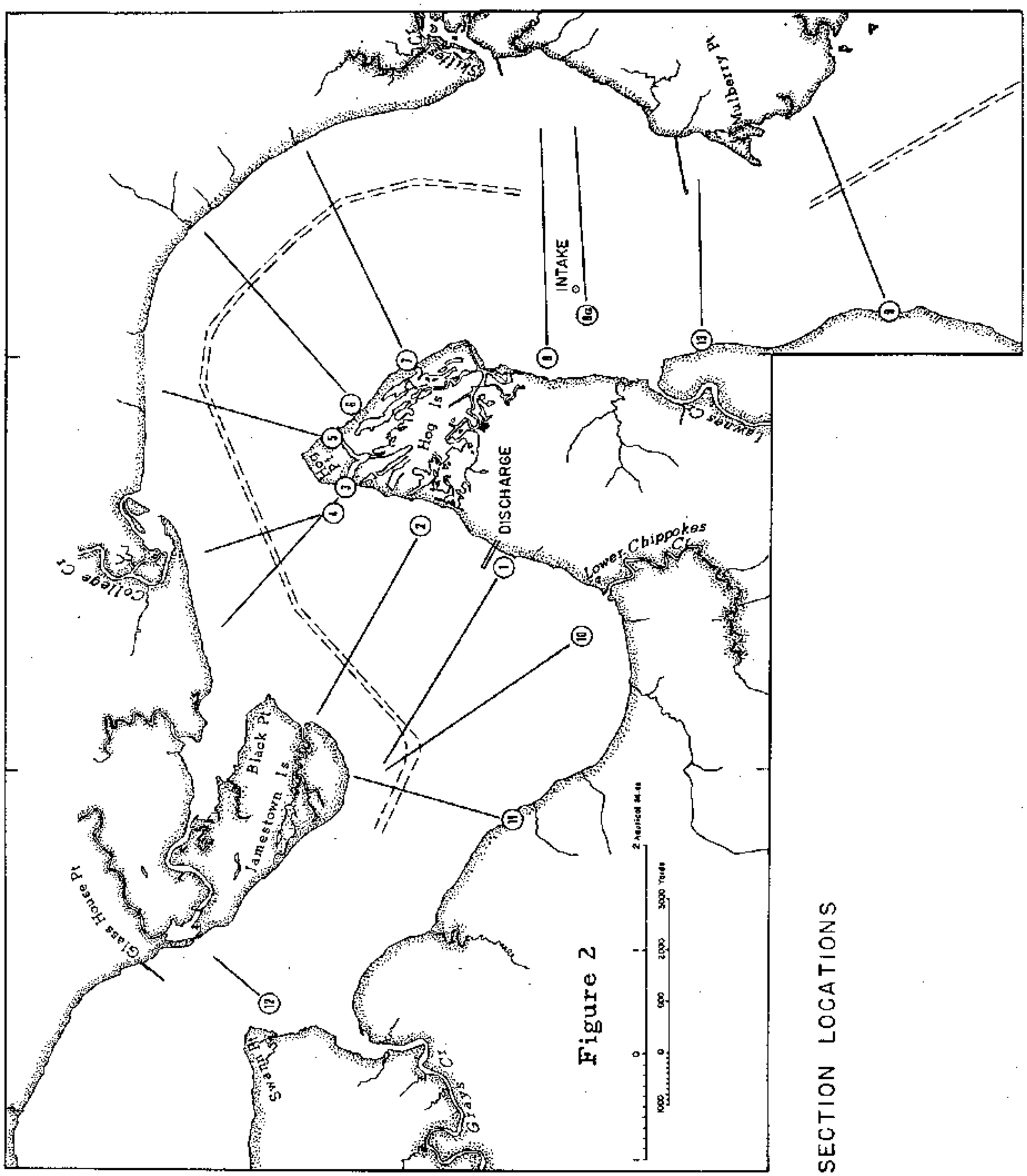


Figure 2

SECTION LOCATIONS

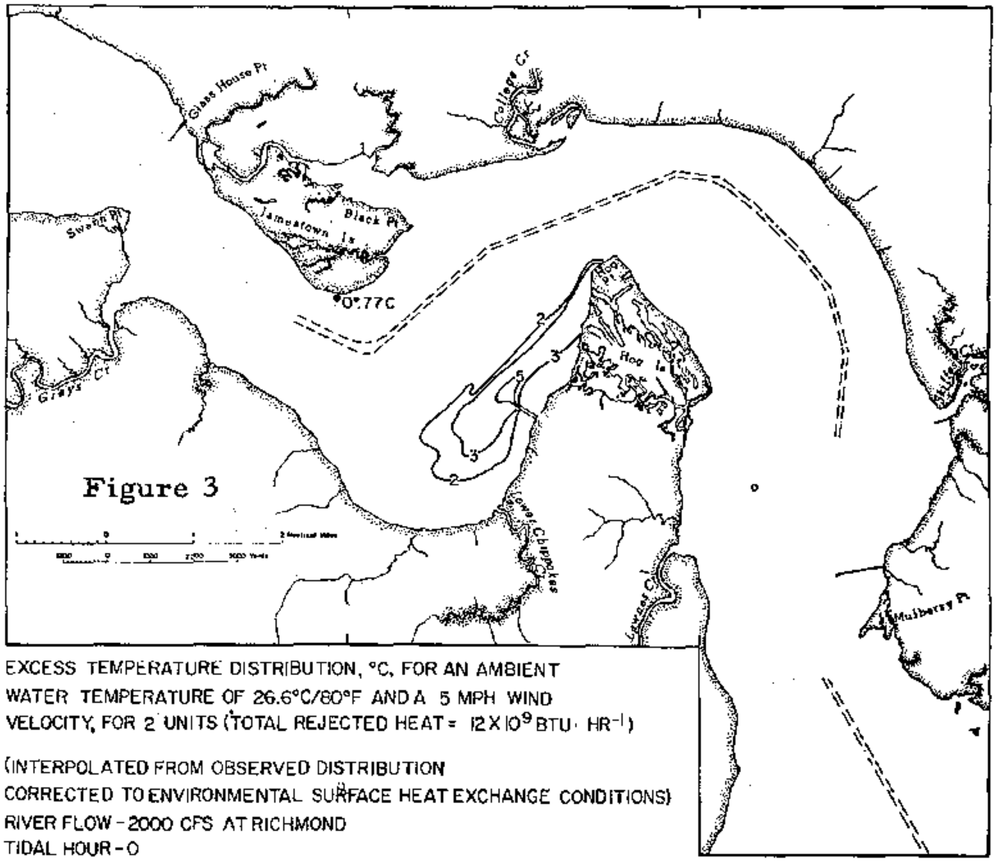


Figure 3

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 2 UNITS (TOTAL REJECTED HEAT = 12×10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 2000 CFS AT RICHMOND
TIDAL HOUR - 0

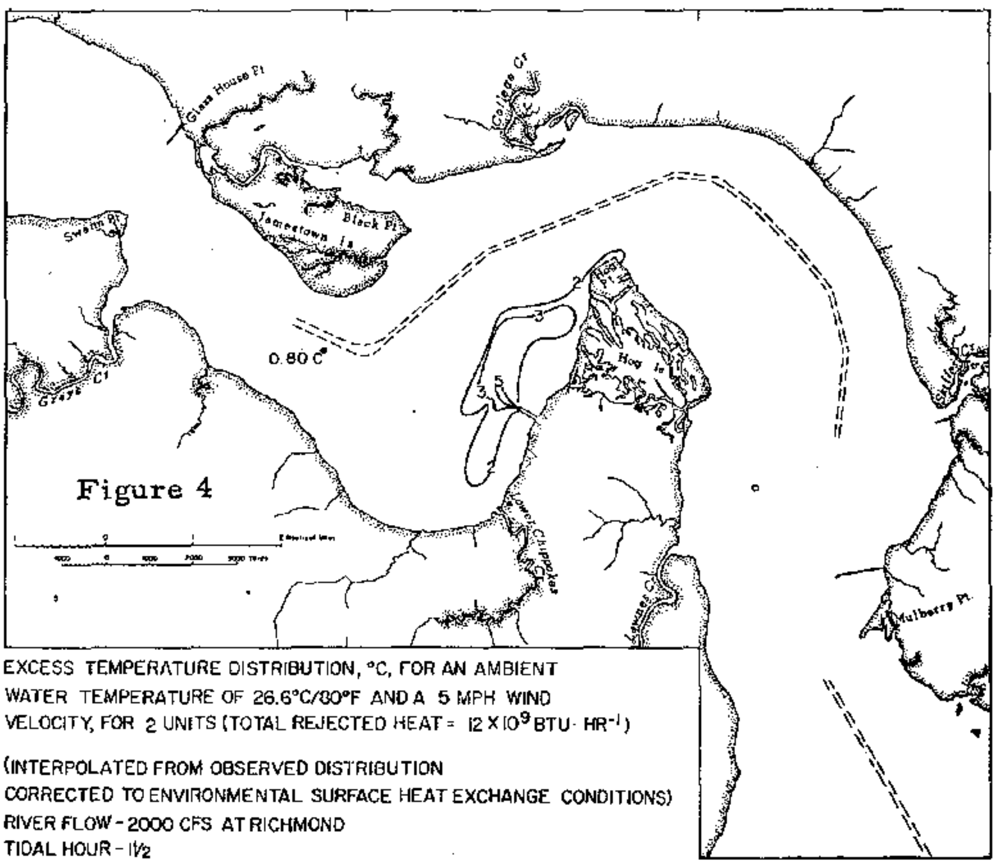
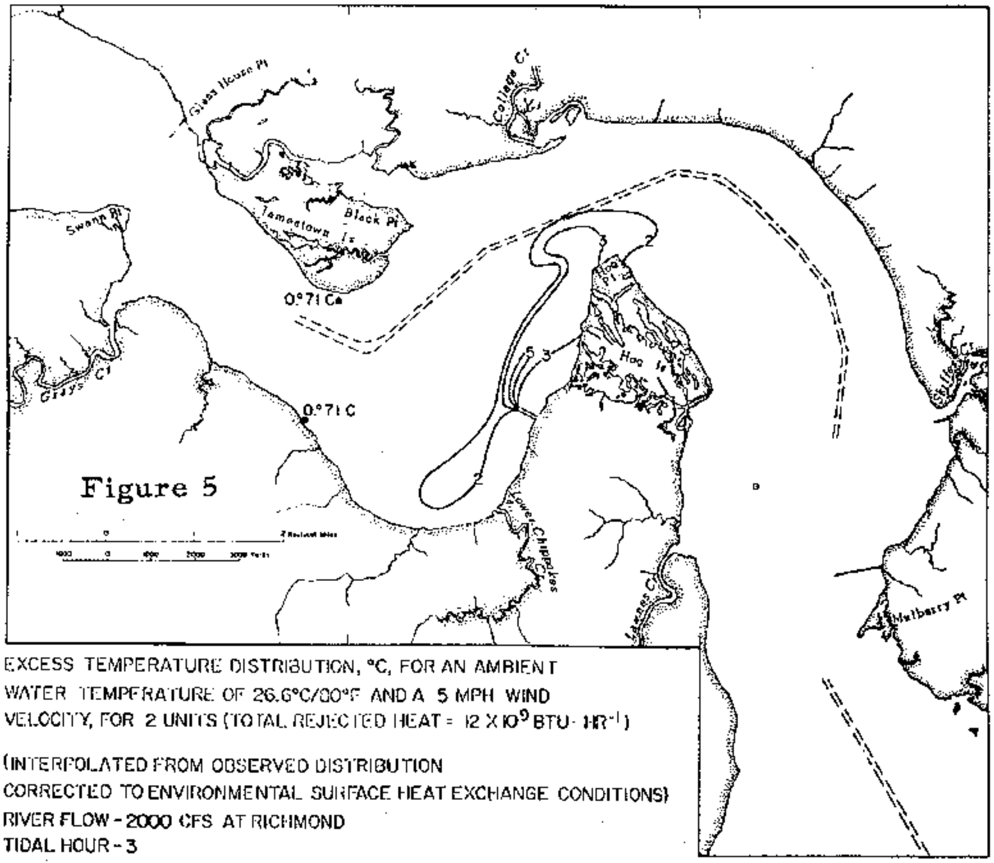


Figure 4

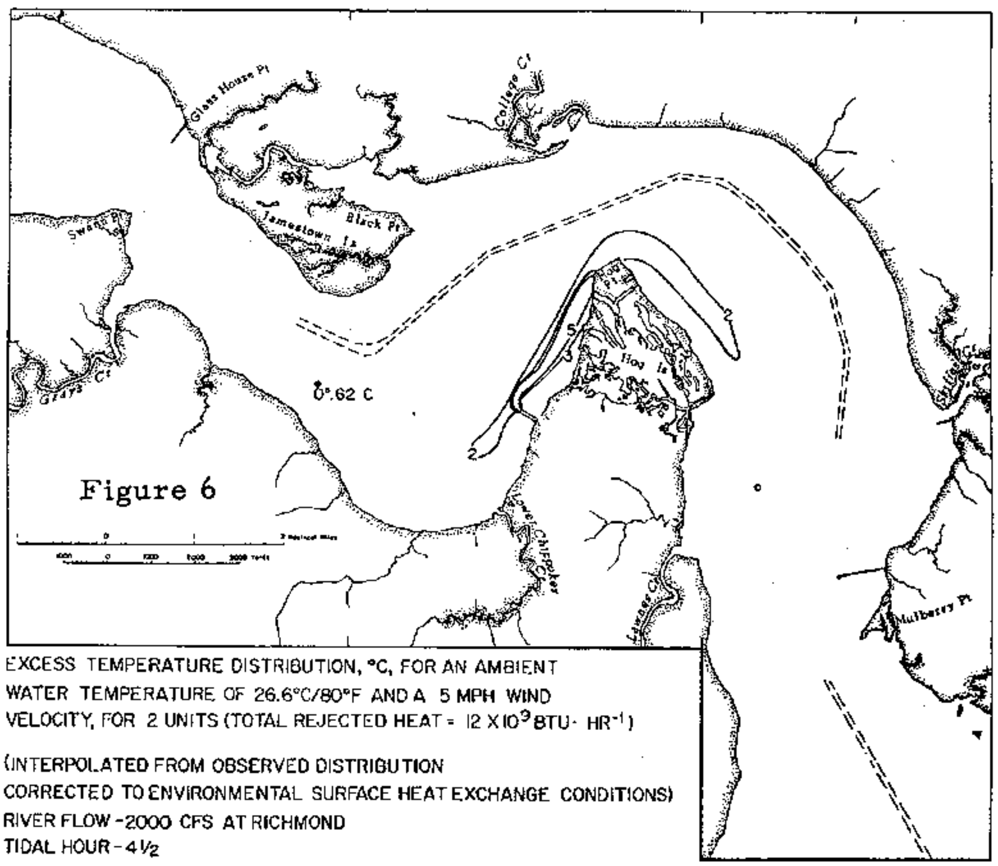
EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 2 UNITS (TOTAL REJECTED HEAT = 12×10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 2000 CFS AT RICHMOND
TIDAL HOUR - 1½



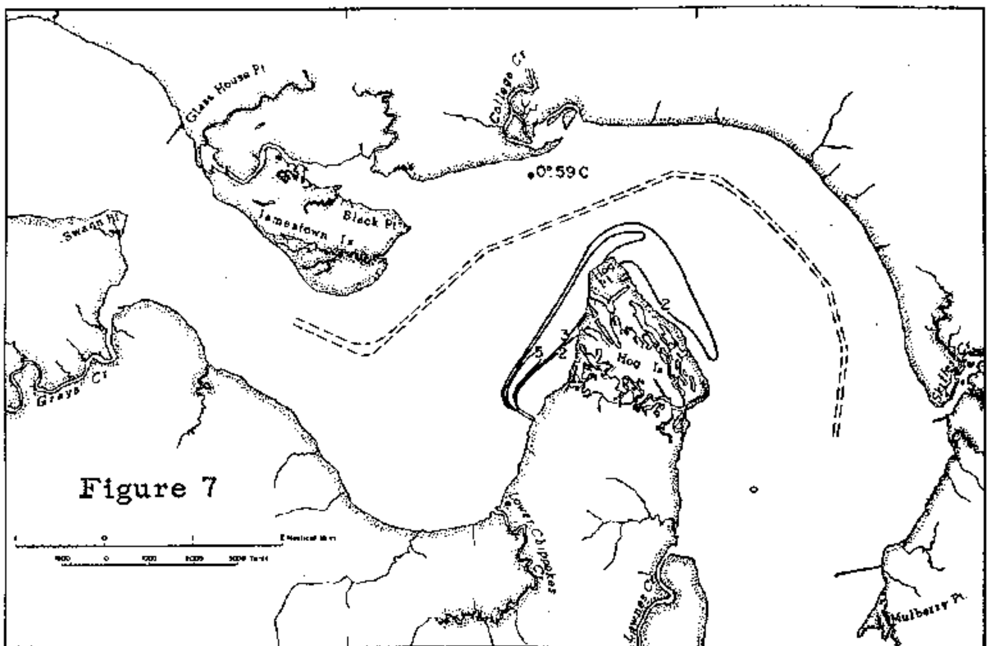
EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 2 UNITS (TOTAL REJECTED HEAT = 12×10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 2000 CFS AT RICHMOND
TIDAL HOUR - 3



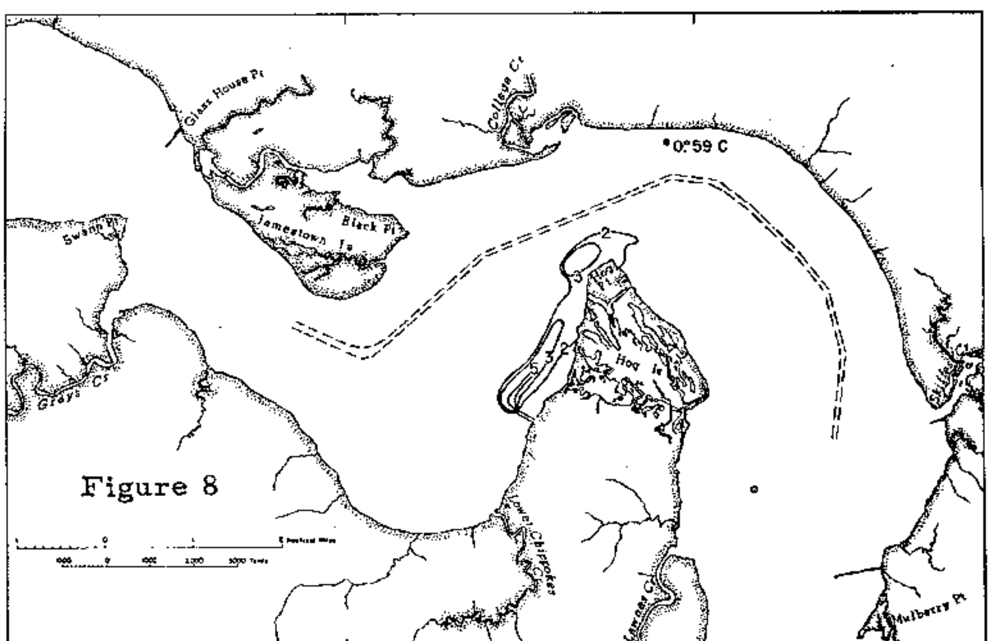
EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 2 UNITS (TOTAL REJECTED HEAT = 12×10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 2000 CFS AT RICHMOND
TIDAL HOUR - 4 1/2



EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 2 UNITS (TOTAL REJECTED HEAT = 12×10^9 BTU· HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION
CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 2000 CFS AT RICHMOND
TIDAL HOUR - 6



EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 2 UNITS (TOTAL REJECTED HEAT = 12×10^9 BTU· HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION
CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 2000 CFS AT RICHMOND
TIDAL HOUR - 7½

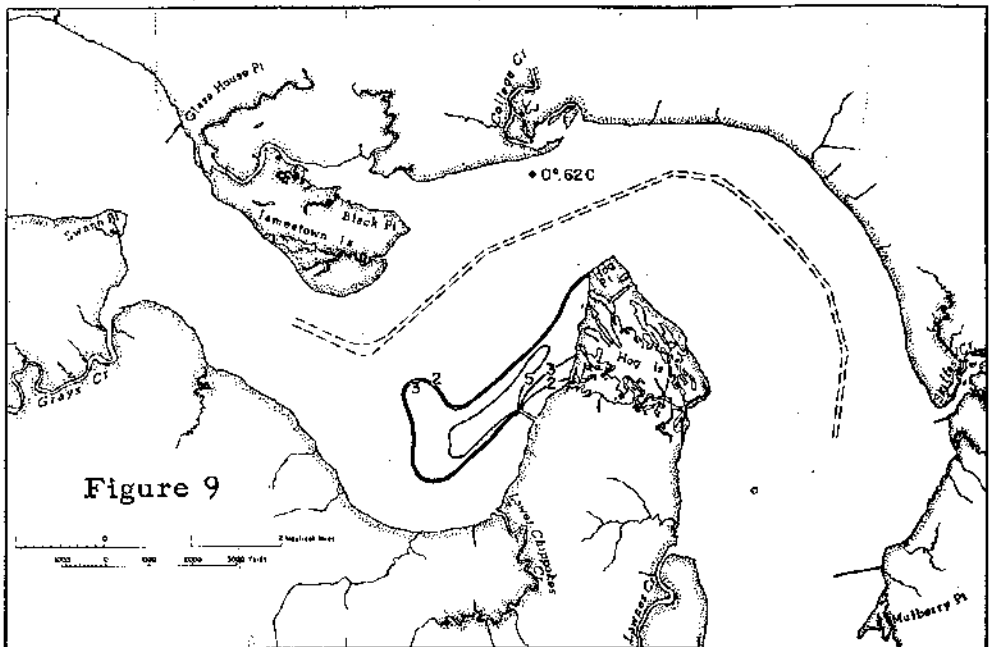


Figure 9

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 2 UNITS (TOTAL REJECTED HEAT = 12×10^9 BTU· HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 2000 CFS AT RICHMOND
TIDAL HOUR - 9

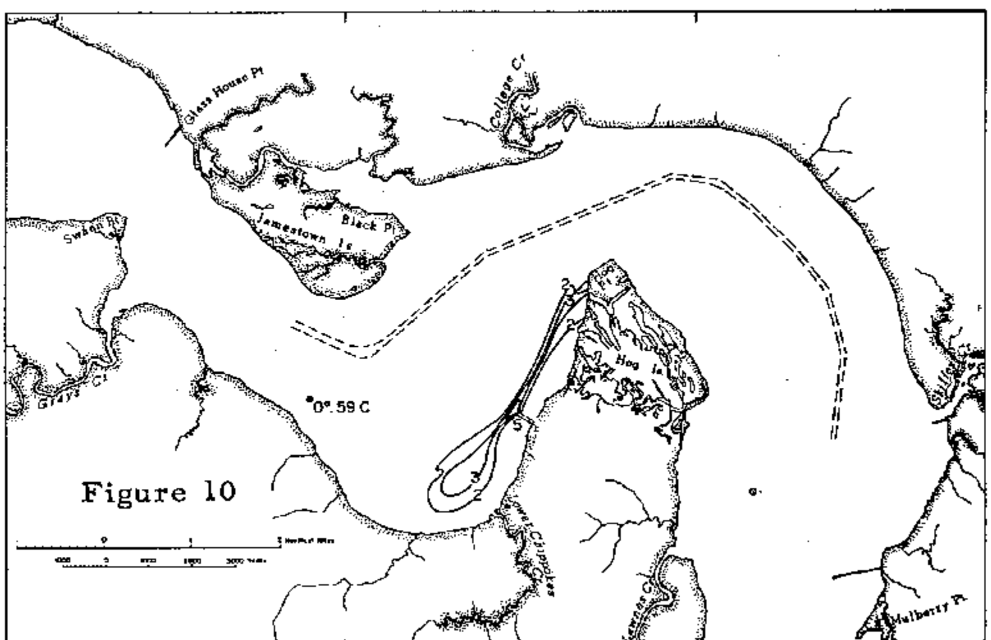


Figure 10

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 2 UNITS (TOTAL REJECTED HEAT = 12×10^9 BTU· HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 2000 CFS AT RICHMOND
TIDAL HOUR - 10 1/2

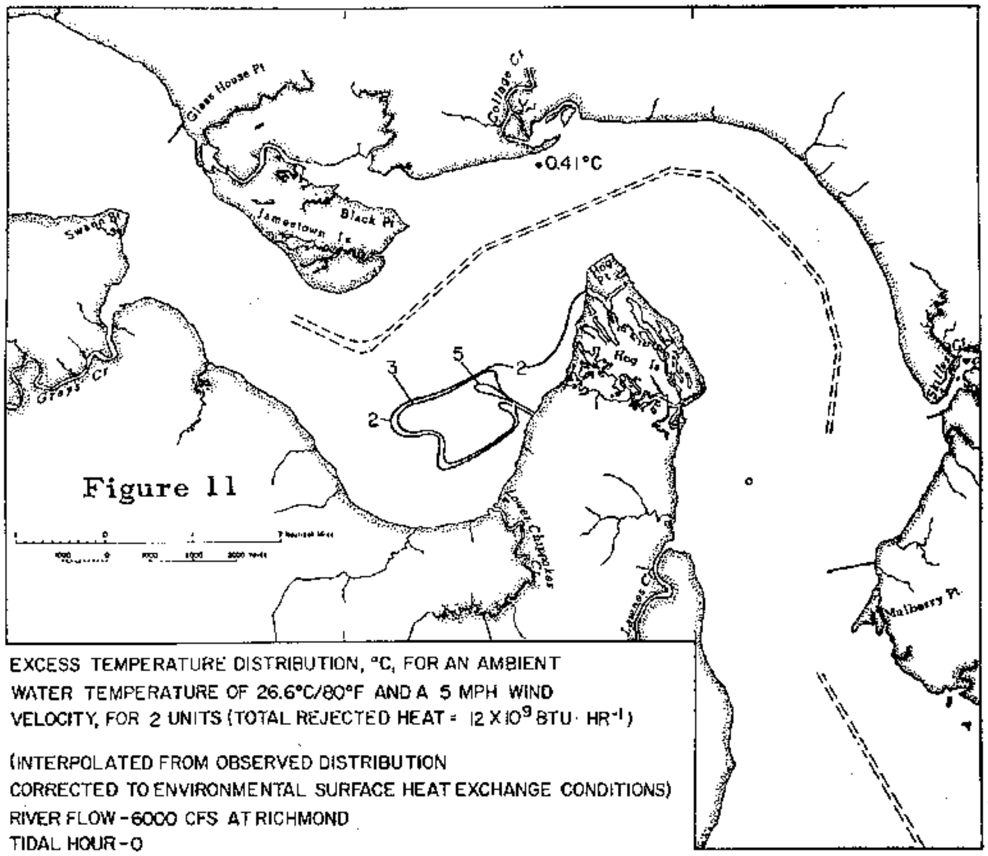


Figure 11

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT
WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND
VELOCITY, FOR 2 UNITS (TOTAL REJECTED HEAT = 12×10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION
CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 6000 CFS AT RICHMOND
TIDAL HOUR - 0

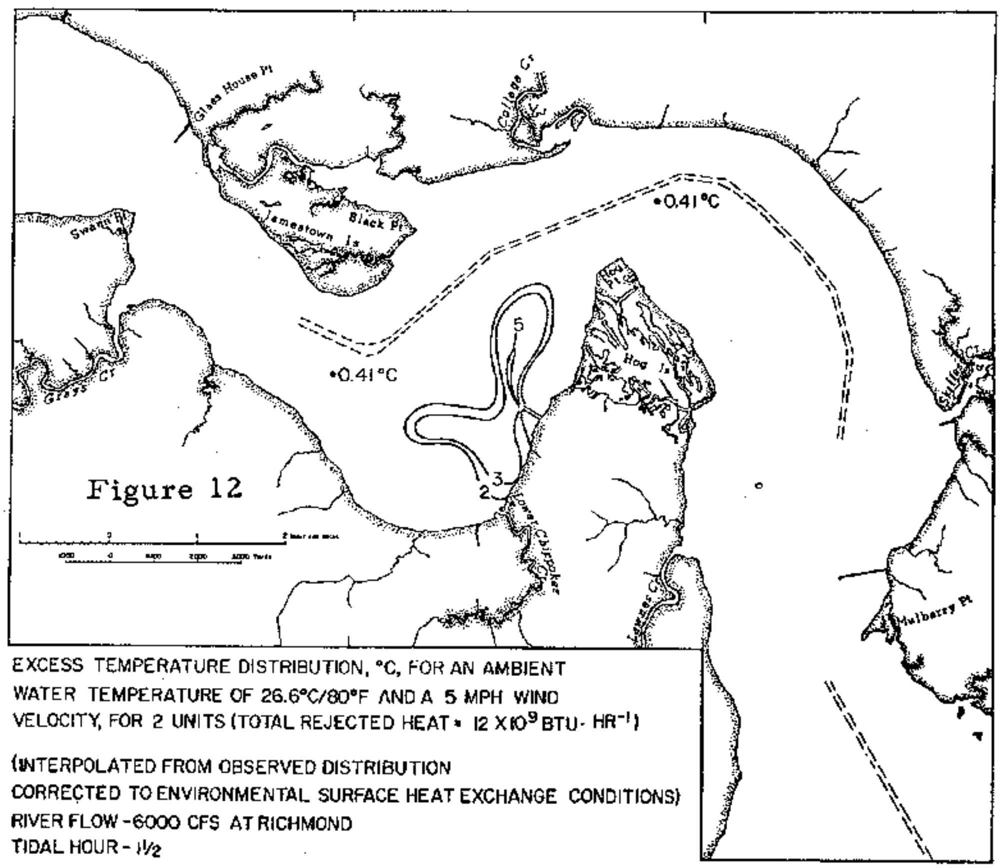


Figure 12

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT
WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND
VELOCITY, FOR 2 UNITS (TOTAL REJECTED HEAT = 12×10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION
CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 6000 CFS AT RICHMOND
TIDAL HOUR - 1½

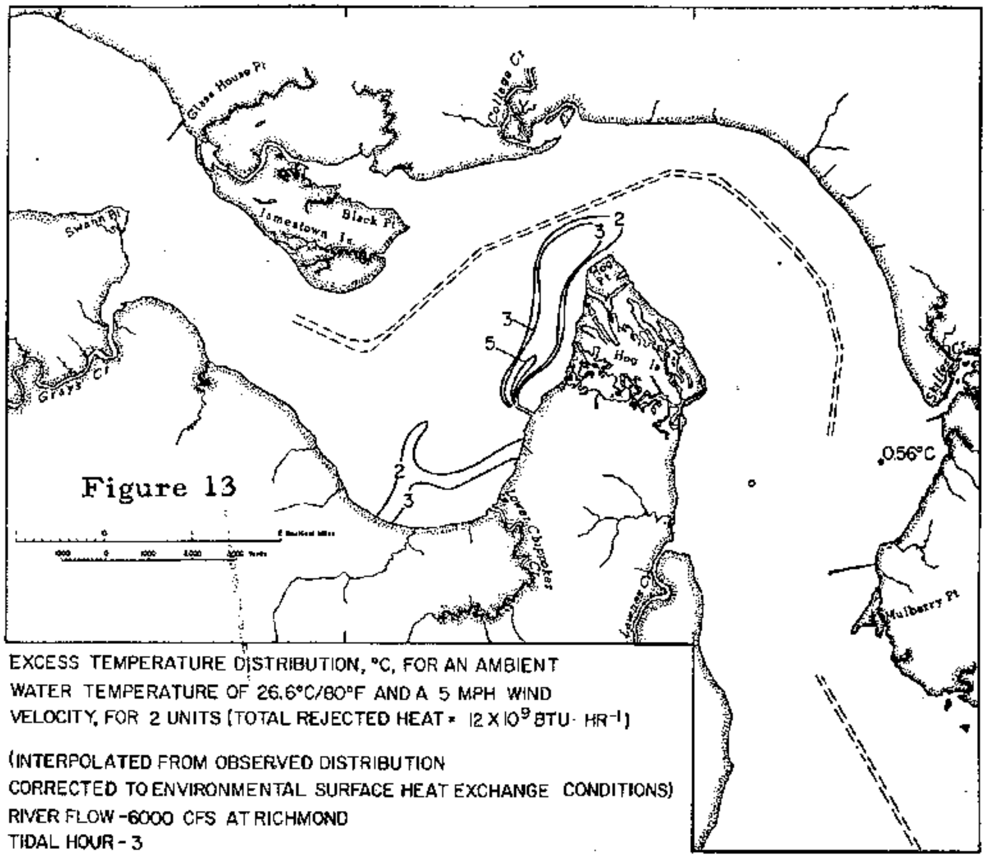


Figure 13

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 2 UNITS (TOTAL REJECTED HEAT = 12×10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 6000 CFS AT RICHMOND
TIDAL HOUR - 3

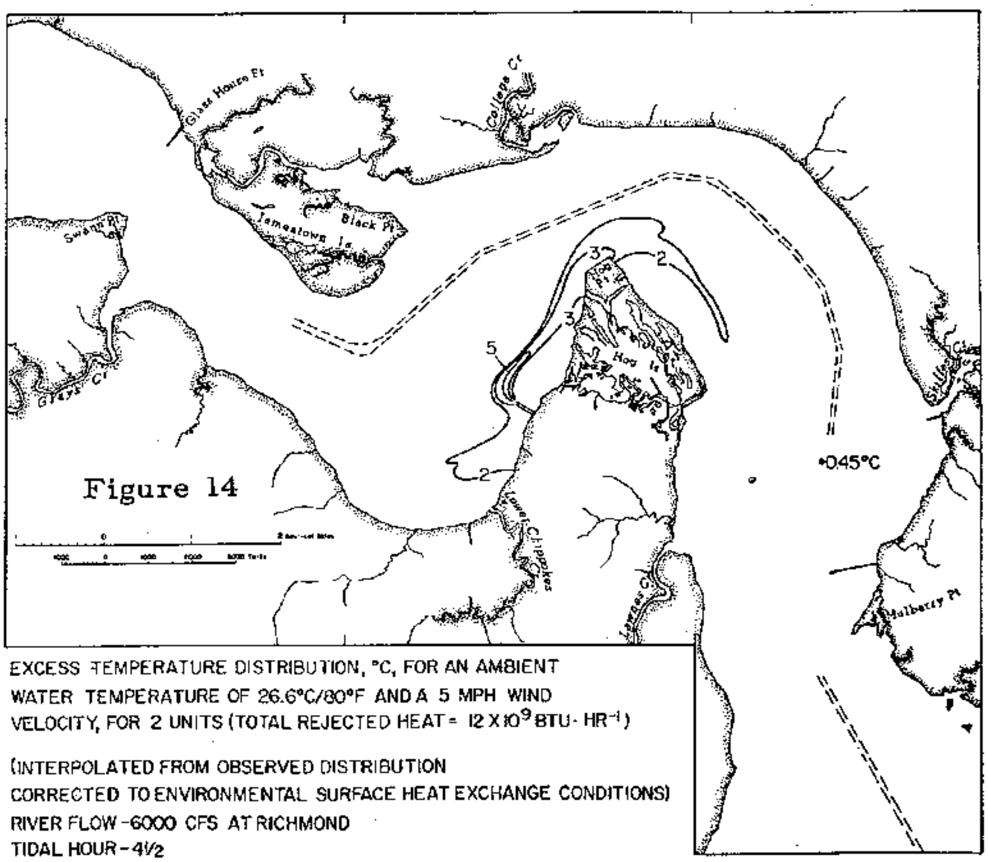


Figure 14

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 2 UNITS (TOTAL REJECTED HEAT = 12×10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 6000 CFS AT RICHMOND
TIDAL HOUR - 4½

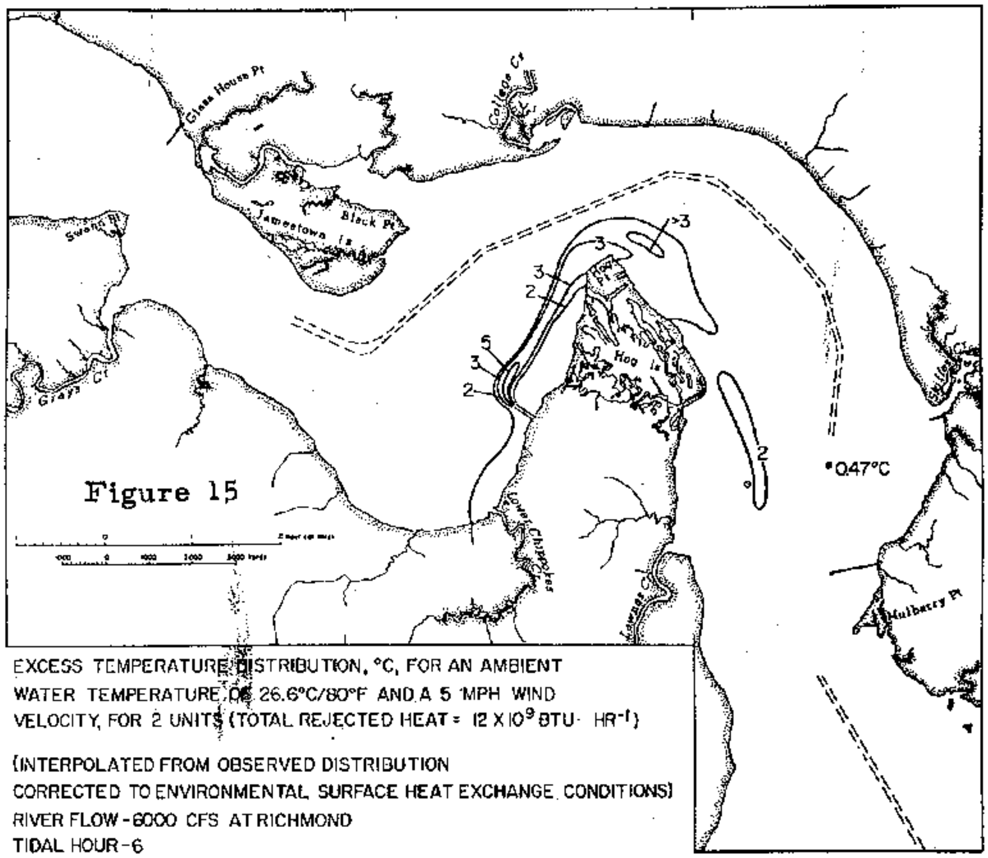


Figure 15

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 2 UNITS (TOTAL REJECTED HEAT = 12×10^9 BTU· HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 6000 CFS AT RICHMOND
TIDAL HOUR - 6

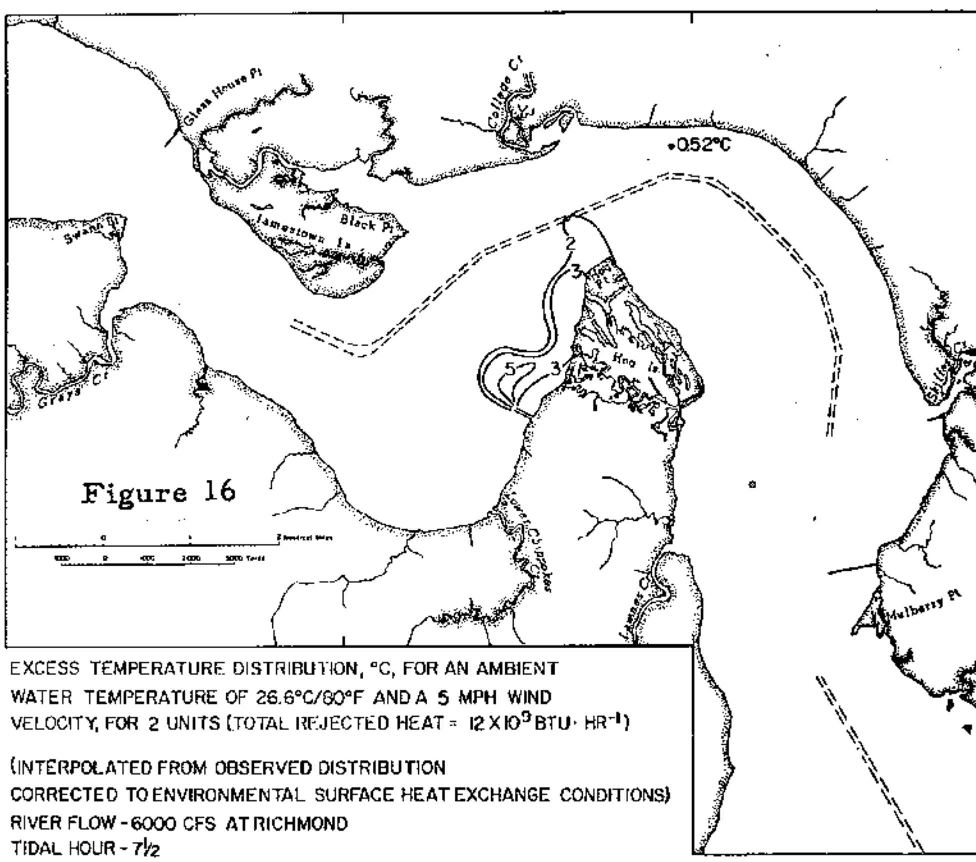


Figure 16

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 2 UNITS (TOTAL REJECTED HEAT = 12×10^9 BTU· HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 6000 CFS AT RICHMOND
TIDAL HOUR - 7½

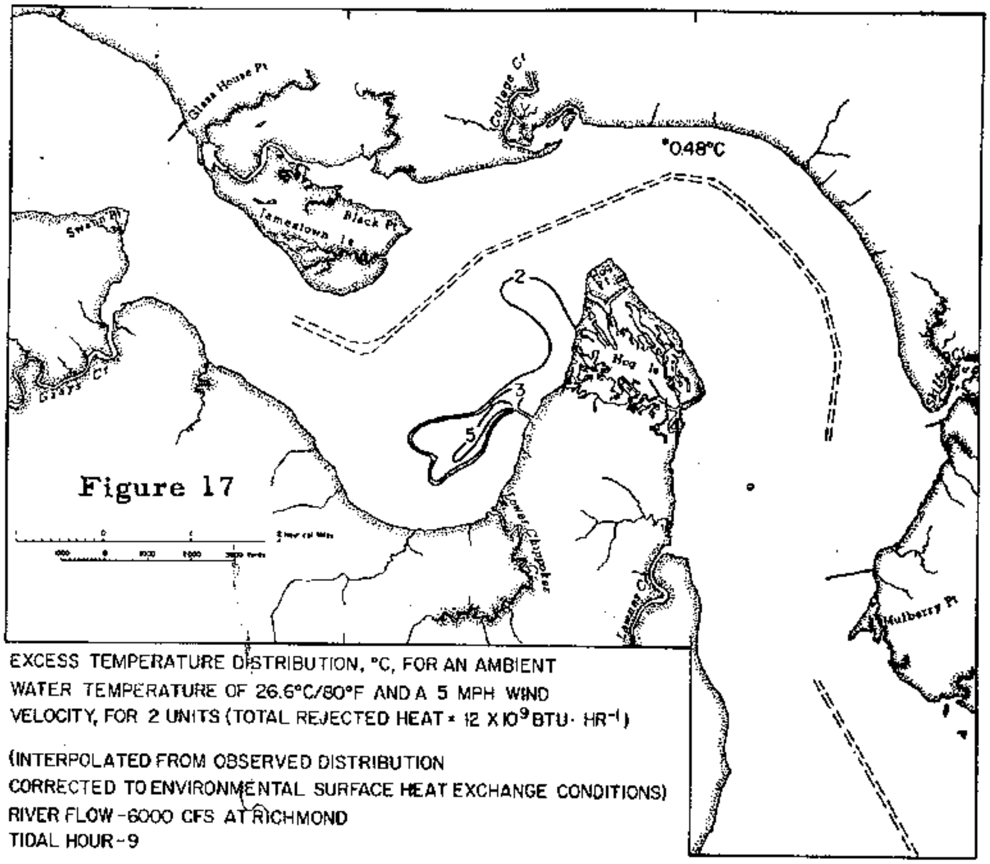


Figure 17

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 2 UNITS (TOTAL REJECTED HEAT = 12 X 10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 6000 CFS AT RICHMOND
TIDAL HOUR - 9

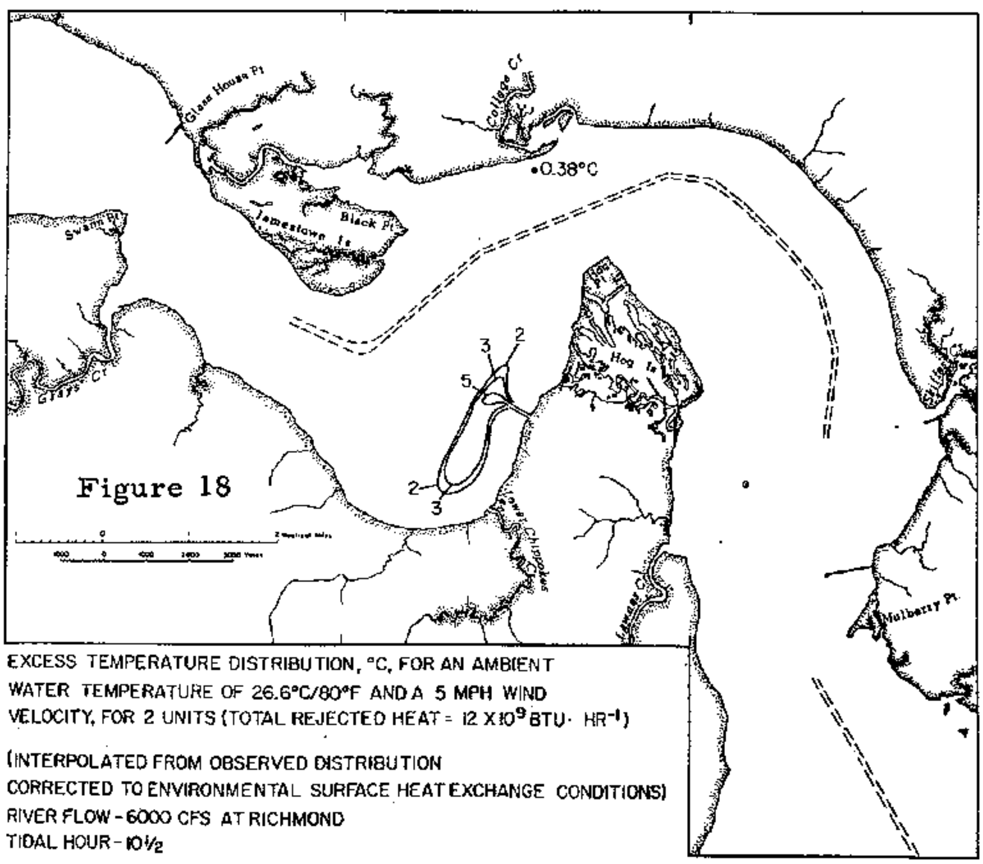
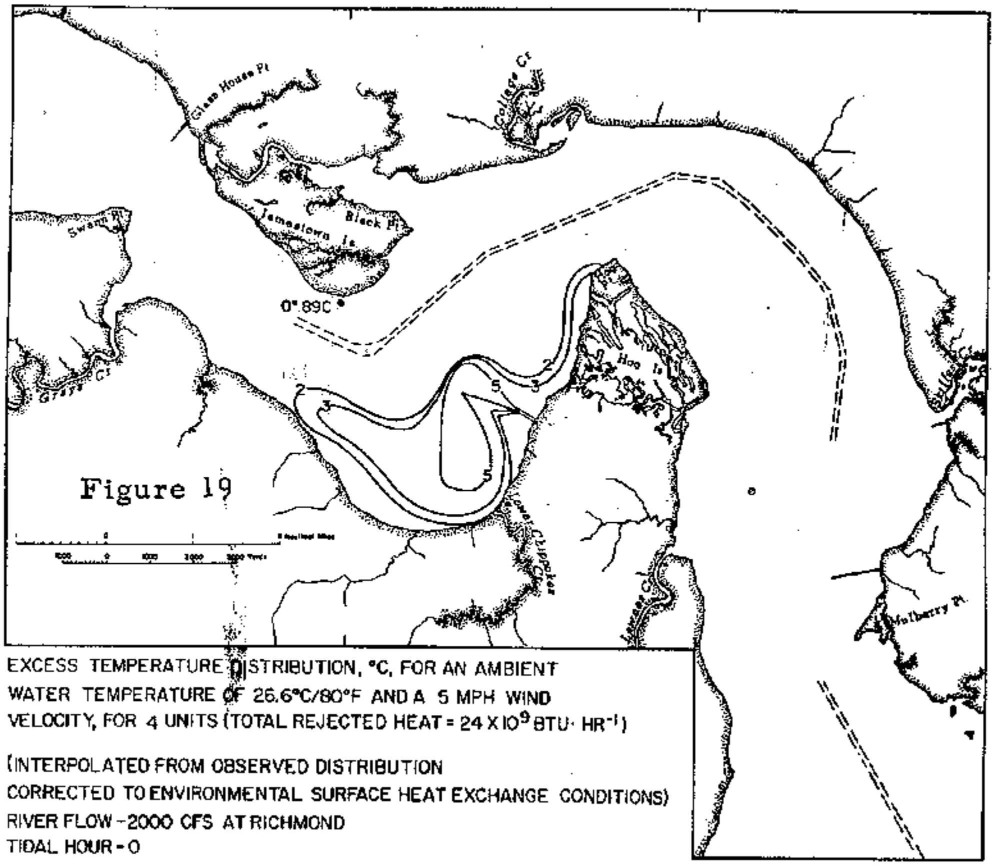


Figure 18

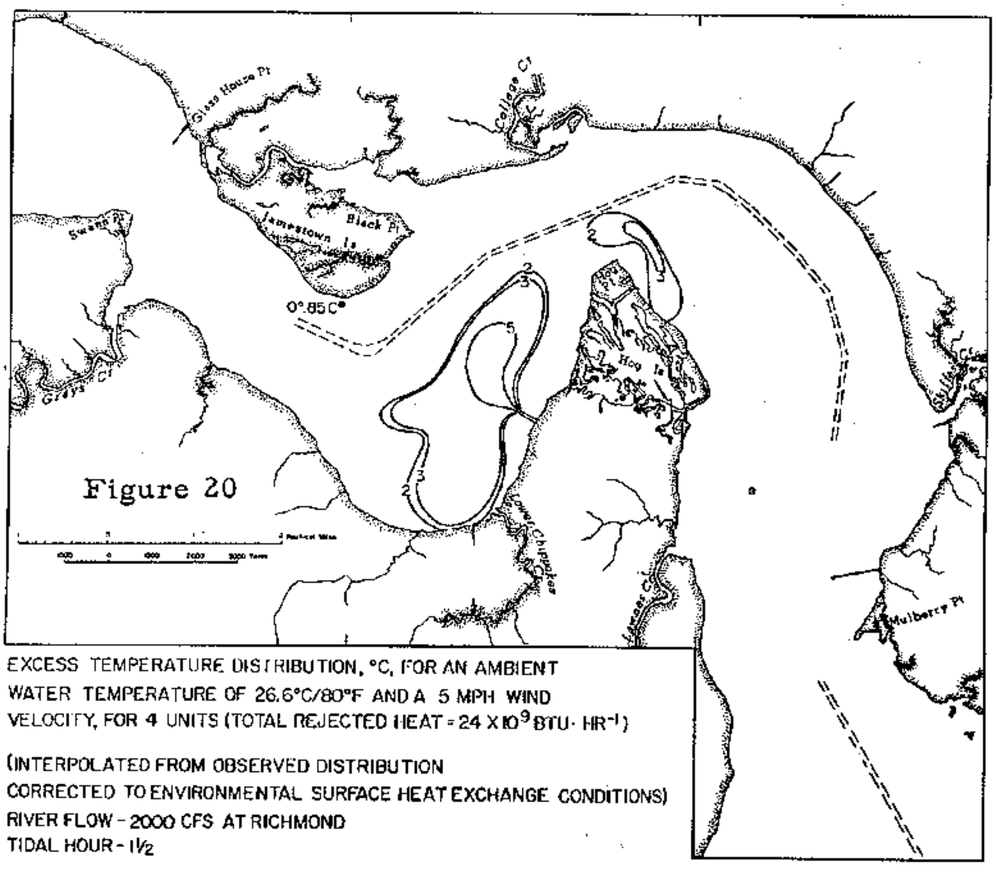
EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 2 UNITS (TOTAL REJECTED HEAT = 12 X 10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 6000 CFS AT RICHMOND
TIDAL HOUR - 10½



EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 4 UNITS (TOTAL REJECTED HEAT = 24 X 10^9 BTU· HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION
CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 2000 CFS AT RICHMOND
TIDAL HOUR - 0



EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 4 UNITS (TOTAL REJECTED HEAT = 24 X 10^9 BTU· HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION
CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 2000 CFS AT RICHMOND
TIDAL HOUR - 1½

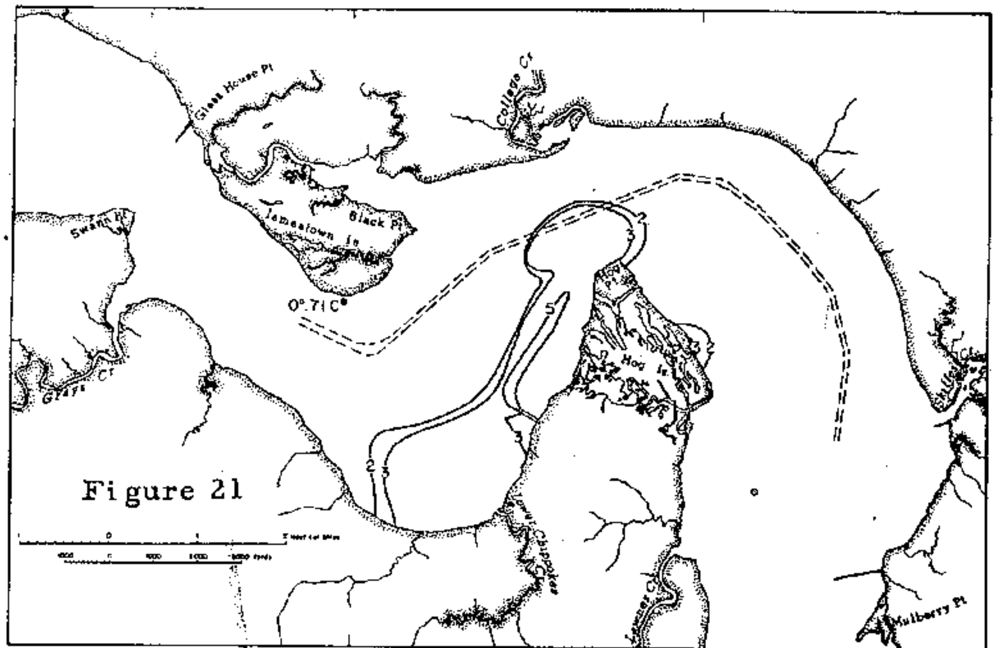


Figure 21

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 4 UNITS (TOTAL REJECTED HEAT = 24 X 10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION
CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 2000 CFS AT RICHMOND
TIDAL HOUR - 3

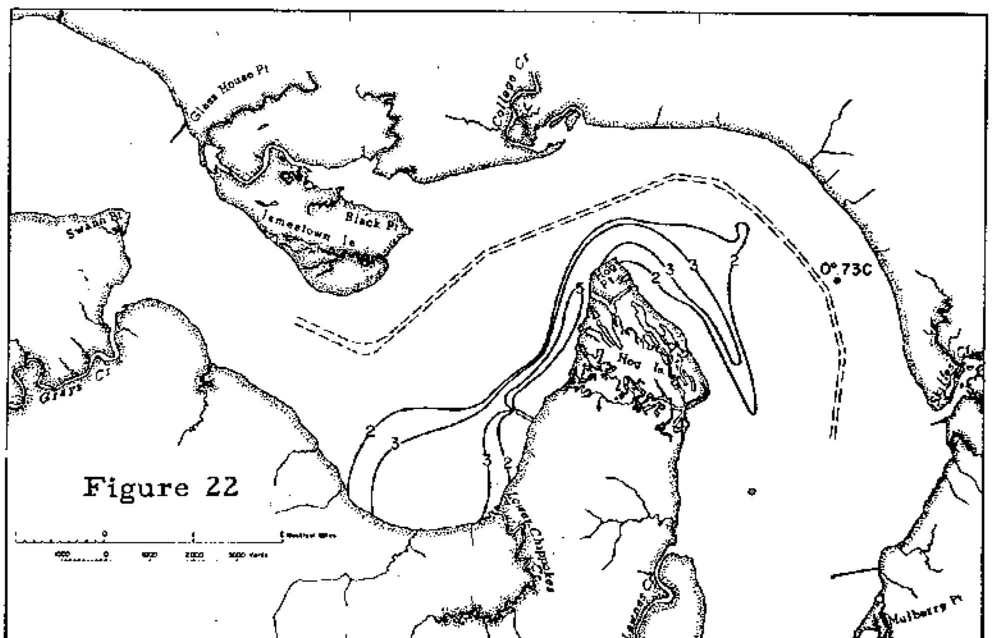


Figure 22

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 4 UNITS (TOTAL REJECTED HEAT = 24 X 10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION
CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 2000 CFS AT RICHMOND
TIDAL HOUR - 4½

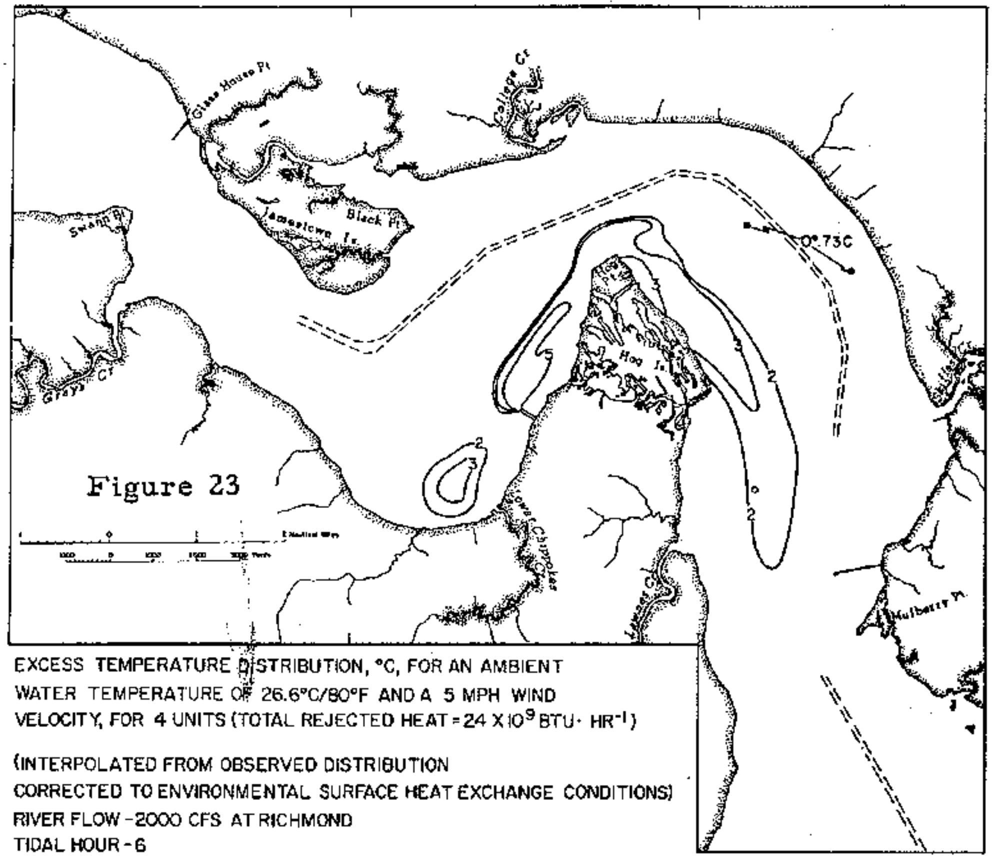


Figure 23

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 4 UNITS (TOTAL REJECTED HEAT = 24 X 10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 2000 CFS AT RICHMOND
TIDAL HOUR - 6

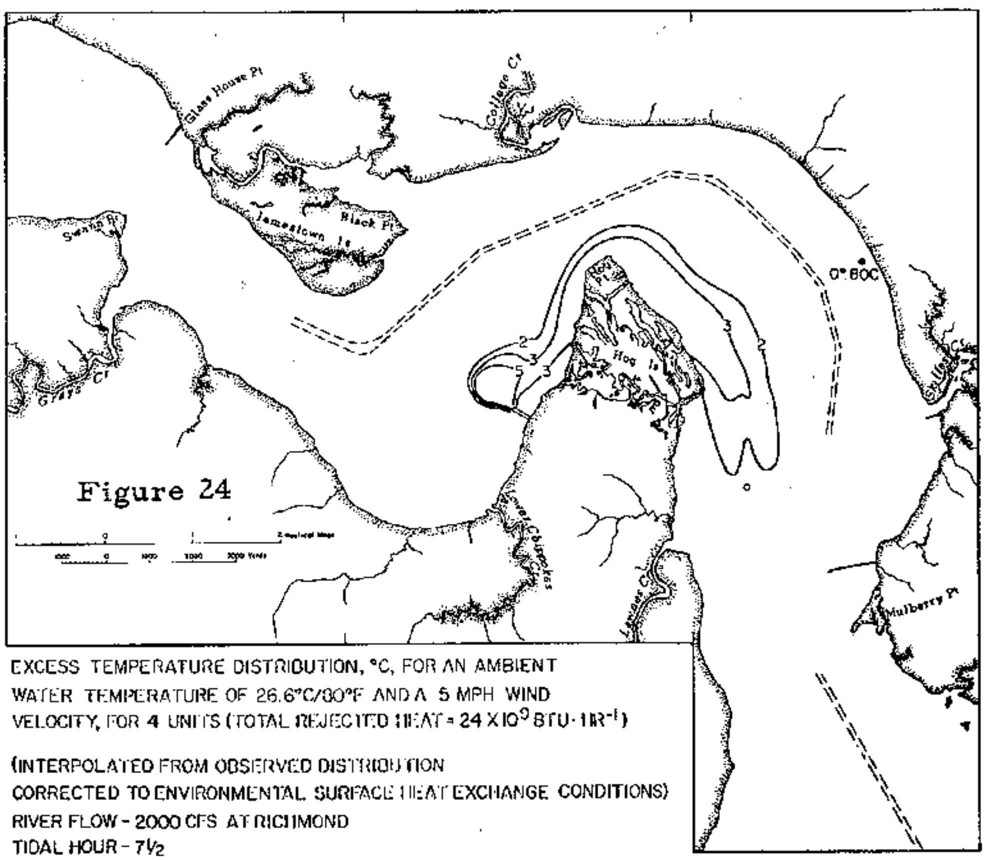


Figure 24

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 4 UNITS (TOTAL REJECTED HEAT = 24 X 10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 2000 CFS AT RICHMOND
TIDAL HOUR - 7½

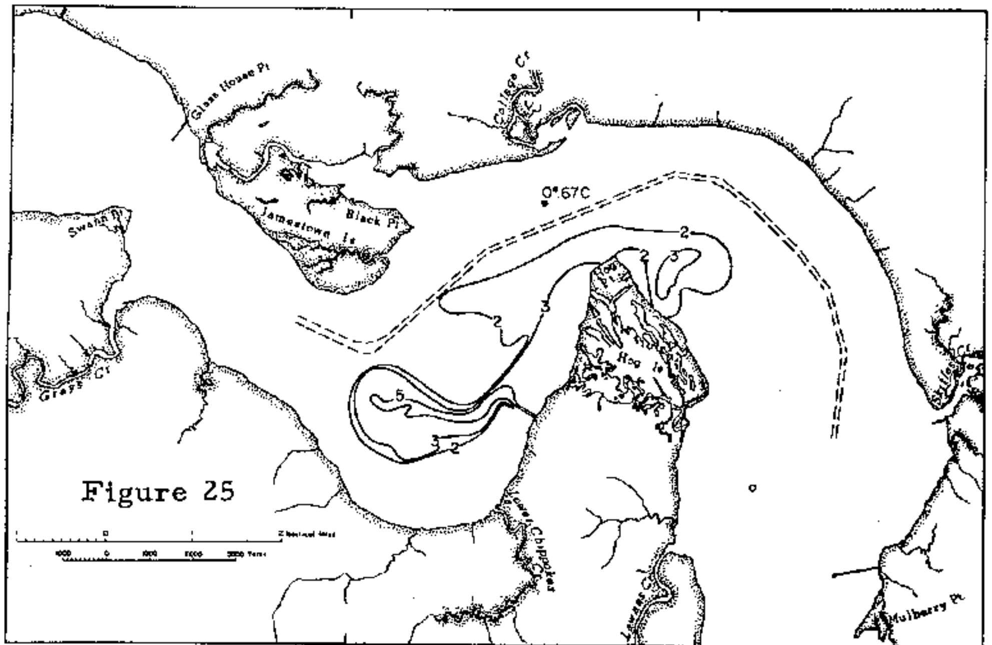


Figure 25

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 4 UNITS (TOTAL REJECTED HEAT = 24 X 10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 2000 CFS AT RICHMOND
TIDAL HOUR - 9

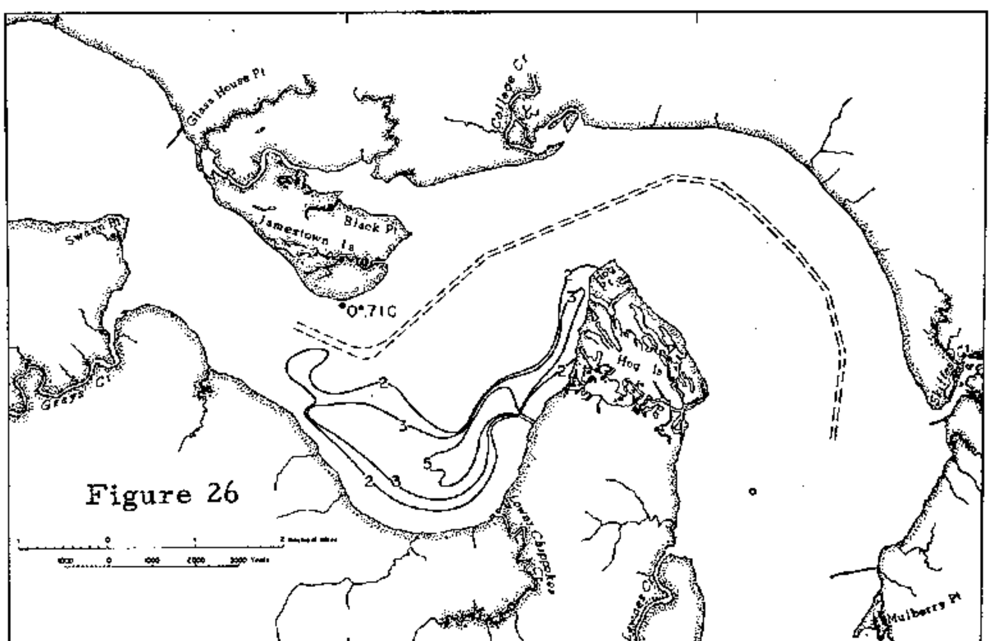


Figure 26

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 4 UNITS (TOTAL REJECTED HEAT = 24 X 10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 2000 CFS AT RICHMOND
TIDAL HOUR - 10½

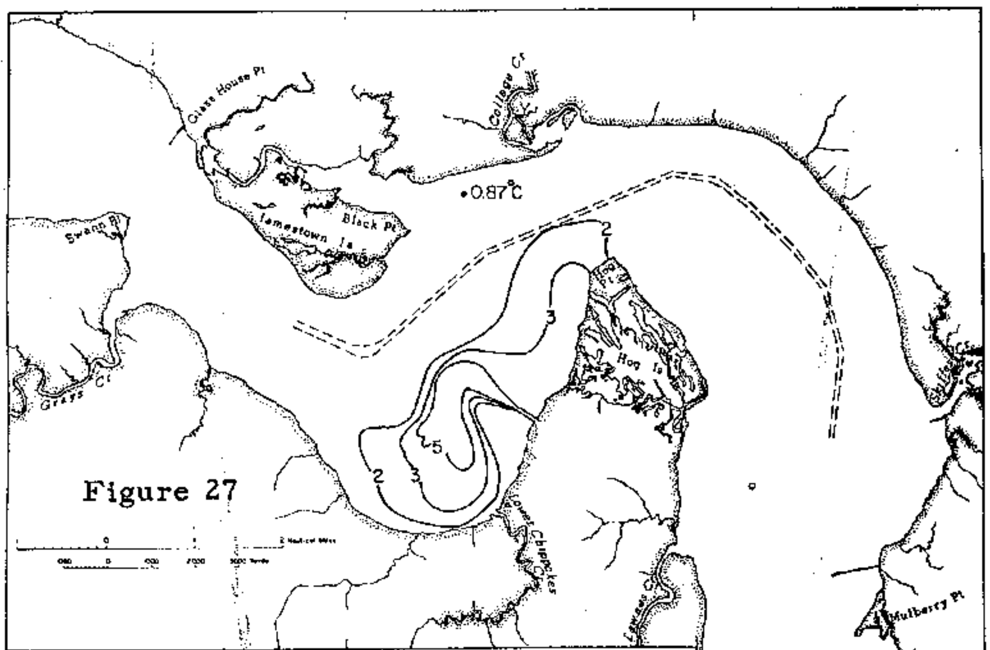


Figure 27

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 4 UNITS (TOTAL REJECTED HEAT = 24 X 10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION
CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 6000 CFS AT RICHMOND
TIDAL HOUR - 0

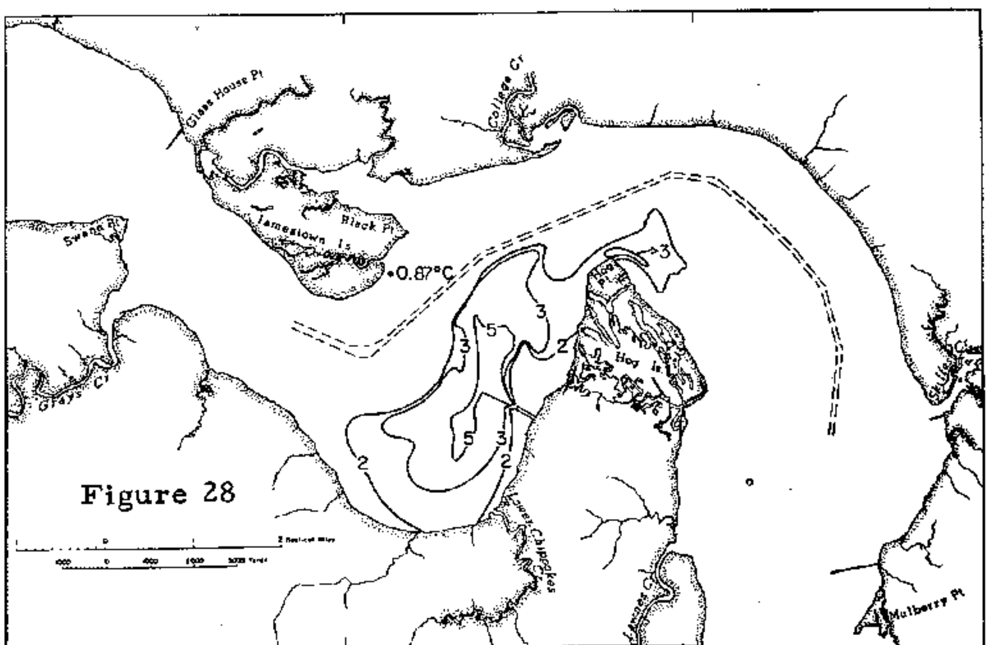


Figure 28

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 4 UNITS (TOTAL REJECTED HEAT = 24 X 10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION
CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 6000 CFS AT RICHMOND
TIDAL HOUR - 1½

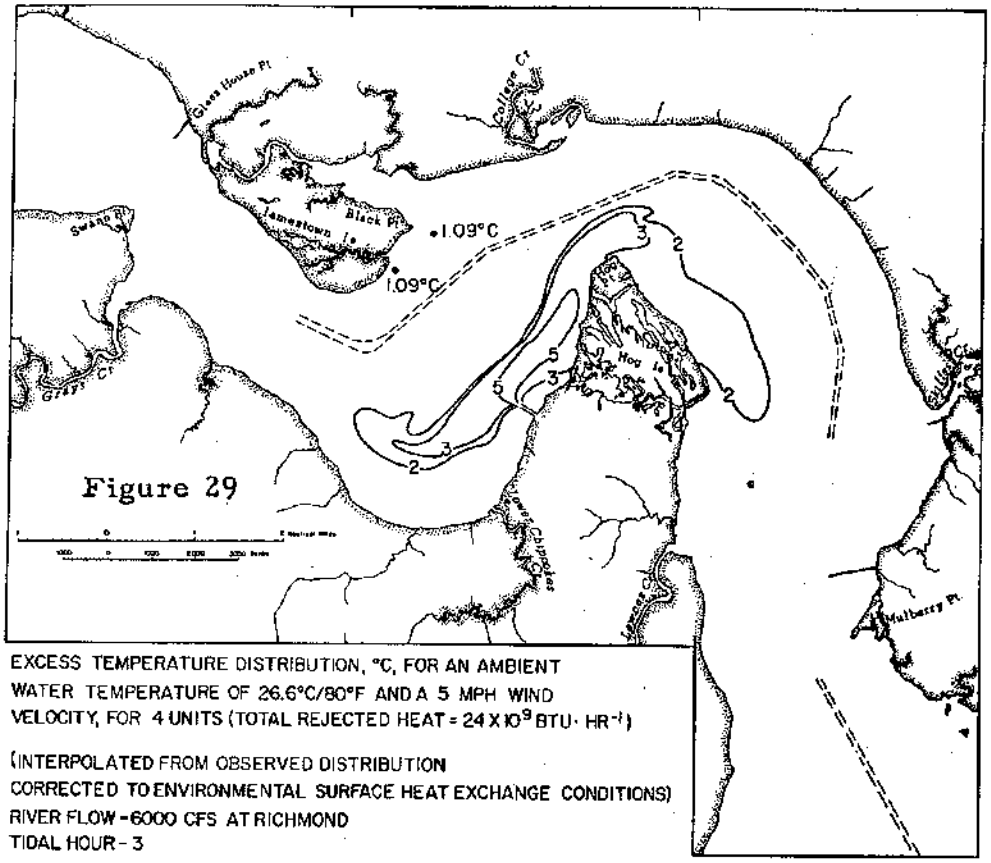


Figure 29

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 4 UNITS (TOTAL REJECTED HEAT = 24×10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 6000 CFS AT RICHMOND
TIDAL HOUR - 3

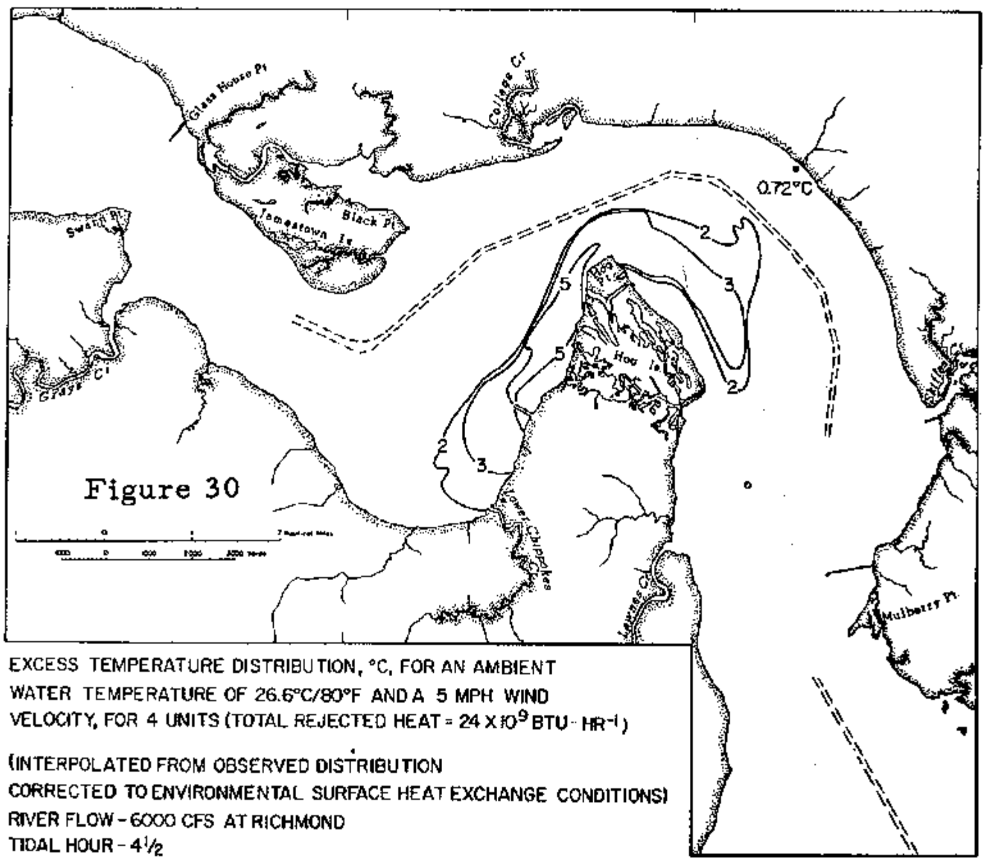


Figure 30

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 4 UNITS (TOTAL REJECTED HEAT = 24×10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 6000 CFS AT RICHMOND
TIDAL HOUR - 4½

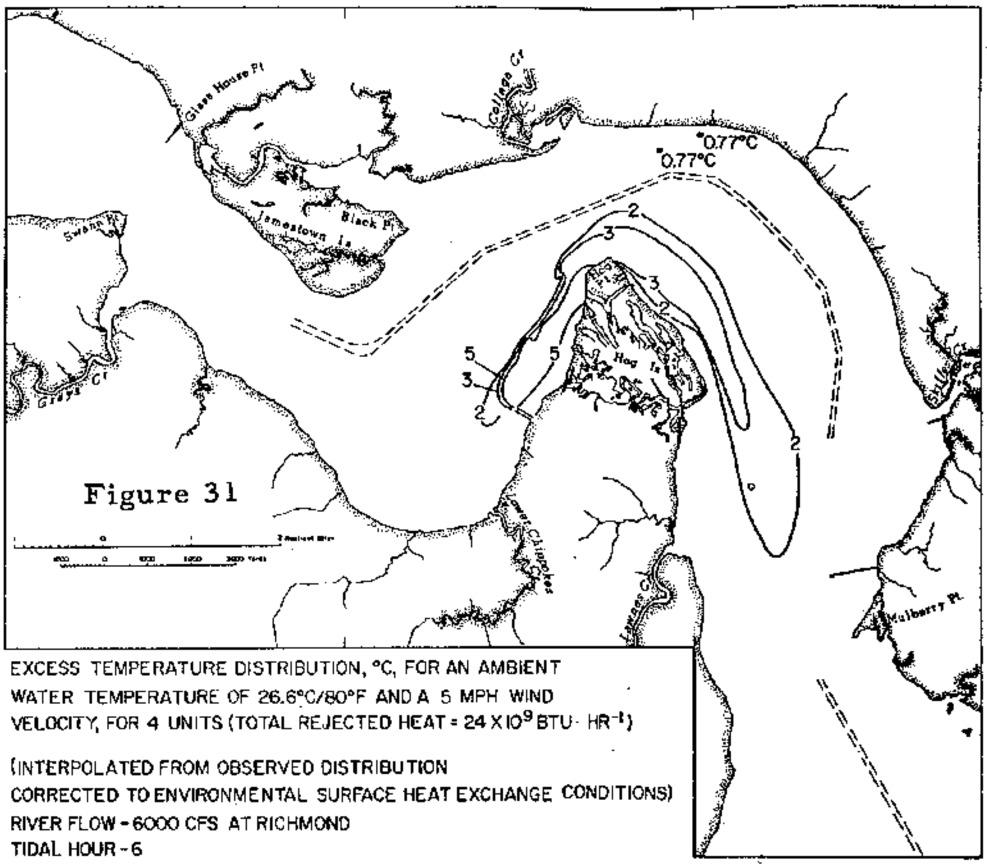


Figure 31

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 4 UNITS (TOTAL REJECTED HEAT = 24 X 10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION
CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 6000 CFS AT RICHMOND
TIDAL HOUR - 6

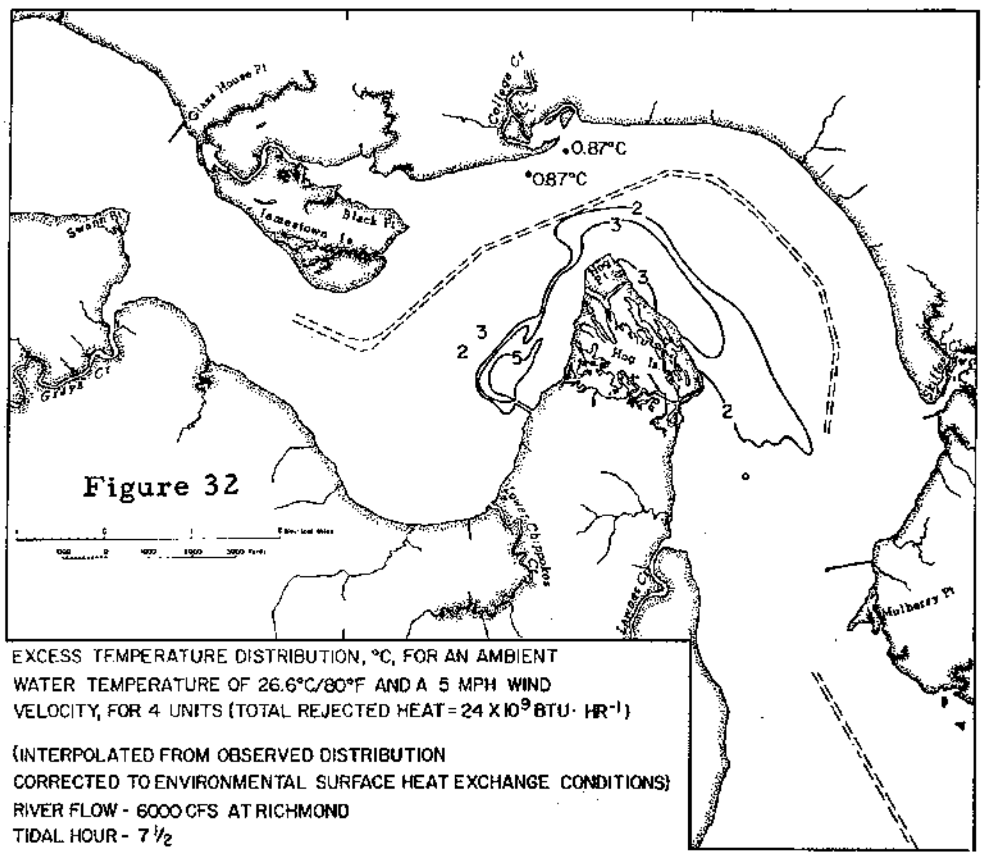


Figure 32

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 4 UNITS (TOTAL REJECTED HEAT = 24 X 10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION
CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 6000 CFS AT RICHMOND
TIDAL HOUR - 7 1/2

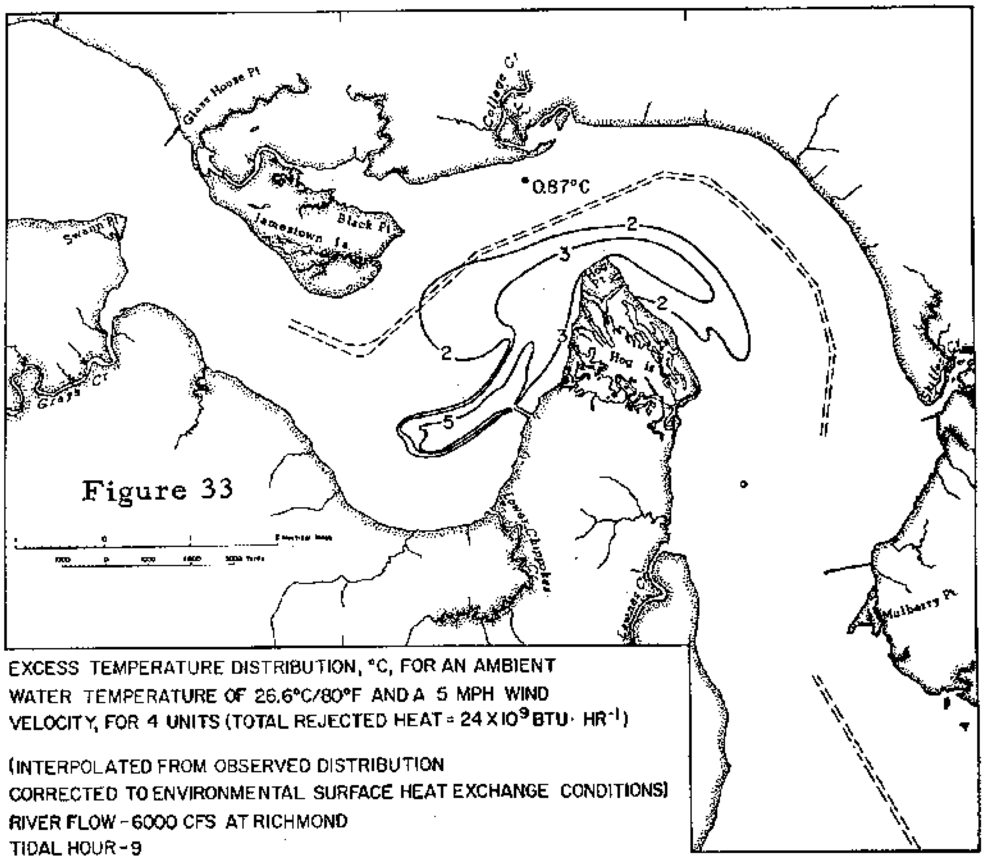


Figure 33

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 4 UNITS (TOTAL REJECTED HEAT = 24×10^9 BTU· HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 6000 CFS AT RICHMOND
TIDAL HOUR - 9

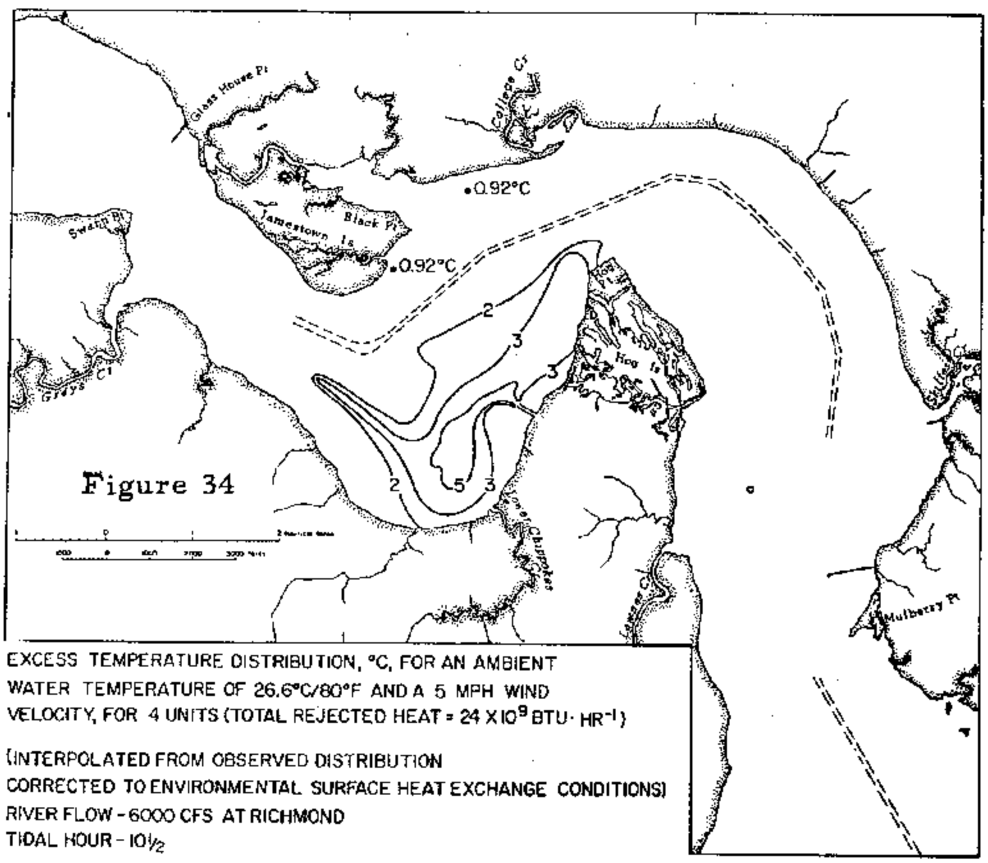


Figure 34

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 26.6°C/80°F AND A 5 MPH WIND VELOCITY, FOR 4 UNITS (TOTAL REJECTED HEAT = 24×10^9 BTU· HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 6000 CFS AT RICHMOND
TIDAL HOUR - 10½

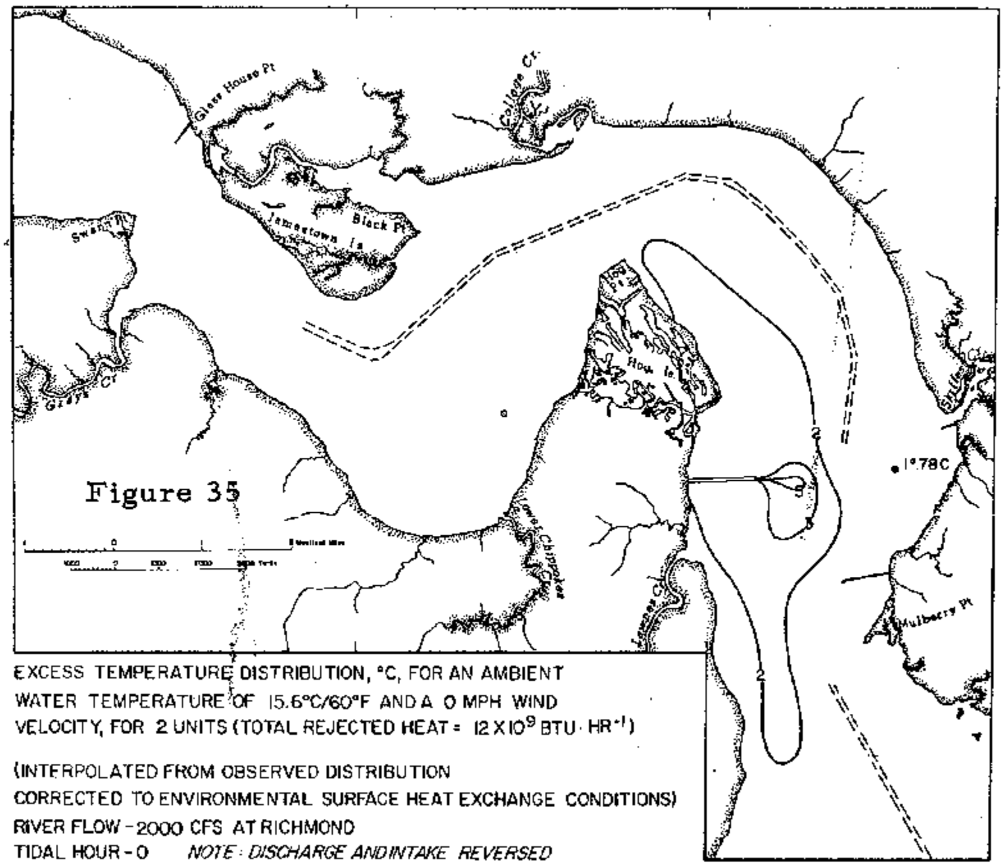


Figure 35

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 15.6°C/60°F AND A 0 MPH WIND VELOCITY, FOR 2 UNITS (TOTAL REJECTED HEAT = 12×10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 2000 CFS AT RICHMOND
TIDAL HOUR - 0 *NOTE: DISCHARGE AND INTAKE REVERSED*

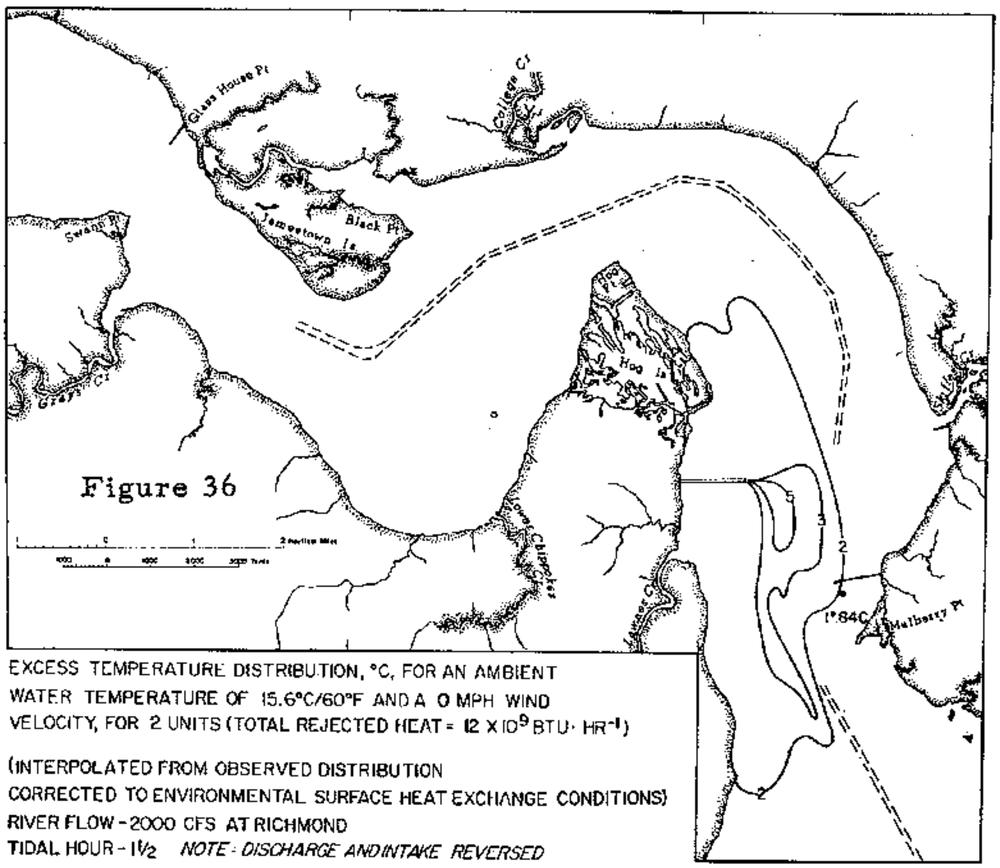


Figure 36

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 15.6°C/60°F AND A 0 MPH WIND VELOCITY, FOR 2 UNITS (TOTAL REJECTED HEAT = 12×10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 2000 CFS AT RICHMOND
TIDAL HOUR - 1½ *NOTE: DISCHARGE AND INTAKE REVERSED*

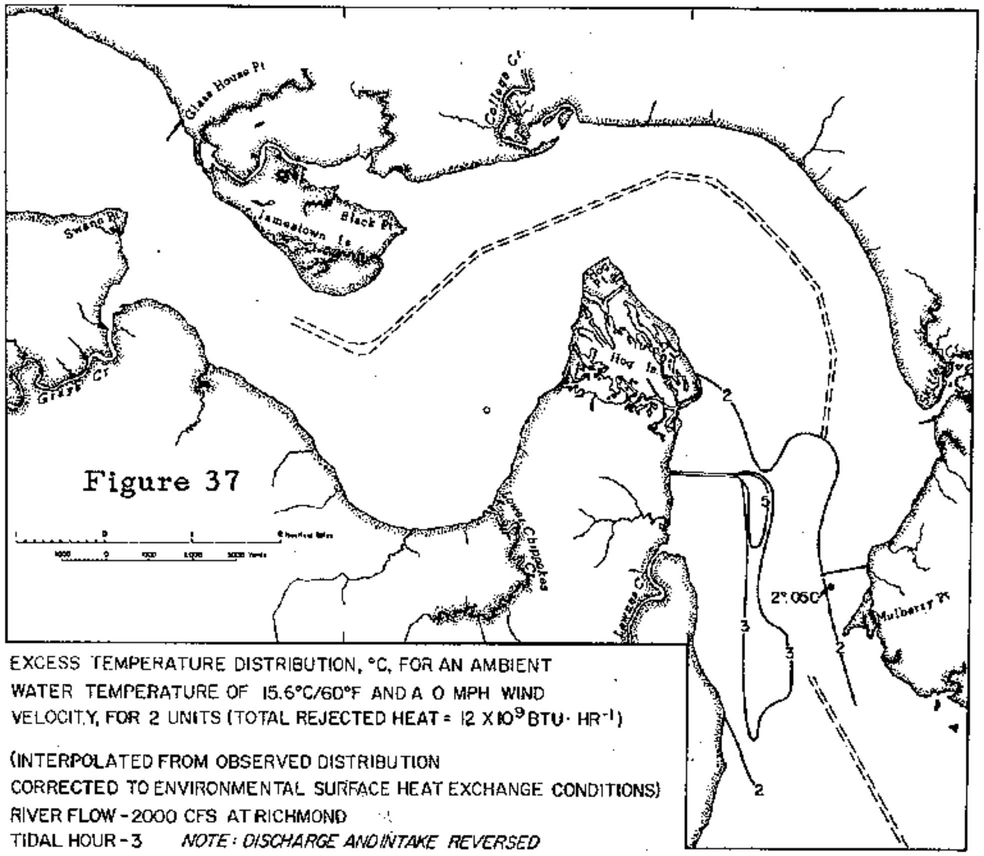


Figure 37

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 15.6°C/60°F AND A 0 MPH WIND VELOCITY, FOR 2 UNITS (TOTAL REJECTED HEAT = 12×10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 2000 CFS AT RICHMOND
TIDAL HOUR - 3 *NOTE: DISCHARGE AND INTAKE REVERSED*

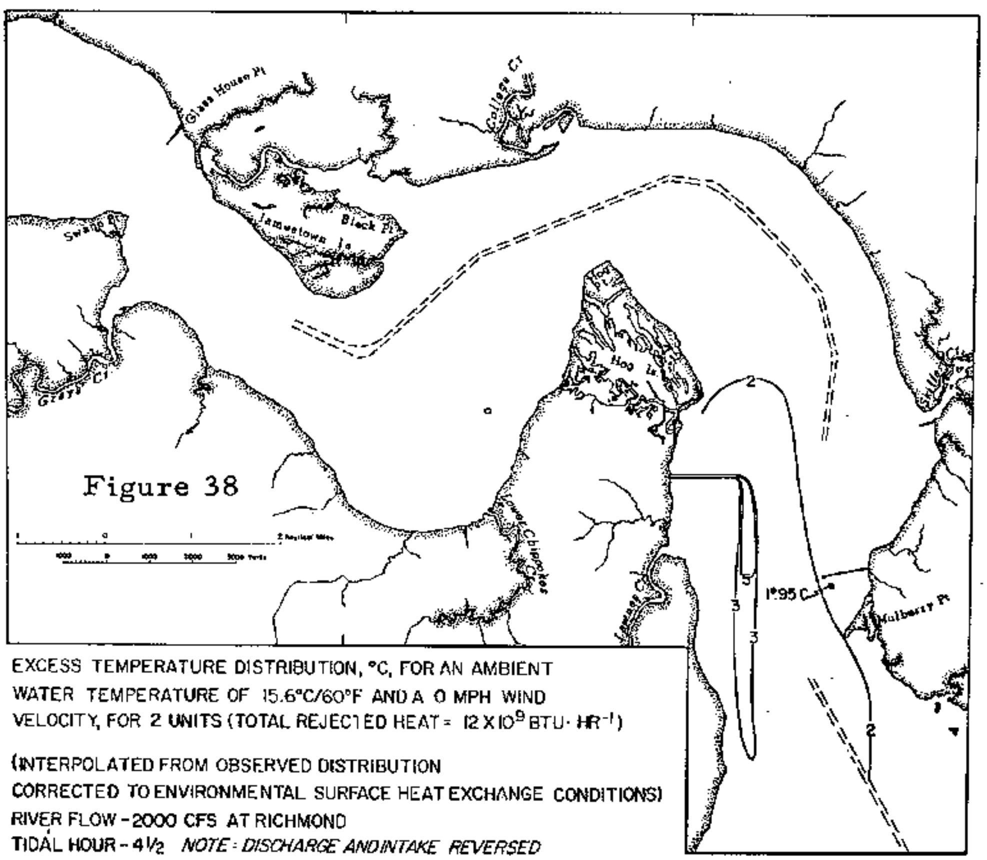


Figure 38

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 15.6°C/60°F AND A 0 MPH WIND VELOCITY, FOR 2 UNITS (TOTAL REJECTED HEAT = 12×10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 2000 CFS AT RICHMOND
TIDAL HOUR - 4½ *NOTE: DISCHARGE AND INTAKE REVERSED*

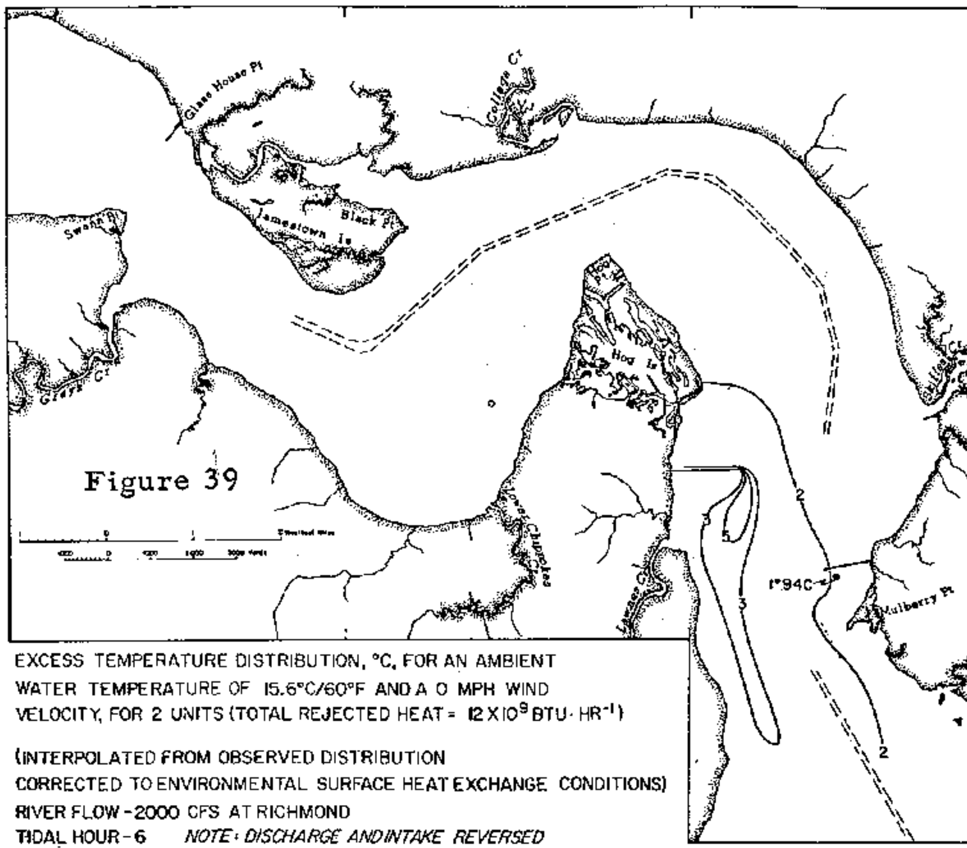


Figure 39

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 15.6°C/60°F AND A 0 MPH WIND VELOCITY, FOR 2 UNITS (TOTAL REJECTED HEAT = 12×10^9 BTU·HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 2000 CFS AT RICHMOND
TIDAL HOUR - 6 *NOTE: DISCHARGE AND INTAKE REVERSED*

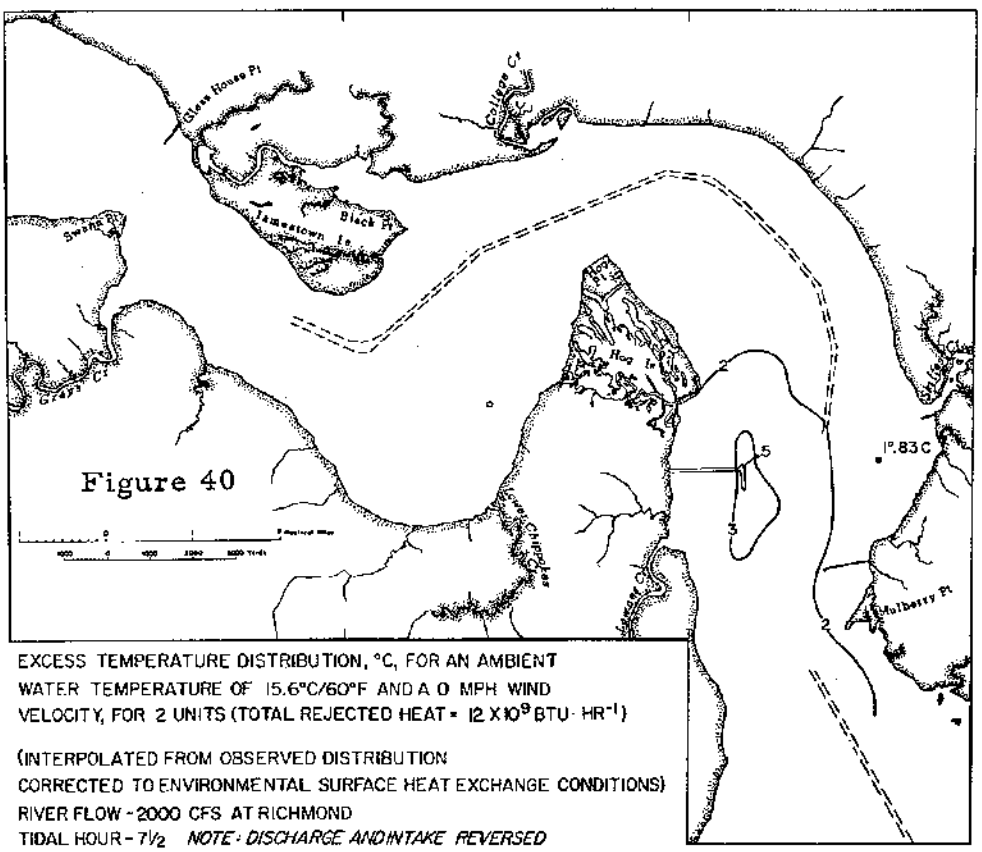


Figure 40

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 15.6°C/60°F AND A 0 MPH WIND VELOCITY, FOR 2 UNITS (TOTAL REJECTED HEAT = 12×10^9 BTU·HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 2000 CFS AT RICHMOND
TIDAL HOUR - 7½ *NOTE: DISCHARGE AND INTAKE REVERSED*

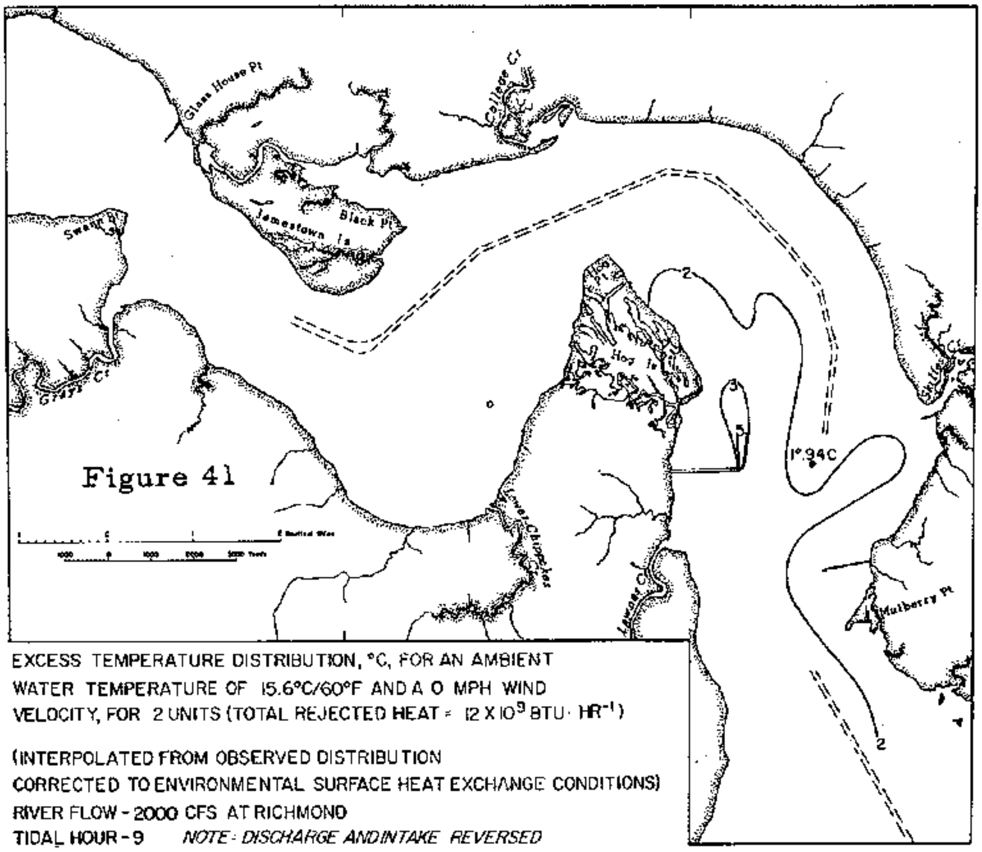


Figure 41

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 15.6°C/60°F AND A 0 MPH WIND VELOCITY, FOR 2 UNITS (TOTAL REJECTED HEAT = 12×10^9 BTU · HR^{-1})

(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 2000 CFS AT RICHMOND
TIDAL HOUR - 9 *NOTE: DISCHARGE AND INTAKE REVERSED*

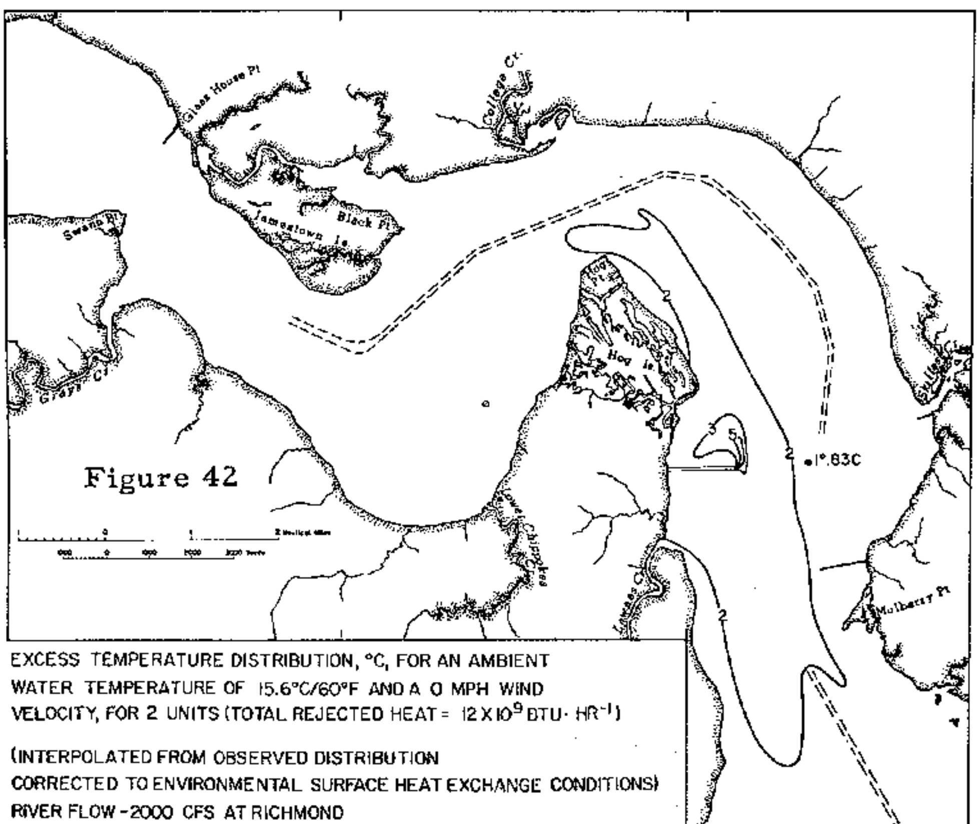


Figure 42

EXCESS TEMPERATURE DISTRIBUTION, °C, FOR AN AMBIENT WATER TEMPERATURE OF 15.6°C/60°F AND A 0 MPH WIND VELOCITY, FOR 2 UNITS (TOTAL REJECTED HEAT = 12×10^9 BTU · HR^{-1})

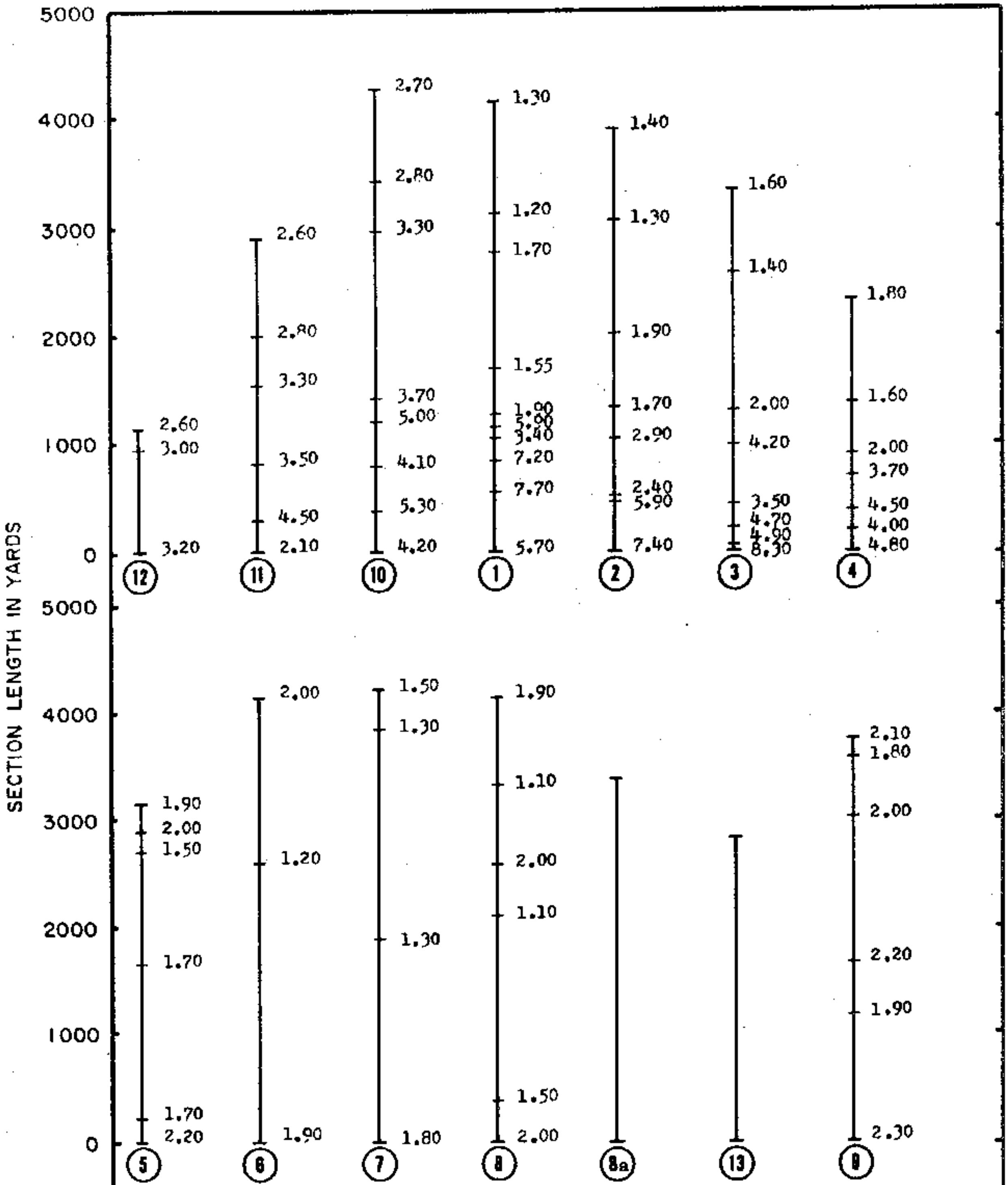
(INTERPOLATED FROM OBSERVED DISTRIBUTION CORRECTED TO ENVIRONMENTAL SURFACE HEAT EXCHANGE CONDITIONS)
RIVER FLOW - 2000 CFS AT RICHMOND
TIDAL HOUR - 10½ *NOTE: DISCHARGE AND INTAKE REVERSED*

APPENDIX

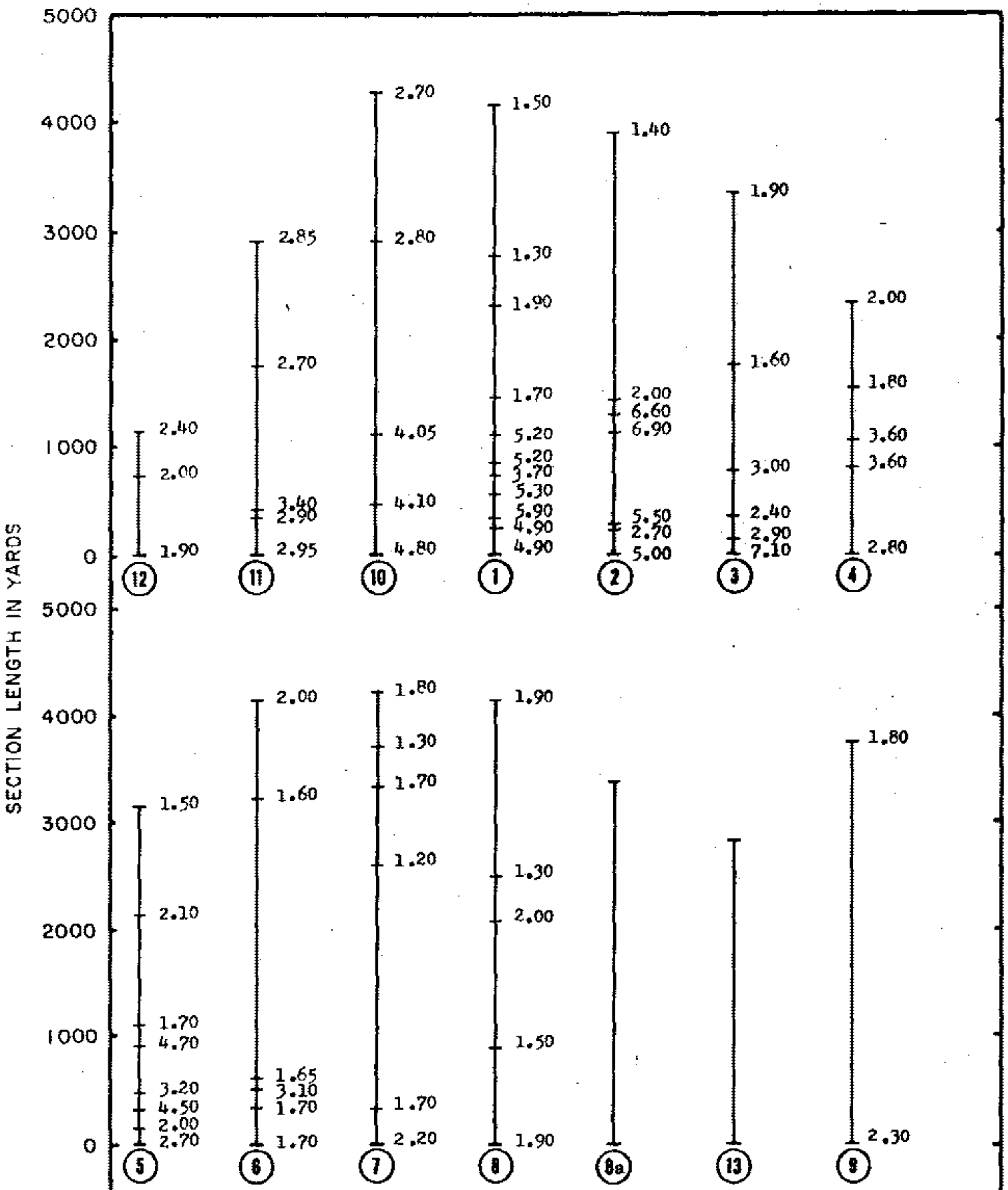
To The Report

Temperature Distribution in the James River Estuary
Which Will Result From the Discharge of Waste Heat
From the Surry Nuclear Power Station

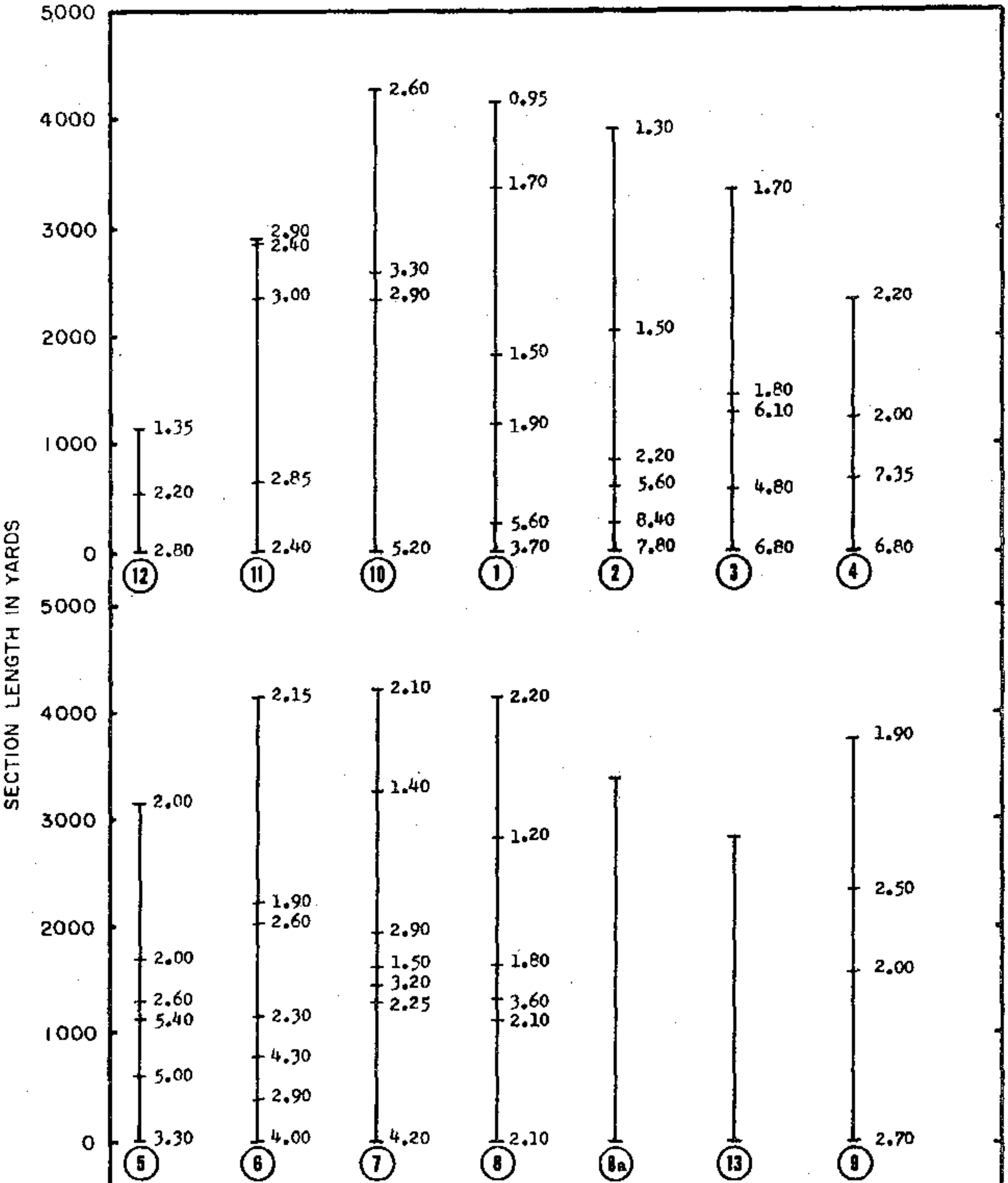
Observed Excess Temperatures
from the
October 1966 Tests Carried Out in
The James River Estuary Model



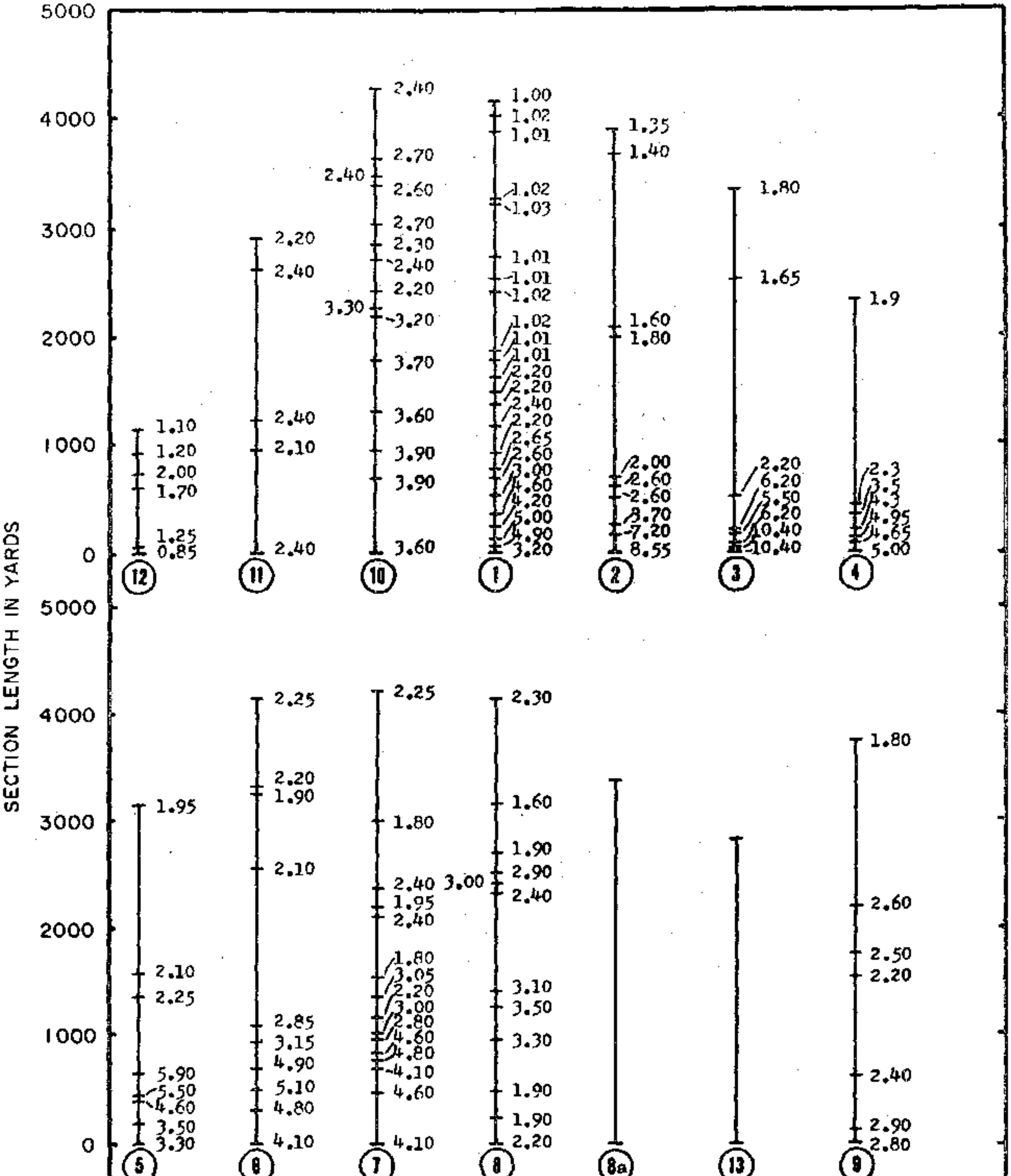
OBSERVED EXCESS TEMPERATURES – °F
(SECTION LOCATIONS SHOWN ON FIGURE 2)
FOR
RIVER FLOW = 2000 cfs
REJECTED HEAT = 12×10^9 BTU/HR.
TIDAL HOUR = 0



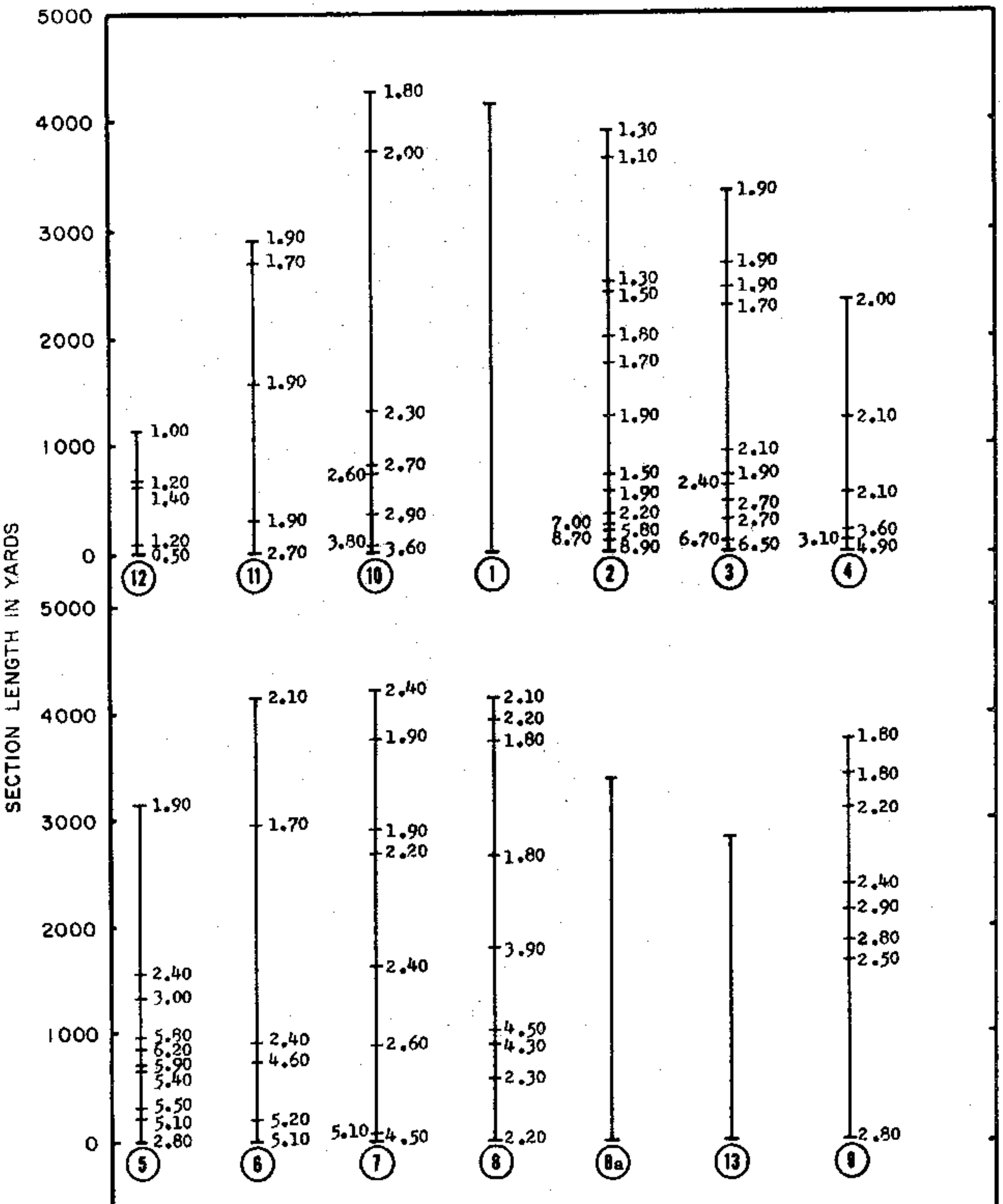
OBSERVED EXCESS TEMPERATURES - °F
(SECTION LOCATIONS SHOWN ON FIGURE 2)
FOR
RIVER FLOW = 2000 cfs
REJECTED HEAT = 12×10^9 BTU/HR.
TIDAL HOUR = 1 1/2



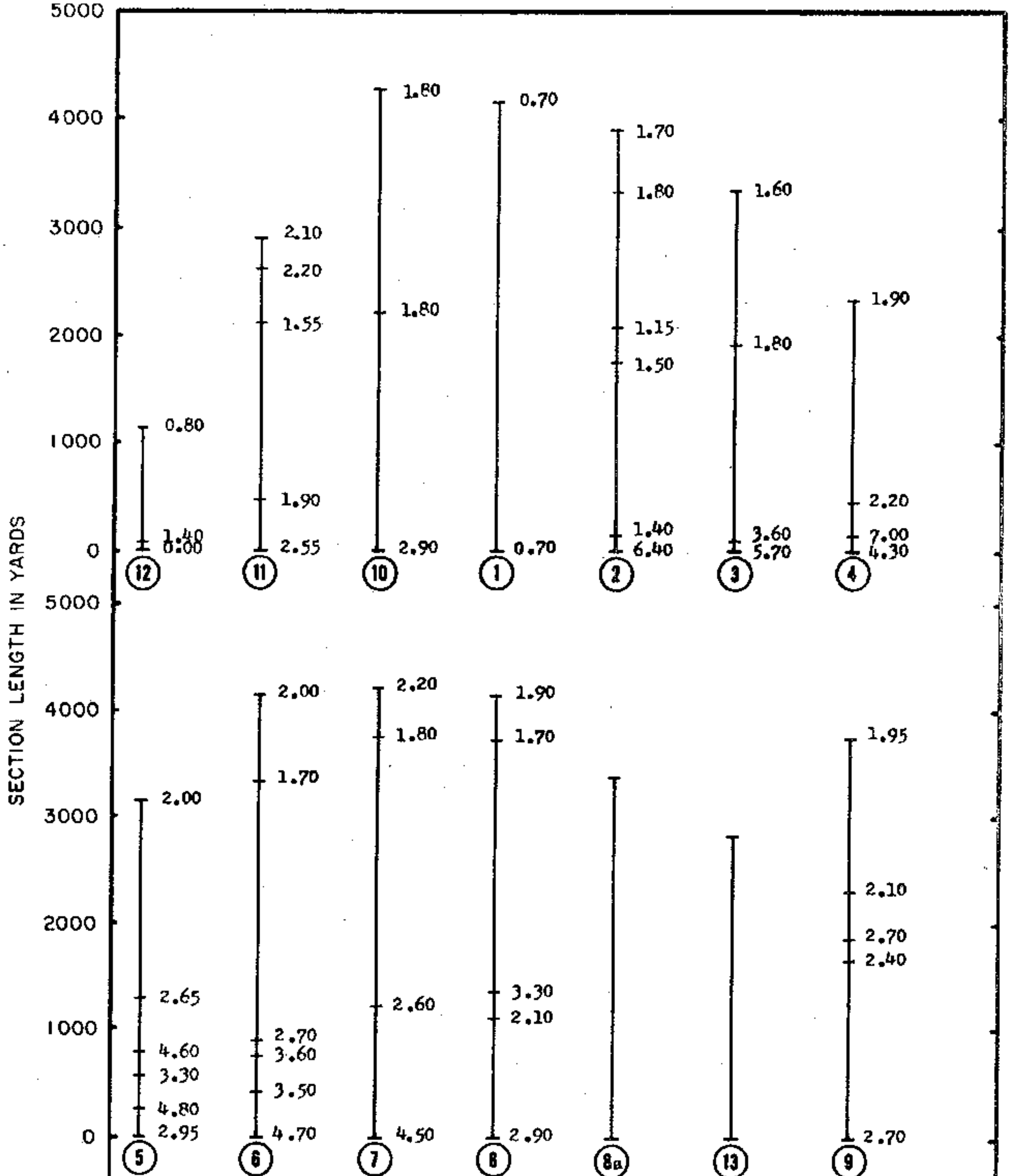
OBSERVED EXCESS TEMPERATURES - °F
(SECTION LOCATIONS SHOWN ON FIGURE 2)
FOR
RIVER FLOW = 2000 cfs
REJECTED HEAT = 12×10^9 BTU / HR.
TIDAL HOUR = 3



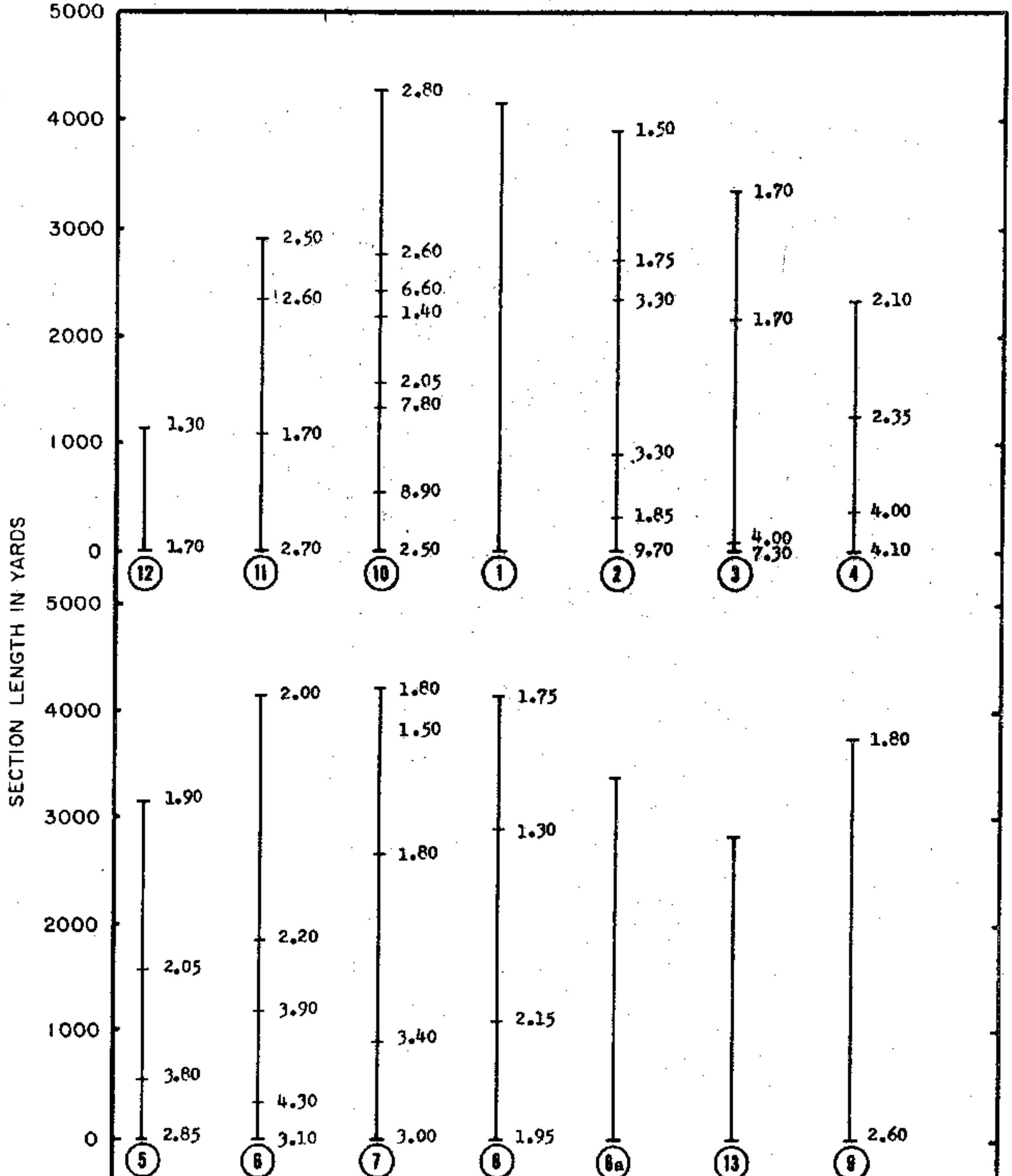
OBSERVED EXCESS TEMPERATURES - °F
(SECTION LOCATIONS SHOWN ON FIGURE 2)
FOR
RIVER FLOW = 2000 cfs
REJECTED HEAT = 12 x 10^9 BTU / HR.
TIDAL HOUR = 4 1/2



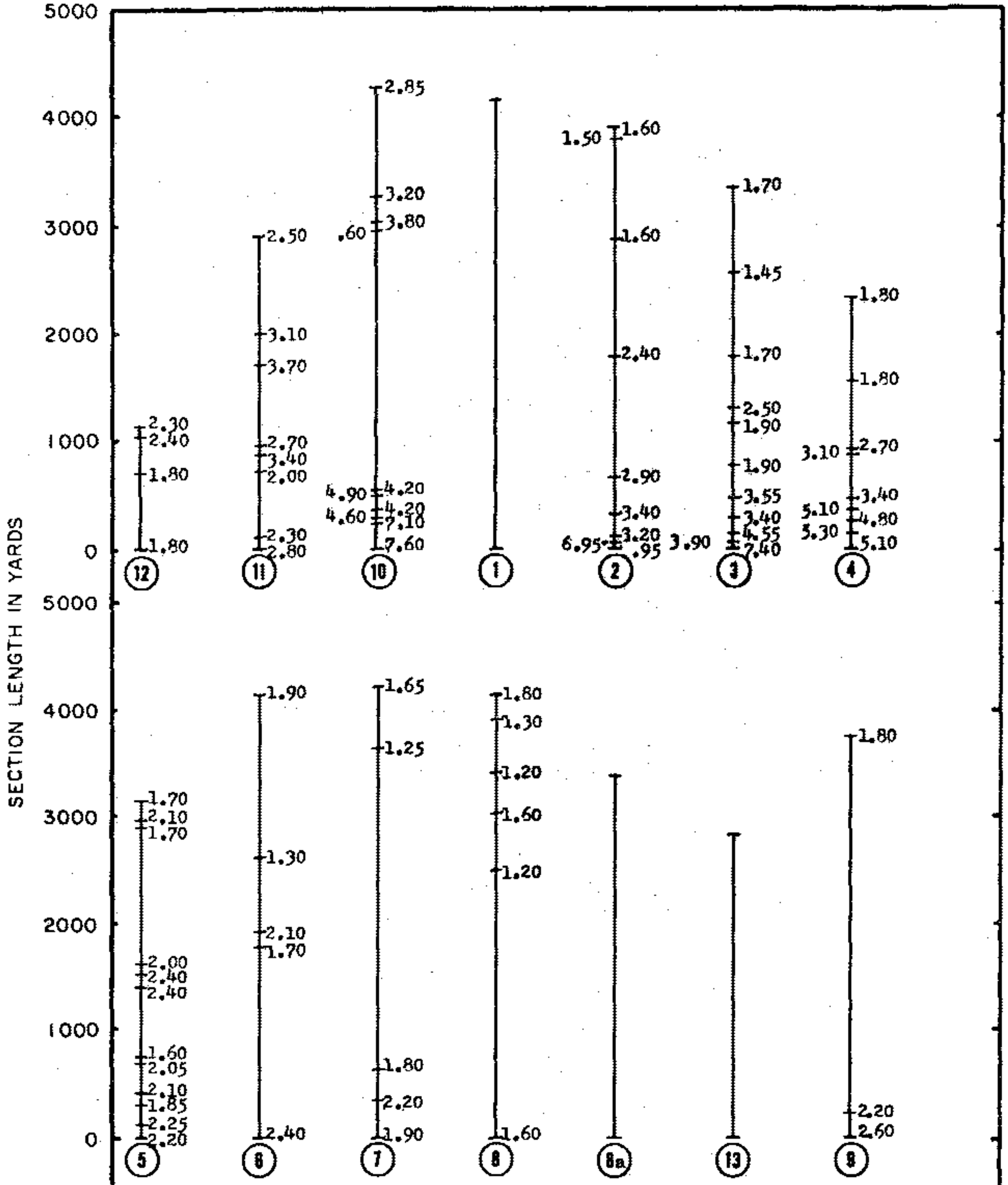
OBSERVED EXCESS TEMPERATURES – °F
(SECTION LOCATIONS SHOWN ON FIGURE 2)
FOR
RIVER FLOW = 2000 cfs
REJECTED HEAT = 12 x 10^9 BTU / HR.
TIDAL HOUR = 6



OBSERVED EXCESS TEMPERATURES - °F
(SECTION LOCATIONS SHOWN ON FIGURE 2)
FOR
RIVER FLOW = 2000 cfs
REJECTED HEAT = 12×10^9 BTU / HR.
TIDAL HOUR = 7 1/2



OBSERVED EXCESS TEMPERATURES - °F
(SECTION LOCATIONS SHOWN ON FIGURE 2)
FOR
RIVER FLOW = 2000 cfs
REJECTED HEAT = 12×10^9 BTU/HR.
TIDAL HOUR = 9



OBSERVED EXCESS TEMPERATURES – °F
(SECTION LOCATIONS SHOWN ON FIGURE 2)
FOR
RIVER FLOW = 2000 cfs
REJECTED HEAT = 12 x 10^9 BTU / HR.
TIDAL HOUR = 10 1/2

RE: Request for Virginia Department of Health (VDH) Input
Dominion Energy Surry Power Station Units 1 and 2
Extension of Operating License from Nuclear Regulatory Commission (NRC)

Date of Request from Dominion Energy: March 27, 2019
Request from: Ken Roller, Manager, Environmental and Tony Banks, MPH, Generation Project Manager, Nuclear

FROM: Marcia Degen, Ph.D., PE
Technical Services Manager
VDH – Office of Environmental Health Services

TO: Ken Roller, Manager, Environmental
Dominion Energy

DATE: May 6, 2019

CC: Tony Banks, Dominion Energy, Generation Manager, Nuclear
Toinette Waldron, VDH, Crater Health District, Environmental Health Manager
Margaret Smigo, VDH, Waterborne Hazards Program Coordinator
Arlene Warren, VDH, Office of Drinking Water
Keith Skiles, VDH, Shellfish Safety, Division Director

Discussion: Dominion Energy is seeking renewal of its NRC operating permit for Surry Power Station Units 1 and 2 for an additional 20 years. As part of the renewal process, Dominion Energy is developing an environmental report to assess the potential environmental impacts from the once through cooling water discharge with continued operation of the facility. NRC has provided guidance that Dominion should consult with VDH concerning potential health concerns from specific organisms:

- The enteric pathogens *Salmonella* spp. and *Shigella* spp., as well as *Pseudomonas aeruginosa* and thermophilic fungi,
- The bacteria *Legionella* spp., which causes Legionnaires' disease, and
- Free-living amoebae of the genera *Naegleria* (*Naegleria fowleri*) and *Acanthamoeba.*

Dominion Energy provided a document entitled "Information to Support VDH Consultation on Thermophilic Microorganisms" which provides a description and analysis of the thermal discharge and its effect on the river and its environment. A 1967 temperature distribution study was attached as supporting documentation.

Conclusion: After review, VDH has the following comments.

Currently any risk is perceived (not known) and not likely given the long-term existence of this discharge and lack of any known issues resulting in exposure for that area. While VDH does not suspect the waste heat discharge exacerbates waterborne pathogen growth, and public health risk is likely very low as a result, the agency opts to withhold a formal statement in this regard until additional modeling is conducted during the upcoming VPDES permit re-issuance. It will coordinate with the company and DEQ to ensure the modeling scenarios incorporate the critical conditions when public risk and temperatures are highest.

VDH – Office of Drinking Water has reviewed the above project. Below are our comments as they relate to proximity to ***public drinking water sources*** *(groundwater wells, springs and surface water intakes). Potential impacts to public water distribution systems or sanitary sewage collection systems* ***must be verified by the local utility.***

The following public groundwater wells are located within a 1 mile radius of the project site:

PWS ID Number	*City/County*	*System Name*	*Facility Name*
3181802	*SURRY*	*VA POWER CONSTRUCTION SITE*	*WELL 1*
3181800	*SURRY*	*SURRY POWER STATION*	*WELL B INSIDE GATE*
3181800	*SURRY*	*SURRY POWER STATION*	*WELL E WAREHOUSE ROAD W*
3181800	*SURRY*	*SURRY POWER STATION*	*WELL C HIGH LEVEL ROAD EAST*

There are no surface water intakes located within a 5-mile radius of the project site.

The project is not within the watershed of any public surface water intakes.

Best Management Practices should be employed, including Erosion & Sedimentation Controls and Spill Prevention Controls & Countermeasures on the project site.

Enclosure 3

ATTACHMENTS FOR RAI WR-1

Virginia Electric and Power Company
(Dominion Energy Virginia or Dominion)
Surry Power Station Units 1 and 2

Appendix B

Water Well Completion Report for Well E (7 pages)

Geophysical Logs and Well Design for Well J (4 pages)

NOTED APR 12 1979 M.F.K.

April 10, 1979

Mr. Russell Ellison
Acting Chief Geologist
Piedmont Regional Office
P. O. Box 6616
Richmond, Virginia 23230

Surry Power Station - Water Well E

Dear Mr. Ellison:

Attached is a copy of the Water Well Completion Report for the above referenced well.

If you have any questions, please contact us.

Very truly yours,

Original Signed By
MORRIS L. BREHMER

Morris L. Brehmer, Ph.D.
Executive Manager
Environmental Services

bc: Mr. A. W. Hadder
Mr. B. R. Sylvia
Mr. W. L. Stewart
Mr. R. H. Coupe
Mr. W. W. Cameron, Jr.)
Mr. D. L. Flippen)
Mr. M. F. Kadlubowski)
Mr. R. L. Birckhead) (attachment)

FORM GW 2
2/77 10,000

COMMONWEALTH OF VIRGINIA
STATE WATER CONTROL BOARD
P. O. Box 11143, 2111 North Hamilton Street
Richmond, Virginia 23230
Phone (804) 770-1411

FOR REFERENCE ONLY

WATER WELL COMPLETION REPORT
(Certification of Completion)

PERMIT NUMBER ______
BWCM WELL NO. E

DATE REC'D 8/30/1978
Well Drill-- --- - TRUCK TAG NO. 243

LOCATION

COUNTY: Surry

WELL IS LOCATED APPROX. 160 feet/miles south (direction) of intake canal and 320 feet/miles east (direction) of the western end of canal.

WELL IS NEWLY CONSTRUCTED ✓ OR IS AN ALTERATION, REHABILITATION, OR EXTENSION OF AN EXISTING WELL ____. NUMBER OF CERTIFICATE OF GROUNDWATER RIGHT OF EXISTING WELL, IF APPLICABLE ______ ______.

FOR OFFICE USE:

VA. PLANE COORDINATES: ______ N ______ E

TOPOGRAPHIC MAP NUMBER: ______

OWNER

NAME: Vepco
STREET: P.O.Box 26666
CITY: Richmond
STATE: Va. ZIP: 23261

WATER WELL USER

NAME: Surry Power Plant
STREET: Rt. 650 Off Hwy. 10
CITY: Surry
STATE: Va. ZIP: 23883

CONTRACTOR

SIGNATURE: Major R. Tillman
NAME (type): Tillman Well Service
STREET: 1644 Jolliff Rd.
CITY: Chesapeake
STATE: Va. ZIP: 23321

BASIC DATA

DATE STARTED: August 8,1978 DATE COMPLETED: August 30,1978 DEPTH DRILLED: 420

DEPTH OF COMPLETED WELL: 420,' STATIC WATER LEVEL: 100 feet below land surface.

YIELD TEST: pump Method; Drawdown 28 feet; Yield 220 gpm; Duration 48 hours.

WAS THE WELL LOGGED? (Yes)/No; if Yes, BY WHOM? Layne Atlantic, TYPE OF LOG(S): Electric.

WAS THE WATER ANALYZED? (Yes)/No; if Yes, BY WHOM? ______. TYPE OF RIG: Failing 1,500

WELL TO SUPPLY: Home/Farm/Municipality/School/(Industry)/Subdivision/Other Vepco
(circle which)

WERE WELL DRILLINGS SAVED? (Yes)/No (Well cuttings should be collected at 10-foot intervals and shipped express collect to this office in a shipping container. Sample bags are furnished free of charge upon request).

PUMP DATA

BRAND NAME: Reda Pump Co.
TYPE: QN 63/8
MODEL NUMBER: 7560-8
RATED CAPACITY: 200 gpm at 320 feet of head.
DEPTH OF INTAKE: 147ft.
RATED HORSEPOWER: 20H.P.

CONSTRUCTION DATA

HOLE SIZE: 12 inches from o to 425 feet
____ inches from ____ to ____ feet
____ inches from ____ to ____ feet

CASE SIZE: 6 inches from 0 to 420 feet
____ inches from ____ to ____ feet
____ inches from ____ to ____ feet

GROUTING? Yes/No; from surface to 0 feet. 50

FOR REFERENCE ONLY

SCREEN DATA

DOES THE WELL HAVE SCREENS? (Yes)/No; OR
DOES THE WELL HAVE SLOTTED OR PERFORATED PIPE? (Yes)/No

LOCATION OF SCREENS: Give the diameter and depth of all screens or sections of slotted or perforated pipe.

6 inches from 400 to 420 feet | ___ inches from ___ to ___ feet
___ inches from ___ to ___ feet | ___ inches from ___ to ___ feet
___ inches from ___ to ___ feet | ___ inches from ___ to ___ feet

QUALITY DATA

DID ANY STRATUM CONTAIN WATER WHICH WAS UNUSUABLE? Yes/(No) TYPE OF WATER ________.

DEPTH OF STRATUM: from 380 to 420 feet; from ___ to ___ feet. WATER TEMPERATURE: ___°F

DRILLER'S LOG

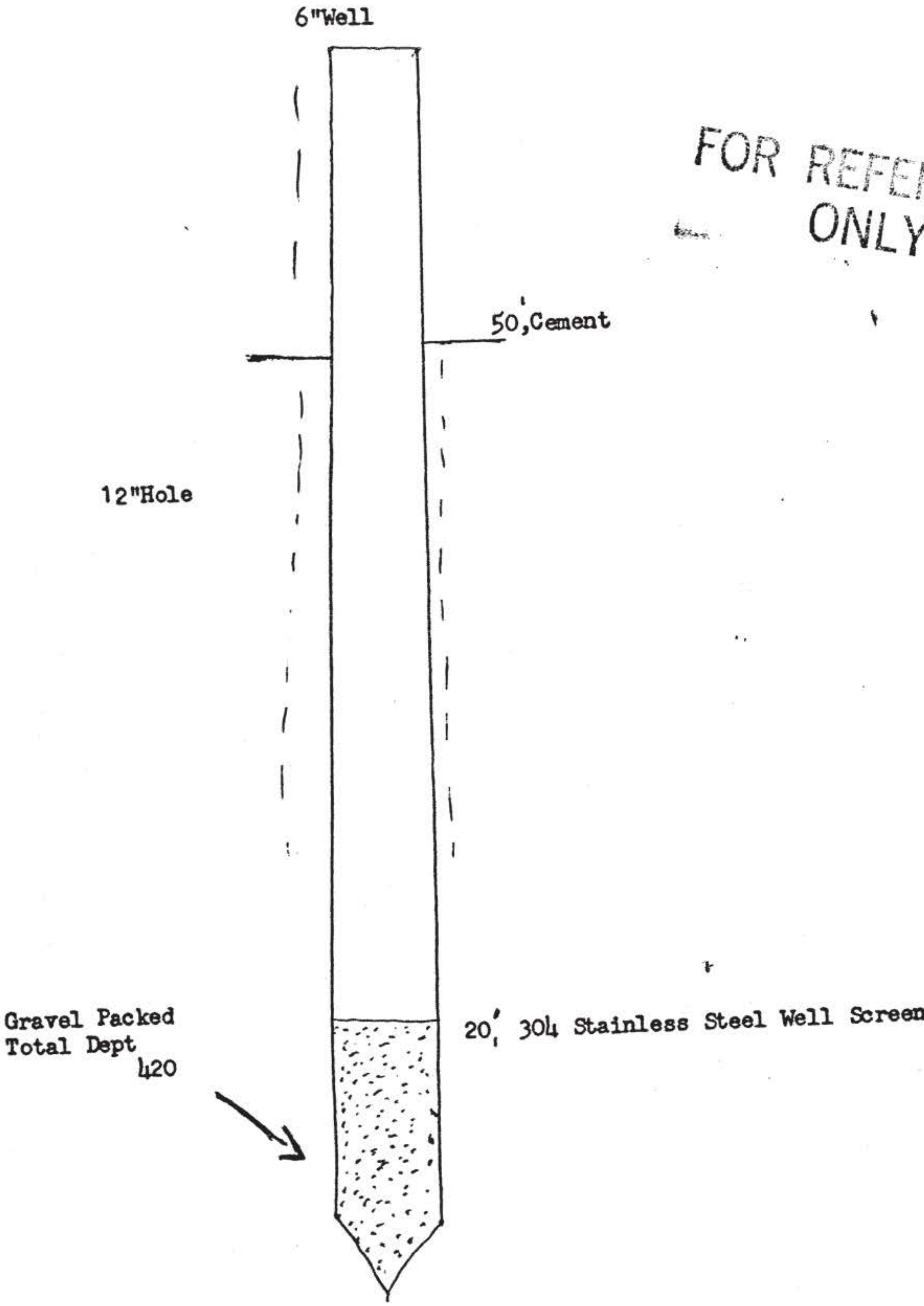
DEPTH (feet)		TYPE OF ROCK OR SOIL PENETRATED (gravel, clay, etc.; hardness, color, etc.)	REMARKS (water, caving, shot, screen, samples, etc.)
From	To		
		See attached sheets.	

D[illegible] Log(Surry Power Plant)
(Well#E)

-10 Clay
-20 Clay
Clay
- Yellow Sand
-Yellow Sand
-60-Gray Sand
-70-Gray Sand&Clay
-80-Gray Sand&Clay
-90-Clay
-100-Clay
-110-Fine Gray Sand
-120-Fine Sand
-130-Clay
-140-Fine Gray Sand&Clay
-150-Clay
-160-Clay
-170-Clay
-180-Fine Gray Sand&Clay
-190-Fine Gray Sand&Clay
0-200-Fine Gray Sand&Clay
0-210-Fine Gray Sand&Clay
0-220-Clay
0-230-Clay
0-240-Clay
0-250-Clay & Yellow Sand
0-260-Clay & Yellow Sand
0-270-Clay & Yellow Sand
0-280-Clay & Yellow Sand
90-Clay & Black Sand
0-300-Black Sand
0-310-Black Sand
0-320-Black Sand
0-330-Black Sand
0-340-Black Sand
0-350-Mud & Black Sand
0-360-Black Sand
0-370-Clear Black Sand
0-380-Clear Black Sand
0-390-Clear Fine Sand
0-400-Sand Is Medium & Course
0-410-Sand Is Medium & Course
0-420-Sand Is Medium & Course

TILLMAN WELL SERVICE
1644 JOLLIFF ROAD
CHESAPEAKE, VIRGINIA 23321

(We / E)



TILLMAN WELL SERVICE
1644 JOLLIFF ROAD
CHESAPEAKE, VIRGINIA 23321

ICB GW-9 800
arch, 1974

BWCM NO. ______

STATE WATER CONTROL BOARD
BUREAU OF WATER CONTROL MANAGEMENT
BOX 11143, RICHMOND, VA.

PUMPING TEST

WELL DATA
PUMPING WELL
OBSERVATION WELL

General Location Surry Power Station Start Date of Test Aug. 24, 1978

Data Recorded by Tillman Well Service Completion Date of Test Aug. 26, 1978
Test Duration (in hours) 48

Owner of Well Vepco Well No. E

Address of Owner P. O. Box 26666, Richmond, VA 23261

Well Depth 420' Casing Dia. 6' Screen Depths 400-420 Ft.

Pump Type Reda Pump Co. - QN 63/8

Pumped Well Static W. L. ______ Obs. Well Static W. L. ______

W. L. Measuring Device ______ Measuring Pt. of Obs. Well ______

TEST DATA

(Start time of pump 10:00 a.m./~~p.m.~~ Stop time of pump 10:00 a.m./~~p.m.~~)

Time hrs., mins.	Elapsed Time	Depth to water (in feet)	Discharge rate (gpm)	Meter Reading	Drawdown or Recovery (in feet)	Remarks
		See	attached shee	ts		

FOR REFERENCE ONLY

(Pump Test for Surry Power Plant)
(Well# E)

e)A.M.	(Gallons Per Minute)	(Draw Down)	(pumping Level)	(Static)Ft.
0	220	28	128	100-
	220	28	128	
0	220	28	128	
:0	220	27	128	
0	220	27	127	
0 P.M.	220	27	127	
0	220	27	127	
0	220	27	127	
0	220	27	127	
0	220	27	127	
00	220	27	127	
00	220	28	128	
00	220	28	128	
00	220	28	128	
00	220	28	128	
00	220,	28	128	
00	220	26	128	
:00	220	28	128	
:00	220	28	128	
:00	220	28	128	
:00	220	28	128	
:00	220	28	128	
:00	220	28	128	
:00	220	28	128	
:00	220	28	128	
:00	220	28	128	
	220	28	128	
:00	220	28	128	
:00	2200	28	128	
:00A.M.	220	28	128	
:00	220	28	128	
:00	220	28	128	
:00	220	28	128	
:00	220	28	128	
:00	220	28	128	
:00	220	28	128	
:00	220	28	128	
:00	220	28	128	
:00	220	28	128	
:00	220	28	128	
:00	220	28	128	
:00P.M.	220	28	128	
:00	220	28	128	
:00	220	28	128	
:00	220	28	128	
:00	220	28	128	
:00	220	28	128	
:00	220	28	128	
:00	220	28	128	
:00	220	28	128	
:00	220	28	128	

FOR REFERENCE ONLY

TILLMAN WELL SERVICE
1644 JOLIFF ROAD
CHESAPEAKE, VIRGINIA 23321

[redacted]

WELL J
DEQ #190-110

A.C. SCHULTES OF DELAWAI

P.O. BOX 188 BRIDGEVILLE, DEL

Water Well Contractors

CUSTOMER VIRGINIA POWER JOB 1583

ADDRESS INNSBROOK TECHNICAL CENTER, GLEN ALLEN, VA 23060 DATE 5/08/97

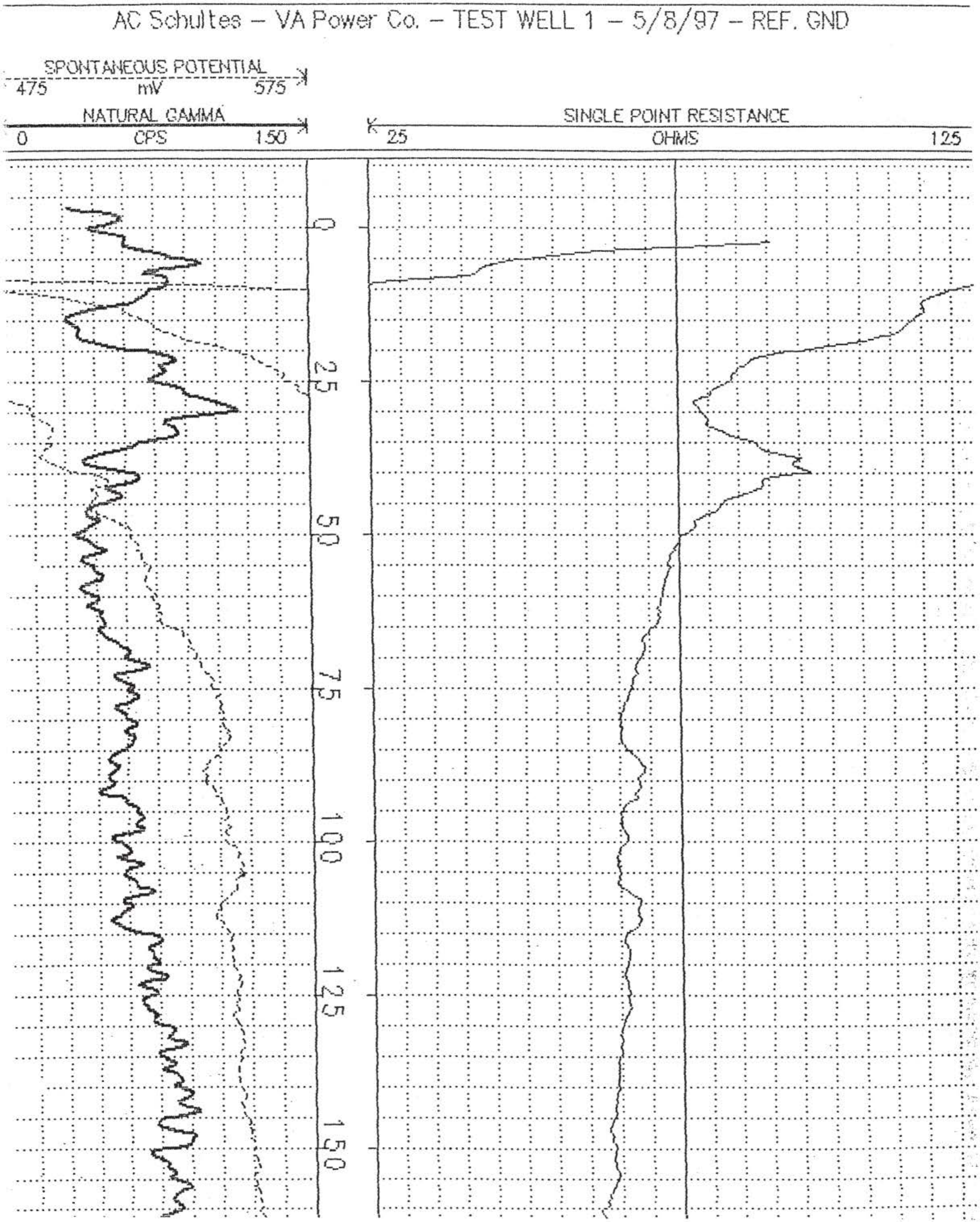
LOCATION GRAVEL NECK COMBUSTION TURBINE FACILITY

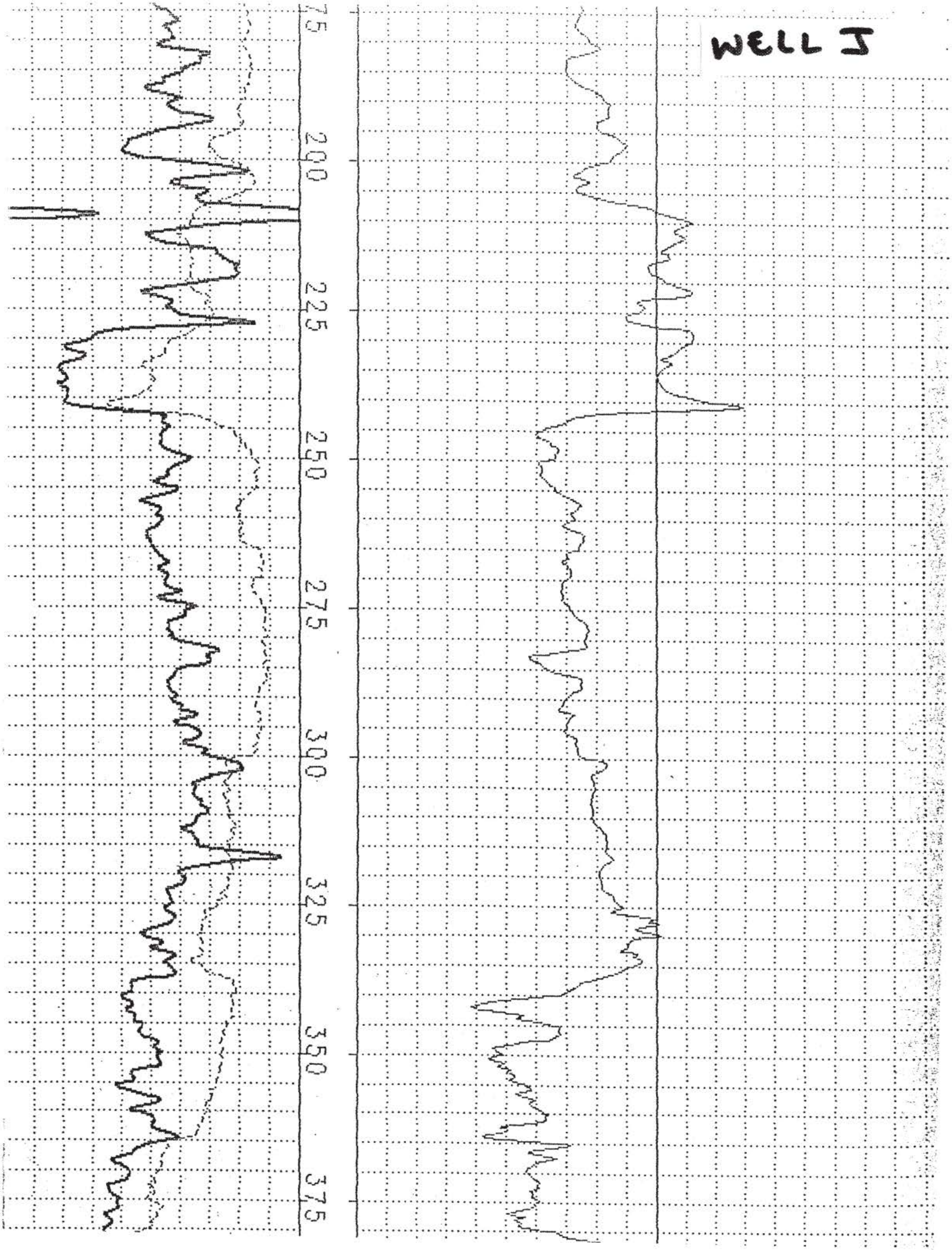
GROUND 2'
397'
TOTAL DEPTH-FT. 417'
CASING
SCREEN

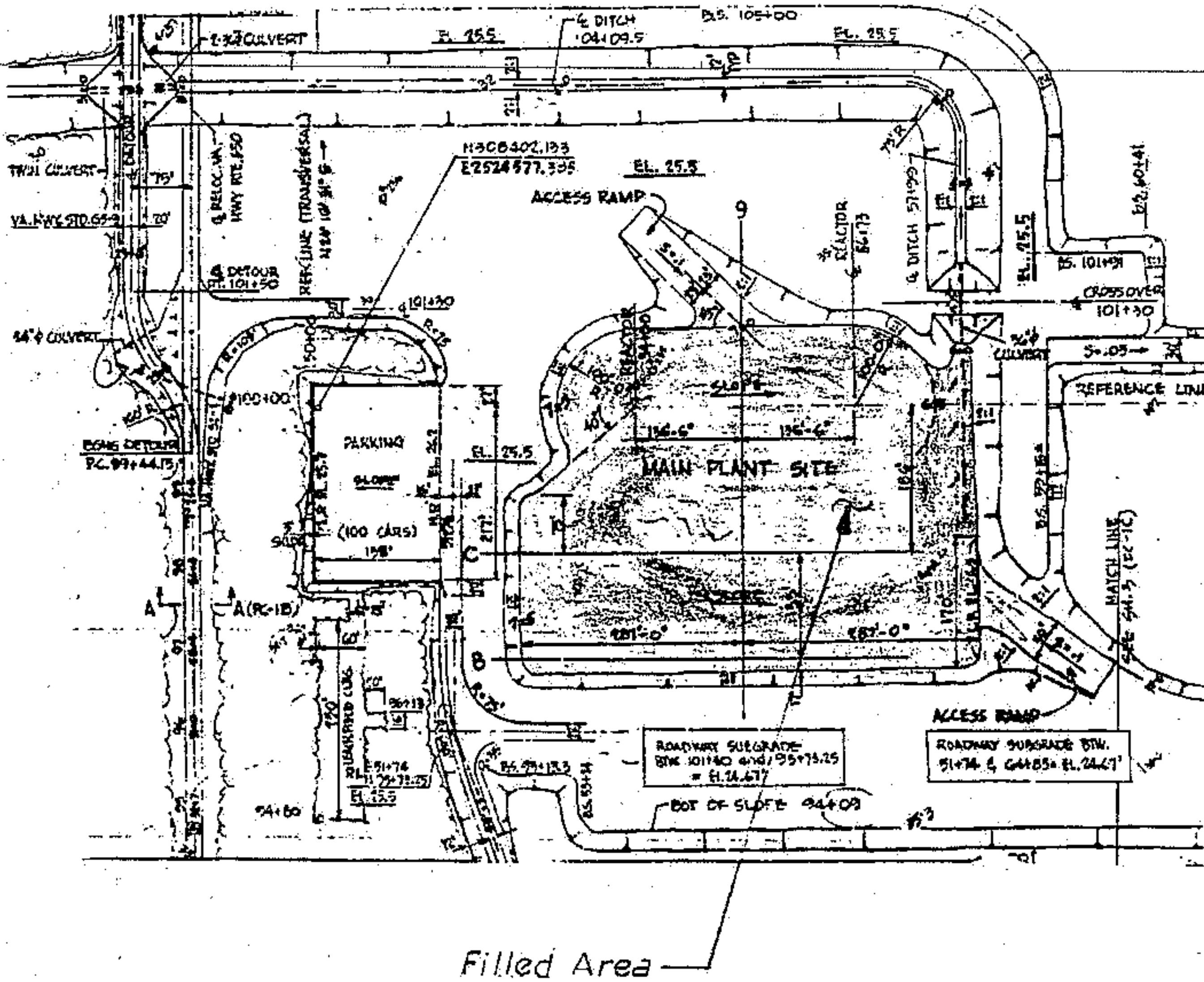
FEET FROM GROUND SURFACE 0 TO............	WELL LOG
0 - 9	YELLOW & WHITE CLAY
9 - 20	FINE TAN SAND
20 - 40	HARD FINE TAN SAND
40 - 62	FINE TAN SAND W/GRAVEL & SHELL
62 - 74	FINE TAN SAND W/GRAVEL & SHELL W/GREEN CLAY
74 - 94	GREEN CLAY W/SHELL
94 -212	GREEN CLAY W/ STONES
212 - 234	GREEN CLAY W/ SAND
234 - 237	ROCK LAYER
237 - 297	GRAY SAND W/SHELL
297 - 310	GRAY SAND W/PEPPER SAND
310 - 315	GREEN CLAY
315 -335	BLACK SAND
335 - 375	HARD GREEN CLAY
375 - 387	FINE TAN SAND
387 - 420	COARSE TO MED SAND

WELL NO. 1	DIAMETER OF WELL 6"	DEPT. OF WELL 417'
HRS. PUMPED 24	SLOT SIZE .020 (SCREEN)	TYPE OF CASING CERTA-LOC PVC
CAPACITY G.P.M. 42	DRILLING MACHINE NO. D-5	LENGTH OF CASING 397'
STATIC LEVEL 106.5'	DRILLERS S.WILLEY/J.ZITTINGER	DISTANCE TO TOP OF SCREEN 397'
PUMPING LEVEL 155.5'	GRAVEL #1	TYPE SCREEN JOHNSON STAINLESS STEEL
SPECIFIC CAPACITY .86	BAGS OF CLAY 10	SIZE OF SCREEN 6"
PUMPED WITH SUBMERSIBLE PUMP	DATE WELL COMPLETED 5/10/97	DRILLER: SHAWN WILLEY
~~DEPTH OF XXXXX~~ CEMENT GROUT 0 -50'	BOREHOLE DIAMETER 14"	HELPER: R. JUSTICE, C.KELL
DEPTH GRAVEL PACKED 325' -417'	CASING OD 6.9"	
DEPTH OF PEA GRAVEL 50 - 325'	CASING WALL THICKNESS .405	

WELL J


AC Schultes – VA Power Co. – TEST WELL 1 – 5/8/97 – REF. GND
SPONTANEOUS POTENTIAL
475
mV
575
NATURAL GAMMA
0
CPS
150
SINGLE POINT RESISTANCE
25
OHMS
125
0
25
50
75
100
125
150


WELL J
75
200
225
250
275
300
325
350
375



SURRY POWER STA.

FIGURE 1

VIRGINIA POWER

Engineering Work Sheet

Document Type ENGINEERING SKETCH	Sheet Number of		
Project SURRY GW STUDY	Document Number FIG. 2A	Revision Number 0	
[S]ubject SOIL PROFILE FROM B-21 TO B-26	Prepared By M.L. BLOUGH	Date 7-11-90	
System	Checked By	Date	

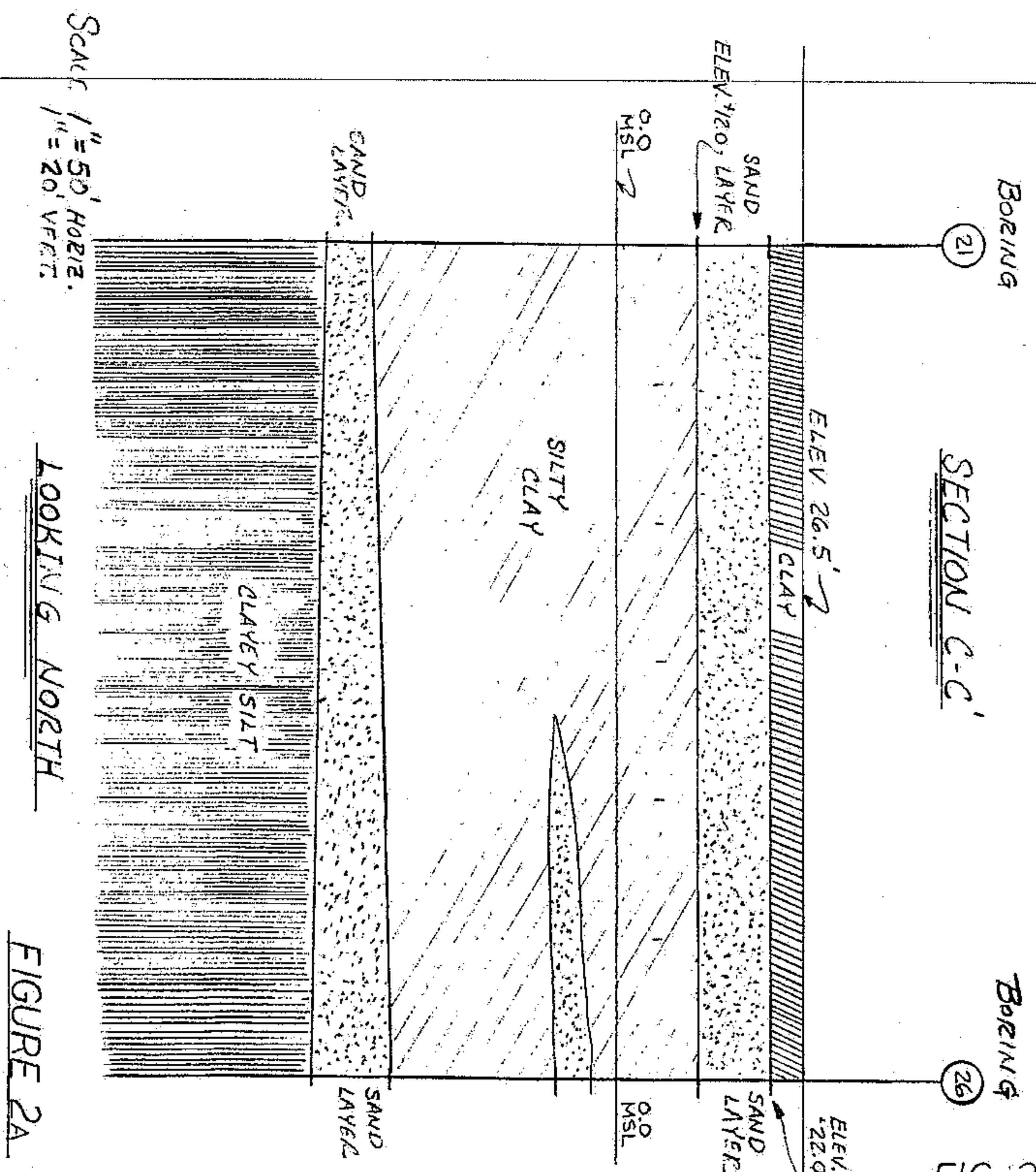


FIG. 2A

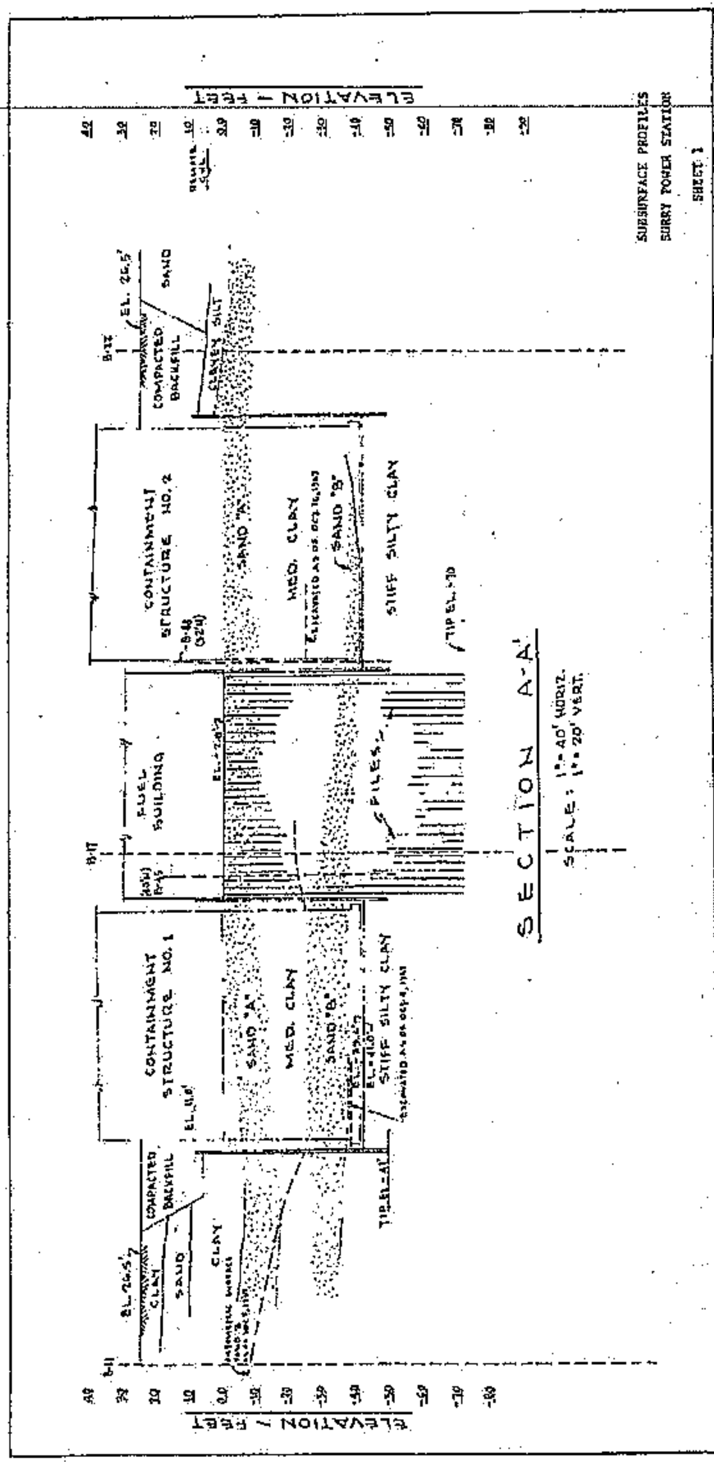

ELEVATION ~ FEET
SUBSURFACE PROFILES
SURRY POWER STATION
SHEET 1
EL. 26.5'
SAND
COMPACTED BACKFILL
CLAYEY SILT
CONTAINMENT STRUCTURE NO. 2
SAND "A"
MED. CLAY
SAND "B"
STIFF SILTY CLAY
FUEL BUILDING
PILES
CONTAINMENT STRUCTURE NO. 1
CLAY
SECTION A-A'
SCALE: 1"= 40' HORIZ. 1"= 20' VERT.

FIGURE 4

Enclosure 4

ATTACHMENTS FOR WR-4

Virginia Electric and Power Company
(Dominion Energy Virginia or Dominion)
Surry Power Station Units 1 and 2

Annual Water Withdrawal Report Summary

DEPARTMENT OF ENVIRONMENTAL QUALITY (DEQ)
ANNUAL REPORT OF WATER WITHDRAWALS
For the Period: January 1, 2018 to December 31, 2018

Organization/Owner: Virginia Electric & Power Company
Facility: Surry Power Station
Facility UserID: 1339
Facility Status: active
Use Type: nuclearpower
Locality: Surry
Report Status: submitted

Type	# of MPs	Total (MGY)
Surface Water Intake	1	662,922.96
Well	7	137.1323

Source Name: JAMES RIVER
MPID: 371018077422301
Source Status: active
Source Type: Surface Water Intake

Source Name: JAMES RIVER

Source Name	Date	Withdrawal (MGM)
JAMES RIVER	Jan/2018	53,086.8
JAMES RIVER	Feb/2018	51,095.76
JAMES RIVER	Mar/2018	53,496
JAMES RIVER	Apr/2018	45,573.48
JAMES RIVER	May/2018	41,288.16
JAMES RIVER	Jun/2018	66,761.28

Source Name	Date	Withdrawal (MGM)
JAMES RIVER	Jul/2018	71,256.96
JAMES RIVER	Aug/2018	70,536
JAMES RIVER	Sep/2018	65,167.44
JAMES RIVER	Oct/2018	57,863.52
JAMES RIVER	Nov/2018	35,019.84
JAMES RIVER	Dec/2018	51,777.72

Source Name: Old Well D - Abandoned
MPID: 370928076405900
Source Status: abandoned
Source Type: Well

Source Name: Well A
MPID: 370918076401501
Source Status: active
Source Type: Well

Source Name: Well A

Source Name	Date	Withdrawal (MGM)
Well A	Jan/2018	0.0034
Well A	Feb/2018	0.0078
Well A	Mar/2018	0.0055
Well A	Apr/2018	0.0573
Well A	May/2018	0.1667
Well A	Jun/2018	0.1875
Well A	Jul/2018	0.1926
Well A	Aug/2018	0.1581
Well A	Sep/2018	0.1
Well A	Oct/2018	0.0873
Well A	Nov/2018	0.0139
Well A	Dec/2018	0.0099

Source Name: Well B
MPID: 370955076420001
Source Status: active
Source Type: Well

Source Name: Well B

Source Name	Date	Withdrawal (MGM)
Well B	Jan/2018	9.0623
Well B	Feb/2018	7.5437
Well B	Mar/2018	7.4286
Well B	Apr/2018	8.2272
Well B	May/2018	7.6433
Well B	Jun/2018	7.6809
Well B	Jul/2018	8.4468
Well B	Aug/2018	7.8814
Well B	Sep/2018	7.2694
Well B	Oct/2018	9.3018
Well B	Nov/2018	7.6649
Well B	Dec/2018	8.3942

Source Name: Well C
MPID: 370950076414801
Source Status: active
Source Type: Well

Source Name: Well C

Source Name	Date	Withdrawal (MGM)
Well C	Jan/2018	2.3956
Well C	Feb/2018	0.5365
Well C	Mar/2018	0.9462
Well C	Apr/2018	2.294
Well C	May/2018	0.7263
Well C	Jun/2018	2.056
Well C	Jul/2018	0.6853
Well C	Aug/2018	3.0619

Source Name	Date	Withdrawal (MGM)
Well C	Sep/2018	0.2042
Well C	Oct/2018	2.3043
Well C	Nov/2018	0.6292
Well C	Dec/2018	3.3288

Source Name: Well CS
MPID: 370958076414201
Source Status: active
Source Type: Well

Source Name: Well CS

Source Name	Date	Withdrawal (MGM)
Well CS	Jan/2018	0.1918
Well CS	Feb/2018	0.1659
Well CS	Mar/2018	0.171
Well CS	Apr/2018	0.2845
Well CS	May/2018	0.2635
Well CS	Jun/2018	0.1901
Well CS	Jul/2018	0.2106
Well CS	Aug/2018	0.1933
Well CS	Sep/2018	0.12
Well CS	Oct/2018	0.2137
Well CS	Nov/2018	0.1898
Well CS	Dec/2018	0.0975

Source Name: Well D - Abandoned
MPID: 371006076414801
Source Status: abandoned
Source Type: Well

Source Name: Well E - Abandoned
MPID: 370925076414501
Source Status: abandoned
Source Type: Well

Source Name: Well ER
MPID:
Source Status: active
Source Type: Well

Source Name: Well ER

Source Name	Date	Withdrawal (MGM)
Well ER	Jan/2018	0.5534
Well ER	Feb/2018	1.958
Well ER	Mar/2018	0.7395
Well ER	Apr/2018	0.5553
Well ER	May/2018	1.8095
Well ER	Jun/2018	0.5114
Well ER	Jul/2018	1.698
Well ER	Aug/2018	0.4677
Well ER	Sep/2018	2.4529
Well ER	Oct/2018	1.2678
Well ER	Nov/2018	1.0424
Well ER	Dec/2018	0.094

Source Name: Well F - Abandoned
MPID: 371009076414801
Source Status: abandoned
Source Type: Well

Source Name: Well G - Abandoned
MPID: 370939076413701
Source Status: abandoned
Source Type: Well

Source Name: Well H
MPID: 370930076413001
Source Status: active
Source Type: Well

Source Name: Well H

Source Name	Date	Withdrawal (MGM)
Well H	Jan/2018	0.003
Well H	Feb/2018	0.002
Well H	Mar/2018	0.0046
Well H	Apr/2018	0.0151
Well H	May/2018	0.0015
Well H	Jun/2018	0.0015
Well H	Jul/2018	0.0015
Well H	Aug/2018	0.0019
Well H	Sep/2018	0.0016
Well H	Oct/2018	0.0156
Well H	Nov/2018	0.0016
Well H	Dec/2018	0.0014

Source Name: Well J - Abandoned
MPID: 370940076413501
Source Status: abandoned
Source Type: Well

Source Name: Well JR
MPID: 370940076413501
Source Status: active
Source Type: Well

Source Name: Well JR

Source Name	Date	Withdrawal (MGM)
Well JR	Jan/2018	1.0093
Well JR	Feb/2018	0.7443
Well JR	Mar/2018	0
Well JR	Apr/2018	0.3726
Well JR	May/2018	0.7818
Well JR	Jun/2018	0.4258

Source Name	Date	Withdrawal (MGM)
Well JR	Jul/2018	0.5451
Well JR	Aug/2018	0
Well JR	Sep/2018	0.2501
Well JR	Oct/2018	0.5264
Well JR	Nov/2018	0.2812
Well JR	Dec/2018	0

Enclosure 5

ATTACHMENTS FOR RAI WR-5

Virginia Electric and Power Company
(Dominion Energy Virginia or Dominion)
Surry Power Station Units 1 and 2

DEPARTMENT OF THE ARMY
US ARMY CORPS OF ENGINEERS
NORFOLK DISTRICT
FORT NORFOLK
803 FRONT STREET
NORFOLK VA 23510-1011

April 17, 2017

Eastern Virginia Regulatory Section
NAO-2018-00103 / VMRC#18-V0069 (James River)

Virginia Power and Electric Company
ATTN: Mr. Fred Mladen
5000 Dominion Boulevard
Glen Allen, Virginia 23060

Dear Mr. Mladen:

This is in regard to your Department of the Army permit application number NAO-2018-00103 (VMRC #18-V0069) you have submitted for as-needed maintenance work at the cooling water intake structure at the Surry Nuclear Power Station in Surry County, Virginia. The proposed work involves the removal of submerged logs and similar debris from a concrete apron and the bottom of the James River immediately outboard of the cooling water intake structure. The work zone for the debris removal will not extend more than 200 feet outboard of the intake structure. All debris will be temporarily stockpiled and transported to an appropriate facility. A project vicinity map and drawing of the intake structure are enclosed.

Your proposed work as outlined above satisfies the criteria contained in the Corps Nationwide Permit (3), attached. The Corps Nationwide Permits were published in the January 6, 2017, Federal Register notice (82 FR 1860) and the regulations governing their use can be found in 33 CFR 330 published in Volume 56, Number 226 of the Federal Register dated November 22, 1991.

This nationwide permit verification is contingent upon the following project specific conditions:

Special Conditions:

1. Time of Year Restrictions: This permit does not authorize in-water work between February 15 and June 30, of any year, in order to minimize impacts on anadromous fish and federally managed species.

2. The permittee understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structure or work herein authorized, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the permittee will be required, upon due notice from the Corps of Engineers, to remove, relocate, or

alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

3. Incidents where any individuals of sea turtles or Atlantic sturgeon listed by NOAA Fisheries under the Endangered Species Act appear to be injured or killed as a result of discharges of dredged or fill material into waters of the United States or structures or work in navigable waters of the United States authorized by this NWP shall be reported to NOAA Fisheries, Office of Protected Resources at (301) 713-1401 and the Regulatory Office of the Norfolk District of the U.S. Army Corps of Engineers at 757-201-7652. The finder should leave the animal alone, make note of any circumstances likely causing the death or injury, note the location and number of individuals involved and, if possible, take photographs. Adult animals should not be disturbed unless circumstances arise where they are obviously injured or killed by discharge exposure, or some unnatural cause. The finder may be asked to carry out instructions provided by NOAA Fisheries, Office of Protected Resources, to collect specimens or take other measures to ensure that evidence intrinsic to the specimen is preserved.

4. Enclosed is a "compliance certification" form, which must be signed and returned within 30 days of completion of the project. Your signature on this form certifies that you have completed the work in accordance with the regional permit terms and conditions.

Please note that you should either obtain a U.S. Fish and Wildlife Service (FWS) bald eagle take permit or a letter of concurrence from FWS indicating that a permit is not necessary prior to initiating construction activities. You should contact Scott Frickey concerning this matter at 413-253-8577 or Scott_frickey@fws.gov.

Provided the project specific conditions (above) and the Nationwide Permit General Conditions (enclosed) are met, an individual Department of the Army Permit will not be required. In addition, the Virginia Department of Environmental Quality has provided an conditional §401 Water Quality Certification for Nationwide Permit Number 3. A permit may be required from the Virginia Marine Resources Commission and/or your local wetlands board, and this verification is not valid until you obtain their approval, if necessary. This authorization does not relieve your responsibility to comply with local requirements pursuant to the Chesapeake Bay Preservation Act (CBPA), nor does it supersede local government authority and responsibilities pursuant to the Act. You should contact your local government before you begin work to find out how the CBPA applies to your project.

This verification is valid until the NWP is modified, reissued, or revoked. All of the existing NWPs are scheduled to be modified, reissued, or revoked prior to March 18,

2022. It is incumbent upon you to remain informed of changes to the NWPs. We will issue a public notice when the NWPs are reissued. Furthermore, if you commence or are under contract to commence this activity before the date that the relevant nationwide permit is modified or revoked, you will have twelve (12) months from the date of the modification or revocation of the NWP to complete the activity under the present terms and conditions of this nationwide permit unless discretionary authority has been exercised on a case-by-case basis to modify, suspend, or revoke the authorization in accordance with 33 CFR 330.4(e) and 33 CFR 330.5 (c) or (d). Project specific conditions listed in this letter continue to remain in effect after the NWP verification expires, unless the district engineer removes those conditions. Activities completed under the authorization of an NWP which was in effect at the time the activity was completed continue to be authorized by that NWP.

In granting an authorization pursuant to this permit, the Norfolk District has relied on the information and data provided by the permittee. If, subsequent to notification by the Corps that a project qualifies for this permit, such information and data prove to be materially false or materially incomplete, the authorization may be suspended or revoked, in whole or in part, and/or the Government may institute appropriate legal proceedings.

If you have any questions and/or concerns about this permit authorization, please contact Audrey Cotnoir at 757-549-8819 or audrey.l.cotnoir@usace.army.mil.

Sincerely,

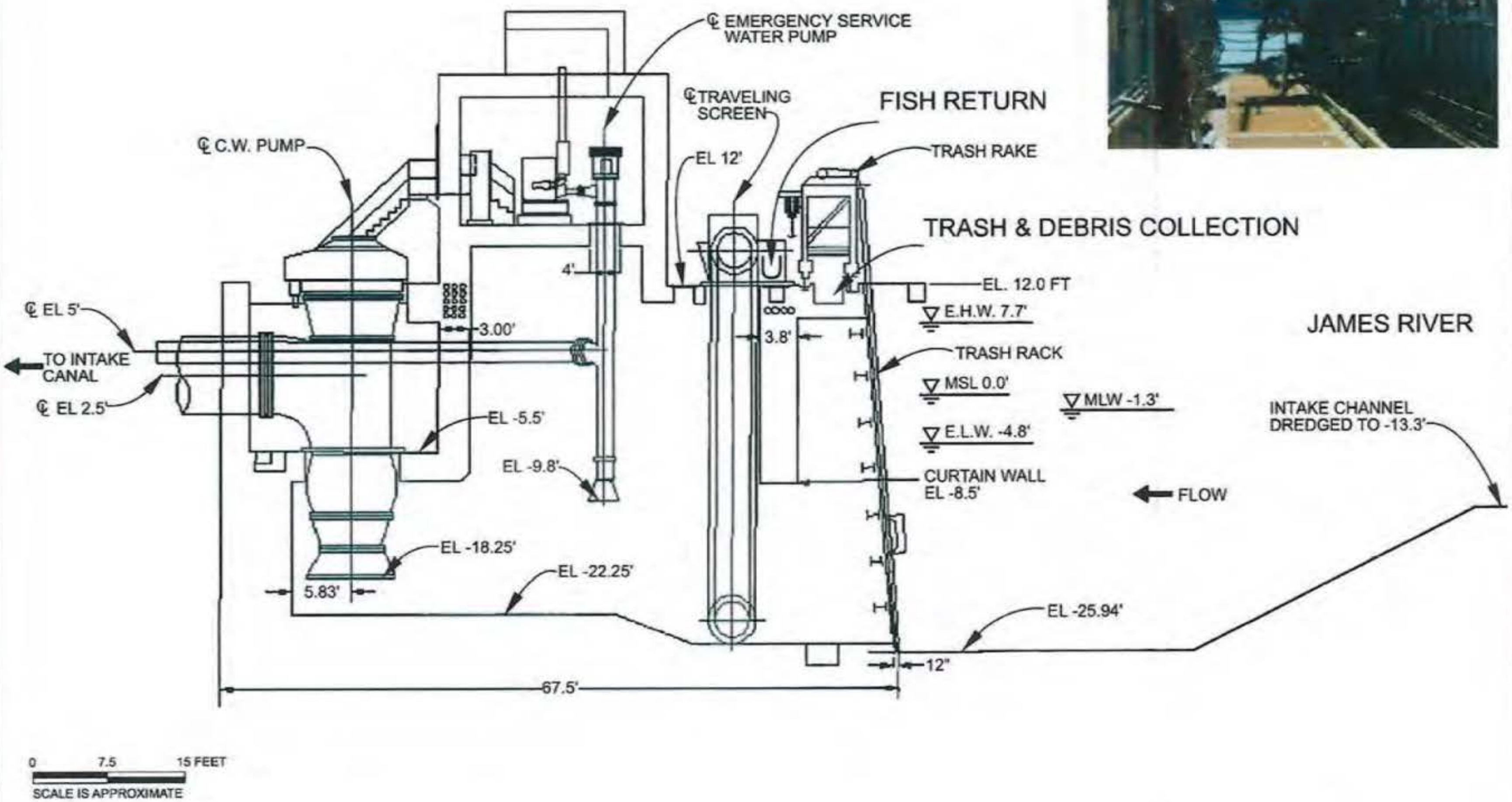
for Peter R. Kube
Chief, Eastern Virginia Regulatory Section

Enclosures
Project Drawings
Compliance Certification
NWP-#3

Cc: Virginia Electric and Power Company, ATTN: Oula Shehab-Dandan
Virginia Marine Resources Commission, ATTN: Mark Eversole


Dominion Surry Power Station
Location of Property Boundary
Map excerpt from USGS Hog Island 7.5 minute quadrangle
0 mile
0.5 mile
1.0 mile
(Scale approximate)
Surry Power Station
Intake Location
HOG ISLAND
STATE WILDLIFE MANAGEMENT AREA
JAMES
HOG
ISLAND
Hog Island Creek
Homewood Creek
Hog Point
Homewood
Walnut Point
Drewry Point
Hunnicut Creek
Creek
SURRY CO
ISLE OF WIGHT CO
HOG ISLAND
STATE WILDLIFE MANAGEMENT AREA

TRASH AND DEBRIS REMOVAL



MODIFIED FROM ALDEN 2003

LOW-LEVEL INTAKE
SURRY POWER STATION

NU082006003RDD_2-4 (8/16/06)

U.S. Army Corps Of Engineers
Norfolk District

CERTIFICATE OF COMPLIANCE WITH ARMY CORPS OF ENGINEERS PERMIT

Permit Number: NAO-2018-00103
VMRC Number: 18-V0069

Corps Contact: Audrey Cotnoir

Name of Permittee: Virginia Power and Electric Company (Surry Nuclear Power Station-cooling water intake structure)

Date of Issuance: April 17, 2018

Permit Type: NWP #3

Within 30 days of completion of the activity authorized by this permit and any mitigation required by the permit, sign this certification and return it to the following address:

Norfolk District, Corps of Engineers
ATTN: Ms. Audrey Cotnoir
Great Bridge Reservation
2509 Reservation Road
Chesapeake, Virginia 23322-5217

Or scan and send via email to audrey.l.cotnoir@usace.army.mil

Please note that your permitted activity is subject to a compliance inspection by a U.S. Army Corps of Engineers representative. If you fail to comply with this permit you are subject to permit suspension, modification or revocation.

I hereby certify that the work authorized by the above referenced permit has been completed in accordance with the terms and conditions of the said permit, and required mitigation has been completed in accordance with the permit conditions.

____________________________ ____________________________

Signature of Permittee Date

Nationwide Permit (3) Maintenance
Effective 3/19/2017
Expires 3/18/2022

(a) The repair, rehabilitation, or replacement of any previously authorized, currently serviceable structure or fill, or of any currently serviceable structure or fill authorized by 33 CFR 330.3, provided that the structure or fill is not to be put to uses differing from those uses specified or contemplated for it in the original permit or the most recently authorized modification. Minor deviations in the structure's configuration or filled area, including those due to changes in materials, construction techniques, requirements of other regulatory agencies, or current construction codes or safety standards that are necessary to make the repair, rehabilitation, or replacement are authorized. This NWP also authorizes the removal of previously authorized structures or fills. Any stream channel modification is limited to the minimum necessary for the repair, rehabilitation, or replacement of the structure or fill; such modifications, including the removal of material from the stream channel, must be immediately adjacent to the project. This NWP also authorizes the removal of accumulated sediment and debris within, and in the immediate vicinity of, the structure or fill. This NWP also authorizes the repair, rehabilitation, or replacement of those structures or fills destroyed or damaged by storms, floods, fire or other discrete events, provided the repair, rehabilitation, or replacement is commenced, or is under contract to commence, within two years of the date of their destruction or damage. In cases of catastrophic events, such as hurricanes or tornadoes, this two-year limit may be waived by the district engineer, provided the permittee can demonstrate funding, contract, or other similar delays.

(b) This NWP also authorizes the removal of accumulated sediments and debris outside the immediate vicinity of existing structures (e.g., bridges, culverted road crossings, water intake structures, etc.). The removal of sediment is limited to the minimum necessary to restore the waterway in the vicinity of the structure to the approximate dimensions that existed when the structure was built, but cannot extend farther than 200 feet in any direction from the structure. This 200 foot limit does not apply to maintenance dredging to remove accumulated sediments blocking or restricting outfall and intake structures or to maintenance dredging to remove accumulated sediments from canals associated with outfall and intake structures. All dredged or excavated materials must be deposited and retained in an area that has no waters of the United States unless otherwise specifically approved by the district engineer under separate authorization.

(c) This NWP also authorizes temporary structures, fills, and work, including the use of temporary mats, necessary to conduct the maintenance activity. Appropriate measures must be taken to maintain normal downstream flows and minimize flooding to the maximum extent practicable, when temporary structures, work, and discharges, including cofferdams, are necessary for construction activities, access fills, or dewatering of construction sites. Temporary fills must consist of materials, and be placed in a manner, that will not be eroded by expected high flows. After conducting the maintenance activity, temporary fills must be removed in their entirety and the affected areas returned to pre-construction elevations. The areas affected by temporary fills must be revegetated, as appropriate.

(d) This NWP does not authorize maintenance dredging for the primary purpose of navigation. This NWP does not authorize beach restoration. This NWP does not authorize new stream channelization or stream relocation projects.

Notification: For activities authorized by paragraph (b) of this NWP, the permittee must submit a pre-construction notification to the district engineer prior to commencing the activity (see general condition 32). The pre-construction notification must include information regarding the original design capacities and configurations of the outfalls, intakes, small impoundments, and canals.

Note: This NWP authorizes the repair, rehabilitation, or replacement of any previously authorized structure or fill that does not qualify for the Clean Water Act section 404(f) exemption for maintenance.

Authority: Section 10 of the Rivers and Harbors Act of 1899 and section 404 of the Clean Water Act (Sections 10 and 404)

REGIONAL CONDITIONS:

1. **Conditions for Waters Containing Submerged Aquatic Vegetation (SAV) Beds:** This condition applies to: NWPs 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22, 23, 25, 27, 28, 29, 31, 32, 33, 35, 36, 37, 38, 39, 44, 45, 48, 52, 53 and 54. A pre-construction notification (PCN) is required if work will occur in areas that contain submerged aquatic vegetation (SAV). Information about SAV habitat can be found at the Virginia Institute of Marine Science's website http://web.vims.edu/bio/sav/. Additional avoidance and minimization measures, such as relocating a structure or time-of-year restrictions (TOYR), may be required to reduce impacts to SAV habitat.

2. **Conditions for Anadromous Fish Use Areas:** To ensure that activities authorized by any NWP do not impact documented spawning habitat or a migratory pathway for anadromous fish, a check for anadromous fish use areas must be conducted via the Norfolk District's Regulatory GIS (for reporting permits) and/or the Virginia Department of Game and Inland Fisheries (VDGIF) Information System (by applicant for non-reporting permits) at http://vafwis.org/fwis/ . For any proposed NWP, if the project is located in an area documented as an anadromous fish use area (confirmed or potential), a time-of-year restriction (TOYR) prohibiting all in-water work will be required from February 15 to June 30 of any given year or any TOYR specified by VDGIF and/or Virginia Marine Resources Commission (VMRC). For permits requiring a PCN, if the Norfolk District determines that the work is minimal and the TOYR is unnecessary, informal consultation will be conducted with NOAA Fisheries Service (NOAA) to obtain concurrence that the TOYR would not be required for the proposed activity. For dredging in the Elizabeth River upstream of the Mid-Town Tunnel on the mainstem and the West Norfolk Bridge (Route 164, Western Freeway) on the Western Branch of the Elizabeth River, a TOYR is not required.

3. **Conditions for Designated Critical Resource Waters, which include National Estuarine Research Reserves:** Notification is required for work under NWPs 3, 8, 10, 13, 15, 18, 19, 22, 23, 25, 27, 28, 30, 33, 34, 36, 37, 38 and 54 in the Chesapeake Bay National Estuarine Research Reserve in Virginia. This multi-site system along a salinity gradient of the York River includes Sweet Hall Marsh, Taskinas Creek, Catlett Islands, and Goodwin Islands. More information can be found at: http://www.vims.edu/cbnerr/. NWPs 7, 12, 14, 16, 17, 21, 29, 31, 35, 39, 40, 42, 43, 44, 49, 50, 51, and 52 cannot be used to authorize the discharge of dredged or fill material in the Chesapeake Bay National Estuarine Research Reserve in Virginia.

4. **Conditions for Federally Listed Species and Designated Critical Habitat:** For ALL NWPs, notification is required for any project that may affect a federally listed threatened or endangered species or designated critical habitat. The U.S. Fish and Wildlife Service (Service) has developed an online system that allows users to find information about sensitive resources that may occur within the vicinity of a proposed project. This system is named "Information, Planning and Conservation System," (IPaC), and is located at: http://ecos.fws.gov/ipac/ . The applicant may use IPaC to determine if any federally listed species or designated critical habitat may be affected by their proposed project. If your Official Species List from IPaC identifies any federally listed endangered or threatened species, you are required to submit a PCN for the proposed activity, unless the project clearly does not impact a listed species or suitable habitat for the listed species. If you are unsure about whether your project will impact listed species, please submit a PCN, so the Norfolk District may review the action. Further information about the Virginia Field Office "Project Review Process" may be found at: http://www.fws.gov/northeast/virginiafield/endangered/projectreviews.html. Additional consultation may also be required with National Marine Fisheries Service for species or critical habitat under their jurisdiction, including sea turtles, marine mammals, shortnose sturgeon, and Atlantic sturgeon. For additional information about their jurisdiction in Virginia, please see https://www.greateratlantic.fisheries.noaa.gov/protected/index.html . Additional resources to assist in determining compliance with this condition can be found on our webpage: http://www.nao.usace.army.mil/Missions/Regulatory/USFWS.aspx

5. **Conditions for Waters with Federally Listed Endangered or Threatened Species, Waters Federally Designated as Critical Habitat, and One-mile Upstream (including tributaries) of Any Such Waters:** Any work proposed in critical habitat, as designated in regional condition 4, requires a PCN.

6. **Conditions for Designated Trout Waters:** Notification is required for work in the areas listed below for NWPs 3, 4, 5, 6, 7, 12, 13, 14, 16, 17, 18, 19, 21, 23, 25, 29, 30, 31, 32, 33, 34, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 49, 50, 51, 52, 53, and 54. This condition applies to activities occurring in two categories of waters; Class V (Put and Take Trout Waters) and Class VI (Natural Trout Waters), as defined by the Virginia State Water Control Board Regulations, Water Quality Standards (VR-680-21-00), dated January 1, 1991, or the most recently updated publication. The Virginia Department of Game and Inland Fisheries (VDGIF) designated these same trout streams into six classes. Classes I-IV are considered wild trout streams. Classes V and VI are considered stockable trout streams. Information on designated trout streams can be obtained via their Virginia Fish and Wildlife Information Service's (VAFWIS's) Cold Water Stream Survey database. Basic access to the VAFWIS is available via http://vafwis.org/fwis/.
The waters, occurring specifically within the mountains of Virginia, are within the following river basins:
1) Potomac-Shenandoah River Basins
2) James River Basin
3) Roanoke River Basin
4) New River Basin
5) Tennessee and Big Sandy River Basins
6) Rappahannock River Basin

VDGIF recommends the following time-of-year restrictions (TOYRs) for any in-stream work within streams identified as wild trout waters in its Cold Water Stream Survey database. The recommended TOYRs for trout species are:

- Brook Trout: October 1 through March 31
- Brown Trout: October 1 through March 31
- Rainbow Trout: March 15 through May 15

This condition applies to the following counties and cities: Albemarle, Allegheny, Amherst, Augusta, Bath, Bedford, Bland, Botetourt, Bristol, Buchanan, Buena Vista, Carroll, Clarke, Covington, Craig, Dickenson, Floyd, Franklin, Frederick, Giles, Grayson, Greene, Henry, Highland, Lee, Loudoun, Madison, Montgomery, Nelson, Page, Patrick, Pulaski, Rappahannock, Roanoke City, Roanoke Co., Rockbridge, Rockingham, Russell, Scott, Shenandoah, Smyth, Staunton, Tazewell, Warren, Washington, Waynesboro, Wise, and Wythe. Any discharge of dredged and/or fill material authorized by the NWPs listed above, which would occur in the designated waterways or adjacent wetlands of the specified counties, requires notification to the appropriate Corps of Engineers field office, and written approval from that office prior to performing the work. The Norfolk District recommends that prospective permittees first contact the applicable Norfolk District Field Office, found at this web link: http://www.nao.usace.army.mil/Missions/Regulatory/Contacts.aspx, to determine if the PCN procedures would apply. The notification must be in writing and include the following information (the standard Joint Permit Application may also be used):

- Name, address, and telephone number of the prospective permittee.
- Name, address, email, and telephone number of the property owner.
- Location of the proposed project.
- Vicinity map and project drawings on 8.5-inch by 11-inch paper (plan view, profile, & cross-sectional view).
- Brief description of the proposed project and the project purpose.
- Where required by the terms of the nationwide permit, a delineation of affected special aquatic sites, including wetlands.

When all required information is received by the appropriate field office, the Corps will notify the prospective permittee within 45 days whether the project can proceed under the NWP or whether an individual permit is required. If, after reviewing the PCN, the District Commander determines that the proposed activity would have more than minimal individual or cumulative adverse impacts on the aquatic environment or otherwise may be contrary to the public interest, then he/she will either condition the nationwide permit authorization to reduce or eliminate the adverse impacts, or notify the prospective permittee that the activity is not authorized by the NWP and provide instructions on how to seek authorization under an individual permit. If the prospective permittee is not notified otherwise within the 45-day period, the prospective permittee may assume that the project can proceed under the NWP.

7. **Conditions Regarding Invasive Species:** Plant species listed by the most current *Virginia Department of Conservation and Recreation's Invasive Alien Plant List* shall not be used for re-vegetation for activities authorized by any NWP. The list of invasive plants in Virginia may be found at: http://www.dcr.virginia.gov/natural-heritage/invsppdflist. DCR recommends the use of regional native species for re-vegetation as identified in the DCR *Native Plants for Conservation, Restoration and Landscaping* brochures for the coastal, piedmont and mountain regions http://www.dcr.virginia.gov/natural-heritage/nativeplants#brochure .

8. **Conditions Pertaining to Countersinking of Pipes and Culverts:** This condition applies to: NWPs 3, 7, 12, 14, 17, 18, 21, 23, 25, 27, 29, 32, 33, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 49, 50, 51, and 52. **NOTE: COUNTERSINKING IS NOT REQUIRED IN TIDAL WATERS.** However, replacement pipes/culverts in tidal waters must be installed with invert elevations no higher than the existing pipe/culvert invert elevation, and a new pipe/culvert must be installed with the invert no higher than the stream bottom elevation. For Nontidal Waters: Following consultation with the Virginia Department of Game and Inland Fisheries (VDGIF), the Norfolk District has determined that fish and other aquatic organisms are most likely present in any stream being crossed, in the absence of site-specific evidence to the contrary. Although prospective permittees have the option of providing such evidence, extensive efforts to collect such information is not encouraged, since countersinking will in most cases be required except as outlined in the conditions below. The following conditions will apply in nontidal waters:

a. All pipes: All pipes and culverts placed in streams will be countersunk at both the inlet and outlet ends, unless indicated otherwise by the Norfolk District on a case-by-case basis (see below). Pipes that are 24" or less in diameter shall be countersunk 3" below the natural stream bottom. Pipes that are greater than 24" in diameter shall be countersunk 6" below the natural stream bottom. The countersinking requirement does not apply to bottomless pipes/culverts or pipe arches. All single pipes or culverts (with bottoms) shall be depressed (countersunk) below the natural streambed at both the inlet and outlet of the structure. In sets of multiple pipes or culverts (with bottoms) at least one pipe or culvert shall be depressed (countersunk) at both the inlet and outlet to convey low flows.

b. When countersinking culverts, permittees must ensure reestablishment of a surface water channel (within 15 days post construction) that allows for the movement of aquatic organisms and maintains the same hydrologic regime that was present pre-construction (i.e. the depth of surface water through the permit area should match the upstream and downstream depths). This may require the addition of finer materials to choke the larger stone and/or placement of riprap to allow for a low flow channel.

c. Exemption for extensions and certain maintenance: The requirement to countersink does not apply to extensions of existing pipes or culverts that are not countersunk, or to maintenance to pipes/culverts that does not involve replacing the pipe/culvert (such as repairing cracks, adding material to prevent/correct scour, etc.).

d. Floodplain pipes: The requirement to countersink does not apply to pipes or culverts that are being placed above ordinary high water, such as those placed to allow for floodplain flows. The placement of pipes above ordinary high water is not jurisdictional (provided no fill is discharged into wetlands).

e. Hydraulic opening: Pipes should be adequately sized to allow for the passage of ordinary high water with the countersinking and invert restrictions taken into account.

f. Pipes on bedrock or above existing utility lines: Different procedures will be followed for pipes or culverts to be placed on bedrock or above existing buried utility lines where it is not practicable to relocate the lines, depending on whether the work is for replacement of an existing pipe/culvert or a new pipe/culvert:

i. Replacement of an existing pipe/culvert: Countersinking is not required provided the elevations of the inlet and outlet ends of the replacement pipe/culvert are no higher above the stream bottom than those of the existing pipe/culvert. Documentation (photographic or other evidence) must be maintained in the permittee's records showing the bedrock condition and the existing inlet and outlet elevations. That documentation will be available to the Norfolk District upon request, but notification or coordination with the Norfolk District is not otherwise required.

ii. A pipe/culvert is being placed in a new location: If the prospective permittee determines that bedrock or an existing buried utility line that is not practicable to relocate prevents countersinking, he/she should evaluate the use of a bottomless pipe/culvert, bottomless utility vault, span (bridge) or other bottomless structure to cross the waterway, and also evaluate alternative locations for the new pipe/culvert that will allow for countersinking. If the prospective permittee determines that neither a bottomless structure nor an alternative location is practicable, then he/she must submit a pre-construction notification (PCN) to the Norfolk District in accordance with General Condition 32 of the NWPs. In addition to the information required by General Condition 32, the prospective permittee must provide documentation of measures evaluated to minimize disruption of the movement of aquatic life as well as documentation of the cost, engineering factors, and site conditions that prohibit countersinking the pipe/culvert. Options that must be considered include partial countersinking (such as less than 3" of countersinking, or countersinking of one end of the pipe), and constructing stone step pools, low rock weirs downstream, or other measures to provide for the movement of aquatic organisms. The PCN must also include photographs documenting site conditions. The prospective permittee may find it helpful to contact the regional fishery biologist for the VDGIF, for recommendations about the measures to be taken to allow for fish movements. When seeking advice from VDGIF, the prospective permittee should provide the VDGIF biologist with all available information such as location, flow rates, stream bottom features, description of proposed pipe(s), slopes, etc. Any recommendations from VDGIF should be included in the PCN. The Norfolk District will notify the prospective permittee whether the proposed work qualifies for the nationwide permit within 45 days of receipt of a complete PCN. NOTE: Blasting of stream bottoms through the use of explosives is not acceptable as a means of providing for countersinking of pipes on bedrock.

g. Pipes on steep terrain: Pipes being placed on steep terrain (slope of 5% or greater) must be countersunk in accordance with the conditions above and will in most cases be non-reporting. It is recommended that on slopes greater than 5%, a larger pipe than required be installed to allow for the passage of ordinary high water in order to increase the likelihood that natural velocities can be maintained. There may be situations where countersinking both the inlet and outlet may result in a slope in the pipe that results in flow velocities that cause excessive scour at the outlet and/or prohibit some fish movement. This type of situation could occur on the side of a mountain where falls and drop pools occur along a stream. Should this be the case, or should the prospective permittee not want to countersink the pipe/culvert for other reasons, he/she must submit a PCN to the Norfolk District in accordance with General Condition 32 of the Nationwide Permits. In addition to the information required by General Condition 32, the prospective permittee must provide documentation of measures evaluated to minimize disruption of the movement of aquatic life as well as documentation of the cost, engineering factors, and site conditions that prohibit countersinking the pipe/culvert. The prospective permittee should design the pipe to be placed at a slope as steep as stream characteristics allow, countersink the inlet 3-6", and implement measures to minimize any disruption of fish movement. These measures can include constructing a stone step/pool structure, preferably using river rock/native stone rather than riprap, constructing low rock weirs to create a pool or pools, or other structures to allow for fish movements in both directions. Stone structures should be designed with sufficient-sized stone to prevent erosion or washout and should include keying-in as appropriate. These structures should be designed both to allow for fish passage and to minimize scour at the outlet. The quantities of fill discharged below ordinary high water necessary to comply with these requirements (i.e., the cubic yards of stone, riprap or other fill placed below the plane of ordinary high water) must be included in project totals. The prospective permittee may find it helpful to contact the regional fishery biologist for the VDGIF for recommendations about the measures to be taken to allow for fish movements. When seeking advice from DGIF, the prospective permittee should provide the DGIF biologist with all available information such as location, flow rates, stream bottom features, description of proposed pipe(s), slopes, etc. Any recommendations from DGIF should be included in the PCN. The Norfolk District will notify the prospective permittee whether the proposed work qualifies for the nationwide permit within 45 days of receipt of a complete PCN.

h. Problems encountered during construction: When a pipe/culvert is being replaced, and the design calls for countersinking at both ends of the pipe/culvert, and during construction it is found that the streambed/banks are on bedrock, a utility line, or other documentable obstacle, then the permittee must stop work and contact the Norfolk District (contact by telephone and/or email is acceptable). The permittee must provide the Norfolk District with specific information concerning site conditions and limitations on countersinking. The Norfolk District will work with the permittee to determine an acceptable plan, taking into consideration the information provided by the permittee, but the permittee should recognize that the Norfolk District could determine that the work will not qualify for a nationwide permit.

i. Emergency pipe replacements: In the case of an emergency situation, such as when a pipe/culvert washes out during a flood, a permittee is encouraged to countersink the replacement pipe at the time of replacement, in accordance with the conditions above. However, if conditions or timeframes do not allow for countersinking, then the pipe can be replaced as it was before the washout, but the permittee will have to come back and replace the pipe/culvert and countersink it in accordance with the guidance above. In other words, the replacement of the washed out pipe is viewed as a temporary repair, and a countersunk replacement should be made at the earliest possible date. The Norfolk District must be notified of all pipes/culverts that are replaced without countersinking at the time that it occurs, even if it is an otherwise non-reporting activity, and must provide the permittee's planned schedule for installing a countersunk replacement (it is acceptable to submit such notification by email). The permittee should anticipate whether bedrock or steep terrain will limit countersinking, and if so, should follow the procedures outlined in (g) and/or (h) above.

9. **Conditions for the Repair of Pipes:** This condition applies to: NWPs 3, 7, 12, 14, 17, 18, 21, 23, 25, 27, 29, 32, 33, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 49, 50, 51, and 52.

NOTE: COUNTERSINKING IS NOT REQUIRED IN TIDAL WATERS. However, replacement pipes/culverts in tidal waters must be installed with invert elevations no higher than the existing pipe/culvert invert elevation, and a new pipe/culvert must be installed with the invert no higher than the stream bottom elevation. For Nontidal Waters: If any discharge of fill material will occur in conjunction with pipe maintenance, such as concrete being pumped over rebar into an existing deteriorated pipe for stabilization, then the following conditions apply:

a. If the existing pipe or multi-barrel array of pipes are NOT currently countersunk:

i. As long as the inlet and outlet invert elevations of at least one pipe located in the low flow channel are not being altered, and provided that no concrete apron is being constructed, then the work may proceed under the NWP for the other pipes, provided it complies with all other NWP General Conditions, including Condition 9 for Management of Water Flows. In such cases, notification to the Norfolk District Commander is not required, unless specified in the NWP Conditions for other reasons, and the permittee may proceed with the work.

ii. Otherwise, the prospective permittee must submit a pre-construction notification (PCN) to the Norfolk District Commander prior to commencing the activity. For all such projects, the following information should be provided:

1) Photographs of the existing inlet and outlet;

2) A measurement of the degree to which the work will raise the invert elevations of both the inlet and outlet of the existing pipe;
3) The reasons why other methods of pipe maintenance are not practicable (such as metal sleeves or a countersunk pipe replacement);
4) A vicinity map showing the pipe locations.

Depending on the specific case, the Norfolk District may discuss potential fish usage of the waterway with the Virginia Department of Game and Inland Fisheries.

The Norfolk District will assess all such pipe repair proposals in accordance with guidelines that can be found under "Pipe Repair Guidelines" at:

http://www.nao.usace.army.mil/Missions/Regulatory/GuidanceDocuments.aspx

iii. If the Norfolk District determines that the work qualifies for the NWP, additional conditions will be placed on the verification. Those conditions can be found at the web link above (in item ii).

iv. If the Norfolk District determines that the work does NOT qualify for the NWP, the applicant will be directed to apply for either Regional Permit 01 (applicable only for Virginia Department of Transportation projects) or an Individual Perm

v. it. However, it is anticipated that the applicant will still be required to perform the work such that the waterway is not blocked or restricted to a greater degree than its current conditions.

b. If the existing pipe or at least one pipe in the multi-barrel array of pipes IS countersunk and at least one pipe located in the low flow channel will continue to be countersunk, and no concrete aprons are proposed: No PCN to the Norfolk District is required, unless specified in the NWP Conditions for other reasons, and the permittee may proceed with the work.

c. If the existing pipe or at least one pipe in the multi-barrel array of pipes IS countersunk and no pipe will continue to be countersunk in the low flow channel: This work cannot be performed under the NWPs. The prospective permittee must apply for either a Regional Permit 01 (applicable only for VDOT projects) or an Individual Permit. However, it is anticipated that the prospective permittee will still be required to perform the work such that the waterway is not blocked or restricted more so than its current conditions.

d. In emergency situations, if conditions or timeframes do not allow for compliance with the procedure outlined herein, then the pipe can be temporarily repaired to the condition before the washout. If the temporary repair would require a PCN by the above procedures, the permittee must submit the PCN at the earliest practicable date, but no longer than 15 days after the temporary repair.

10. **Condition for Impacts Requiring a Mitigation Plan:** When a PCN is required, a mitigation plan needs to be submitted when the permanent loss of wetlands exceeds 1/10 acre and/or 300 linear feet of waters of the U.S., unless otherwise stated in the Regional Conditions (see Regional Condition 12).

11. **Condition for Temporary Impacts:** All temporarily disturbed waters and wetlands must be restored to their pre-construction contours within 12 months of commencing the temporary impacts' construction. Impacts that will not be restored within 12 months (calculated from the start of the temporary impacts' construction) will be considered permanent, unless otherwise approved by the Corps, and mitigation may be required. Once restored to their natural contours, soil in these areas must be mechanically loosened to a depth of 12 inches and wetland areas must be seeded or sprigged with appropriate native vegetation (see Regional Condition 7 regarding revegetation).

12. **Condition for Transportation Projects Funded in Part or in Total by Local, State or Federal Funds:** For all impacts associated with transportation projects funded in part or in total by local, state or federal funds and requiring a PCN, compensatory mitigation will generally be required for all permanent wetland impacts (including impacts less than 1/10 acre). Therefore, the PCN must include a mitigation plan addressing the proposed compensatory mitigation.

13. Condition for Projects Requiring Coordination Under Section 408: General Condition 31 of the NWPs requires that prospective permittees submit a pre-construction notification (PCN) if an NWP activity also requires permission from the Corps pursuant to 33 U.S.C. 408 because it will alter or temporarily or permanently occupy or use a US Army Corps of Engineers (USACE) federally authorized civil works project. For information on the location of Norfolk District projects, prospective permittees are directed to the maps showing the locations of Norfolk District projects located at: http://www.nao.usace.army.mil/Portals/31/docs/regulatory/RPSPdocs/RP-17_Corps_Project_Maps.pdf. If the prospective permittee is uncertain whether the proposed activity might alter or temporarily or permanently occupy or use a Norfolk District federally authorized civil works project, the prospective permittee shall submit a PCN.

GENERAL CONDITIONS:

Note: To qualify for NWP authorization, the prospective permittee must comply with the following general conditions, as applicable, in addition to any regional or case-specific conditions imposed by the division engineer or district engineer. Prospective permittees should contact the appropriate Corps district office to determine if regional conditions have been imposed on an NWP. Prospective permittees should also contact the appropriate Corps district office to determine the status of Clean Water Act Section 401 water quality certification and/or Coastal authorization under one or more NWPs, or who is currently relying on an existing or prior permit authorization under one or more NWPs, has been and is on notice that all of the provisions of 33 CFR §§ 330.1 through 330.6 apply to every NWP authorization. Note especially 33 CFR § 330.5 relating to the modification, suspension, or revocation of any NWP authorization.

1. Navigation.

(a) No activity may cause more than a minimal adverse effect on navigation.

(b) Any safety lights and signals prescribed by the U.S. Coast Guard, through regulations or otherwise, must be installed and maintained at the permittee's expense on authorized facilities in navigable waters of the United States.

(c) The permittee understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structure or work herein authorized, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the permittee will be required, upon due notice from the Corps of Engineers, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

2. Aquatic Life Movements. No activity may substantially disrupt the necessary life cycle movements of those species of aquatic life indigenous to the waterbody, including those species that normally migrate through the area, unless the activity's primary purpose is to impound water. All permanent and temporary crossings of waterbodies shall be suitably culverted, bridged, or otherwise designed and constructed to maintain low flows to sustain the movement of those aquatic species. If a bottomless culvert cannot be used, then the crossing should be designed and constructed to minimize adverse effects to aquatic life movements.

3. Spawning Areas. Activities in spawning areas during spawning seasons must be avoided to the maximum extent practicable. Activities that result in the physical destruction (e.g., through excavation, fill, or downstream smothering by substantial turbidity) of an important spawning area are not authorized.

4. Migratory Bird Breeding Areas. Activities in waters of the United States that serve as breeding areas for migratory birds must be avoided to the maximum extent practicable.

5. Shellfish Beds. No activity may occur in areas of concentrated shellfish populations, unless the activity is directly related to a shellfish harvesting activity authorized by NWPs 4 and 48, or is a shellfish seeding or habitat restoration activity authorized by NWP 27.

6. Suitable Material. No activity may use unsuitable material (e.g., trash, debris, car bodies, asphalt, etc.). Material used for construction or discharged must be free from toxic pollutants in toxic amounts (see section 307 of the Clean Water Act).

7. Water Supply Intakes. No activity may occur in the proximity of a public water supply intake, except where the activity is for the repair or improvement of public water supply intake structures or adjacent bank stabilization.

8. Adverse Effects from Impoundments. If the activity creates an impoundment of water, adverse effects to the aquatic system due to accelerating the passage of water, and/or restricting its flow must be minimized to the maximum extent practicable.

9. Management of Water Flows. To the maximum extent practicable, the pre-construction course, condition, capacity, and location of open waters must be maintained for each activity, including stream channelization, storm water management activities, and temporary and permanent road crossings, except as provided below. The activity must be constructed to withstand expected high flows. The activity must not restrict or impede the passage of normal or high flows, unless the primary purpose of the activity is to impound water or manage high flows. The activity may alter the pre-construction course, condition, capacity, and location of open waters if it benefits the aquatic environment (e.g., stream restoration or relocation activities).

10. Fills Within 100-Year Floodplains. The activity must comply with applicable FEMA-approved state or local floodplain management requirements.

11. Equipment. Heavy equipment working in wetlands or mudflats must be placed on mats, or other measures must be taken to minimize soil disturbance.

12. Soil Erosion and Sediment Controls. Appropriate soil erosion and sediment controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, must be permanently stabilized at the earliest practicable date. Permittees are encouraged to perform work within waters of the United States during periods of low-flow or no-flow, or during low tides.

13. Removal of Temporary Fills. Temporary fills must be removed in their entirety and the affected areas returned to pre-construction elevations. The affected areas must be revegetated, as appropriate.

14. Proper Maintenance. Any authorized structure or fill shall be properly maintained, including maintenance to ensure public safety and compliance with applicable NWP general conditions, as well as any activity-specific conditions added by the district engineer to an NWP authorization.

15. Single and Complete Project. The activity must be a single and complete project. The same NWP cannot be used more than once for the same single and complete project.

16. Wild and Scenic Rivers.

(a) No NWP activity may occur in a component of the National Wild and Scenic River System, or in a river officially designated by Congress as a "study river" for possible inclusion in the system while the river is in an official study status, unless the appropriate Federal agency with direct management responsibility for such river, has determined in writing that the proposed activity will not adversely affect the Wild and Scenic River designation or study status.

(b) If a proposed NWP activity will occur in a component of the National Wild and Scenic River System, or in a river officially designated by Congress as a "study river" for possible inclusion in the system while the river is in an official study status, the permittee must submit a pre-construction notification (see general condition 32). The district engineer will coordinate the PCN with the Federal agency with direct management responsibility for that river. The permittee shall not begin the NWP activity until notified by the district engineer that the Federal agency with direct management responsibility for that river has determined in writing that the proposed

NWP activity will not adversely affect the Wild and Scenic River designation or study status.

(c) Information on Wild and Scenic Rivers may be obtained from the appropriate Federal land management agency responsible for the designated Wild and Scenic River or study river (e.g., National Park Service, U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service). Information on these rivers is also available at: http://www.rivers.gov/.

17. Tribal Rights. No NWP activity may cause more than minimal adverse effects on tribal rights (including treaty rights), protected tribal resources, or tribal lands.

18. Endangered Species.

(a) No activity is authorized under any NWP which is likely to directly or indirectly jeopardize the continued existence of a threatened or endangered species or a species proposed for such designation, as identified under the Federal Endangered Species Act (ESA), or which will directly or indirectly destroy or adversely modify the critical habitat of such species. No activity is authorized under any NWP which "may affect" a listed species or critical habitat, unless ESA section 7 consultation addressing the effects of the proposed activity has been completed. Direct effects are the immediate effects on listed species and critical habitat caused by the NWP activity. Indirect effects are those effects on listed species and critical habitat that are caused by the NWP activity and are later in time, but still are reasonably certain to occur.

(b) Federal agencies should follow their own procedures for complying with the requirements of the ESA. If pre-construction notification is required for the proposed activity, the Federal permittee must provide the district engineer with the appropriate documentation to demonstrate compliance with those requirements. The district engineer will verify that the appropriate documentation has been submitted. If the appropriate documentation has not been submitted, additional ESA section 7 consultation may be necessary for the activity and the respective federal agency would be responsible for fulfilling its obligation under section 7 of the ESA.

(c) Non-federal permittees must submit a pre-construction notification to the district engineer if any listed species or designated critical habitat might be affected or is in the vicinity of the activity, or if the activity is located in designated critical habitat, and shall not begin work on the activity until notified by the district engineer that the requirements of the ESA have been satisfied and that the activity is authorized. For activities that might affect Federally-listed endangered or threatened species or designated critical habitat, the pre-construction notification must include the name(s) of the endangered or threatened species that might be affected by the proposed activity or that utilize the designated critical habitat that might be affected by the proposed activity. The district engineer will determine whether the proposed activity "may affect" or will have "no effect" to listed species and designated critical habitat and will notify the non-Federal applicant of the Corps' determination within 45 days of receipt of a complete pre-construction notification. In cases where the non-Federal applicant has identified listed species or critical habitat that might be affected or is in the vicinity of the activity, and has so notified the Corps, the applicant shall not begin work until the Corps has provided notification that the proposed activity will have "no effect" on listed species or critical habitat, or until ESA section 7 consultation has been completed. If the non-Federal applicant has not heard back from the Corps within 45 days, the applicant must still wait for notification from the Corps.

(d) As a result of formal or informal consultation with the FWS or NMFS the district engineer may add species-specific permit conditions to the NWPs.

(e) Authorization of an activity by an NWP does not authorize the "take" of a threatened or endangered species as defined under the ESA. In the absence of separate authorization (e.g., an ESA Section 10 Permit, a Biological Opinion with "incidental take" provisions, etc.) from the FWS or the NMFS, the Endangered Species Act prohibits any person subject to the jurisdiction of the United States to take a listed species, where "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. The word "harm" in the definition of "take" means an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering.

(f) If the non-federal permittee has a valid ESA section 10(a)(1)(B) incidental take permit with an approved Habitat Conservation Plan for a project or a group of projects that includes the proposed NWP activity, the non-federal applicant should provide a copy of that ESA section 10(a)(1)(B) permit with the PCN required by paragraph (c) of this general condition. The district engineer will coordinate with the agency that issued the ESA section 10(a)(1)(B) permit to determine whether the proposed NWP activity and the associated incidental take were considered in the internal ESA section 7 consultation conducted for the ESA section 10(a)(1)(B) permit. If that coordination results in concurrence from the agency that the proposed NWP activity and the associated incidental take were considered in the internal ESA section 7 consultation for the ESA section 10(a)(1)(B) permit, the district engineer does not need to conduct a separate ESA section 7 consultation for the proposed NWP activity. The district engineer will notify the non-federal applicant within 45 days of receipt of a complete pre-construction notification whether the ESA section 10(a)(1)(B) permit covers the proposed NWP activity or whether additional ESA section 7 consultation is required.

(g) Information on the location of threatened and endangered species and their critical habitat can be obtained directly from the offices of the FWS and NMFS or their World Wide Web pages at http://www.fws.gov/ or http://www.fws.gov/ipac and http://www.nmfs.noaa.gov/pr/species/esa/ respectively.

19. Migratory Birds and Bald and Golden Eagles. The permittee is responsible for ensuring their action complies with the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. The permittee is responsible for contacting appropriate local office of the U.S. Fish and Wildlife Service to determine applicable measures to reduce impacts to migratory birds or eagles, including whether "incidental take" permits are necessary and available under the Migratory Bird Treaty Act or Bald and Golden Eagle Protection Act for a particular activity.

20. Historic Properties.

(a) In cases where the district engineer determines that the activity may have the potential to cause effects to properties listed, or eligible for listing, in the National Register of Historic Places, the activity is not authorized, until the requirements of Section 106 of the National Historic Preservation Act (NHPA) have been satisfied.

(b) Federal permittees should follow their own procedures for complying with the requirements of section 106 of the National Historic Preservation Act. If pre-construction notification is required for the proposed NWP activity, the Federal permittee must provide the district engineer with the appropriate documentation to demonstrate compliance with those requirements. The district engineer will verify that the appropriate documentation has been submitted. If the appropriate documentation is not submitted, then additional consultation under section 106 may be necessary. The respective federal agency is responsible for fulfilling its obligation to comply with section 106.

(c) Non-federal permittees must submit a pre-construction notification to the district engineer if the NWP activity might have the potential to cause effects to any historic properties listed on, determined to be eligible for listing on, or potentially eligible for listing on the National Register of Historic Places, including previously unidentified properties. For such activities, the pre-construction notification must state which historic properties might have the potential to be affected by the proposed NWP activity or include a vicinity map indicating the location of the historic properties or the potential for the presence of historic properties. Assistance regarding information on the location of, or potential for, the presence of historic properties can be sought from the State Historic Preservation Officer, Tribal Historic Preservation Officer, or designated tribal representative, as appropriate, and the National Register of Historic Places (see 33 CFR 330.4(g)). When reviewing pre-construction notifications, district engineers will comply with the current procedures for addressing the requirements of section 106 of the National Historic Preservation Act. The district engineer shall make a reasonable and good faith effort to carry out appropriate identification efforts, which may include background research, consultation, oral history interviews, sample field investigation, and field survey. Based on the information submitted in the PCN and these identification efforts, the district engineer shall determine whether the proposed NWP activity has the potential to cause effects on the historic properties. Section 106 consultation is not required when the district engineer determines that the activity does not have the potential to cause effects on historic properties (see 36 CFR 800.3(a)). Section 106 consultation is required when the district engineer determines that the activity has the potential to cause effects on historic properties. The district engineer will conduct consultation with consulting parties identified under 36 CFR 800.2(c) when he or she makes any of the following effect determinations for the purposes of section 106 of the NHPA: no historic properties affected, no adverse effect, or adverse effect. Where the non-Federal applicant has identified historic properties on which the activity might have the potential to cause effects and so notified the Corps, the non-Federal applicant shall not begin the activity until notified by the district engineer either that the activity has no potential to cause effects to historic properties or that NHPA section 106 consultation has been completed.

(d) For non-federal permittees, the district engineer will notify the prospective permittee within 45 days of receipt of a complete pre-construction notification whether NHPA section 106 consultation is required. If NHPA section 106 consultation is required, the district engineer will notify the non-Federal applicant that he or she cannot begin the activity until section 106 consultation is completed. If the non-Federal applicant has not heard back from the Corps within 45 days, the applicant must still wait for notification from the Corps.

(e) Prospective permittees should be aware that section 110k of the NHPA (54 U.S.C. 306113) prevents the Corps from granting a permit or other assistance to an applicant who, with intent to avoid the requirements of section 106 of the NHPA, has intentionally significantly adversely affected a historic property to which the permit would relate, or having legal power to prevent it, allowed such significant adverse effect to occur, unless the Corps, after consultation with the Advisory Council on Historic Preservation (ACHP), determines that circumstances justify granting such assistance despite the adverse effect created or permitted by the applicant. If circumstances justify granting the assistance, the Corps is required to notify the ACHP and provide documentation specifying the circumstances, the degree of damage to the integrity of any historic properties affected, and proposed mitigation. This documentation must include any views obtained from the applicant, SHPO/THPO, appropriate Indian tribes if the undertaking occurs on or affects historic properties on tribal lands or affects properties of interest to those tribes, and other parties known to have a legitimate interest in the impacts to the permitted activity on historic properties.

21. Discovery of Previously Unknown Remains and Artifacts. If you discover any previously unknown historic, cultural or archeological remains and artifacts while accomplishing the activity authorized by this permit, you must immediately notify the district engineer of what you have found, and to the maximum extent practicable, avoid construction activities that may affect the remains and artifacts until the required coordination has been completed. The district engineer will initiate the Federal, Tribal, and state coordination required to determine if the items or remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

22. Designated Critical Resource Waters. Critical resource waters include, NOAA-managed marine sanctuaries and marine monuments, and National Estuarine Research Reserves. The district engineer may designate, after notice and opportunity for public comment, additional waters officially designated by a state as having particular environmental or ecological significance, such as outstanding national resource waters or state natural heritage sites. The district engineer may also designate additional critical resource waters after notice and opportunity for public comment.

(a) Discharges of dredged or fill material into waters of the United States are not authorized by NWPs 7, 12, 14, 16, 17, 21, 29, 31, 35, 39, 40, 42, 43, 44, 49, 50, 51, and 52 for any activity within, or directly affecting, critical resource waters, including wetlands adjacent to such waters.

(b) For NWPs 3, 8, 10, 13, 15, 18, 19, 22, 23, 25, 27, 28, 30, 33, 34, 36, 37, 38, and 54, notification is required in accordance with general condition 32, for any activity proposed in the designated critical resource waters including wetlands adjacent to those waters. The district engineer may authorize activities under these NWPs only after it is determined that the impacts to the critical resource waters will be no more than minimal.

23. Mitigation. The district engineer will consider the following factors when determining appropriate and practicable mitigation necessary to ensure that the individual and cumulative adverse environmental effects are no more than minimal:

(a) The activity must be designed and constructed to avoid and minimize adverse effects, both temporary and permanent, to waters of the United States to the maximum extent practicable at the project site (i.e., on site).

(b) Mitigation in all its forms (avoiding, minimizing, rectifying, reducing, or compensating for resource losses) will be required to the extent necessary to ensure that the individual and cumulative adverse environmental effects are no more than minimal.

(c) Compensatory mitigation at a minimum one-for-one ratio will be required for all wetland losses that exceed 1/10-acre and require pre-construction notification, unless the district engineer determines in writing that either some other form of mitigation would be more environmentally appropriate or the adverse environmental effects of the proposed activity are no more than minimal, and provides an activity-specific waiver of this requirement. For wetland losses of 1/10-acre or less that require pre-construction notification, the district engineer may determine on a case-by-case basis that compensatory mitigation is required to ensure that the activity results in only minimal adverse environmental effects.

(d) For losses of streams or other open waters that require pre-construction notification, the district engineer may require compensatory mitigation to ensure that the activity results in no more than minimal adverse environmental effects. Compensatory mitigation for losses of streams should be provided, if practicable, through stream rehabilitation, enhancement, or preservation, since streams are difficult-to-replace resources (see 33 CFR 332.3(e)(3)).

(e) Compensatory mitigation plans for NWP activities in or near streams or other open waters will normally include a requirement for the restoration or enhancement, maintenance, and legal protection (e.g., conservation easements) of riparian areas next to open waters. In some cases, the restoration or maintenance/protection of riparian areas may be the only compensatory mitigation required. Restored riparian areas should consist of native species. The width of the required riparian area will address documented water quality or aquatic habitat loss concerns. Normally, the riparian area will be 25 to 50 feet wide on each side of the stream, but the district engineer may require slightly wider riparian areas to address documented water quality or habitat loss concerns. If it is not possible to restore or maintain/protect a riparian area on both sides of a stream, or if the waterbody is a lake or coastal waters, then restoring or maintaining/protecting a riparian area along a single bank or shoreline may be sufficient. Where both wetlands and open waters exist on the project site, the district engineer will determine the appropriate compensatory mitigation (e.g., riparian areas and/or wetlands compensation) based on what is best for the aquatic environment on a watershed basis. In cases where riparian areas are determined to be the most appropriate form of minimization or compensatory mitigation, the district engineer may waive or reduce the requirement to provide wetland compensatory mitigation for wetland losses.

(f) Compensatory mitigation projects provided to offset losses of aquatic resources must comply with the applicable provisions of 33 CFR part 332.

(1) The prospective permittee is responsible for proposing an appropriate compensatory mitigation option if compensatory mitigation is necessary to ensure that the activity results in no more than minimal adverse environmental effects. For the NWPs, the preferred mechanism for providing compensatory mitigation is mitigation bank credits or in-lieu fee program credits (see 33 CFR 332.3(b)(2) and (3)). However, if an appropriate number and type of mitigation bank or in-lieu credits are not available at the time the PCN is submitted to the district engineer, the district engineer may approve the use of permittee-responsible mitigation.

(2) The amount of compensatory mitigation required by the district engineer must be sufficient to ensure that the authorized activity results in no more than minimal individual and cumulative adverse environmental effects (see 33 CFR 330.1(e)(3)). (See also 33 CFR 332.3(f)).

(3) Since the likelihood of success is greater and the impacts to potentially valuable uplands are reduced, aquatic resource restoration should be the first compensatory mitigation option considered for permittee-responsible mitigation.

(4) If permittee-responsible mitigation is the proposed option, the prospective permittee is responsible for submitting a mitigation plan. A conceptual or detailed mitigation plan may be used by the district engineer to make the decision on the NWP verification request, but a final mitigation plan that addresses the applicable requirements of 33 CFR 332.4(c)(2) through (14) must be approved by the district engineer before the permittee begins work in waters of the United States, unless the district engineer determines that prior approval of the final mitigation plan is not practicable or not necessary to ensure timely completion of the required compensatory mitigation (see 33 CFR 332.3(k)(3)).

(5) If mitigation bank or in-lieu fee program credits are the proposed option, the mitigation plan only needs to address the baseline conditions at the impact site and the number of credits to be provided.

(6) Compensatory mitigation requirements (e.g., resource type and amount to be provided as compensatory mitigation, site protection, ecological performance standards, monitoring requirements) may be addressed through conditions added to the NWP authorization, instead of components of a compensatory mitigation plan (see 33 CFR 332.4(c)(1)(ii)).

(g) Compensatory mitigation will not be used to increase the acreage losses allowed by the acreage limits of the NWPs. For example, if an NWP has an acreage limit of 1/2-acre, it cannot be used to authorize any NWP activity resulting in the loss of greater than 1/2-acre of waters of the United States, even if compensatory mitigation is provided that replaces or restores some of the lost waters. However, compensatory mitigation can and should be used, as necessary, to ensure that an NWP activity already meeting the established acreage limits also satisfies the no more than minimal impact requirement for the NWPs.

(h) Permittees may propose the use of mitigation banks, in-lieu fee programs, or permittee-responsible mitigation. When developing a compensatory mitigation proposal, the permittee must consider appropriate and practicable options consistent with the framework at 33 CFR 332.3(b). For activities resulting in the loss of marine or estuarine resources, permittee-responsible mitigation may be environmentally preferable if there are no mitigation banks or in-lieu fee programs in the area that have marine or estuarine credits available for sale or transfer to the permittee. For permittee-responsible mitigation, the special conditions of the NWP verification must clearly indicate the party or parties responsible for the implementation and performance of the compensatory mitigation project, and, if required, its long-term management.

(i) Where certain functions and services of waters of the United States are permanently adversely affected by a regulated activity, such as discharges of dredged or fill material into waters of the United States that will convert a forested or scrub-shrub wetland to a herbaceous wetland in a permanently maintained utility line right-of-way, mitigation may be required to reduce the adverse environmental effects of the activity to the no more than minimal level.

24. Safety of Impoundment Structures. To ensure that all impoundment structures are safely designed, the district engineer may require non-Federal applicants to demonstrate that the structures comply with established state dam safety criteria or have been designed by qualified persons. The district engineer may also require documentation that the design has been independently reviewed by similarly qualified persons, and appropriate modifications made to ensure safety.

25. Water Quality. Where States and authorized Tribes, or EPA where applicable, have not previously certified compliance of an NWP with CWA section 401, individual 401 Water Quality Certification must be obtained or waived (see 33 CFR 330.4(c)). The district engineer or State or Tribe may require additional water quality management measures to ensure that the authorized activity does not result in more than minimal degradation of water quality.

26. Coastal Zone Management. In coastal states where an NWP has not previously received a state coastal zone management consistency concurrence, an individual state coastal zone management consistency concurrence must be obtained, or a presumption of concurrence must occur (see 33 CFR 330.4(d)). The district engineer or a State may require additional measures to ensure that the authorized activity is consistent with state coastal zone management requirements.

27. Regional and Case-By-Case Conditions. The activity must comply with any regional conditions that may have been added by the Division Engineer (see 33 CFR 330.4(e)) and with any case specific conditions added by the Corps or by the state, Indian Tribe, or U.S. EPA in its section 401 Water Quality Certification, or by the state in its Coastal Zone Management Act consistency determination.

28. Use of Multiple Nationwide Permits. The use of more than one NWP for a single and complete project is prohibited, except when the acreage loss of waters of the United States authorized by the NWPs does not exceed the acreage limit of the NWP with the highest specified acreage limit. For example, if a road crossing over tidal waters is constructed under NWP 14, with associated bank stabilization authorized by NWP 13, the maximum acreage loss of waters of the United States for the total project cannot exceed 1/3-acre.

29. Transfer of Nationwide Permit Verifications. If the permittee sells the property associated with a nationwide permit verification, the permittee may transfer the nationwide permit verification to the new owner by submitting a letter to the appropriate Corps district office to validate the transfer. A copy of the nationwide permit verification must be attached to the letter, and the letter must contain the following statement and signature:

"When the structures or work authorized by this nationwide permit are still in existence at the time the property is transferred, the terms and conditions of this nationwide permit, including any special conditions, will continue to be binding on the new owner(s) of the property. To validate the transfer of this nationwide permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below."

____
(Transferee)

____
(Date)

30. Compliance Certification. Each permittee who receives an NWP verification letter from the Corps must provide a signed certification documenting completion of the authorized activity and implementation of any required compensatory mitigation. The success of any required permittee-responsible mitigation, including the achievement of ecological performance standards, will be addressed separately by the district engineer. The Corps will provide the permittee the certification document with the NWP verification letter. The certification document will include:

(a) A statement that the authorized activity was done in accordance with the NWP authorization, including any general, regional, or activity-specific conditions;

(b) A statement that the implementation of any required compensatory mitigation was completed in accordance with the permit conditions. If credits from a mitigation bank or in-lieu fee program are used to satisfy the compensatory mitigation requirements, the certification must include the documentation required by 33 CFR 332.3(l)(3) to confirm that the permittee secured the appropriate number and resource type of credits; and

(c) The signature of the permittee certifying the completion of the activity and mitigation.

The completed certification document must be submitted to the district engineer within 30 days of completion of the authorized activity or the implementation of any required compensatory mitigation, whichever occurs later.

31. Activities Affecting Structures or Works Built by the United States. If an NWP activity also requires permission from the Corps pursuant to 33 U.S.C. 408 because it will alter or temporarily or permanently occupy or use a U.S. Army Corps of Engineers (USACE) federally authorized Civil Works project (a "USACE project"), the prospective permittee must submit a pre-construction notification. See paragraph (b)(10) of general condition 32. An activity that requires section 408 permission is not authorized by NWP until the appropriate Corps office issues the section 408 permission to alter, occupy, or use the USACE project, and the district engineer issues a written NWP verification.

32. Pre-Construction Notification.

(a) Timing. Where required by the terms of the NWP, the prospective permittee must notify the district engineer by submitting a pre-construction notification (PCN) as early as possible. The district engineer must determine if the PCN is complete within 30 calendar days of the date of receipt and, if the PCN is determined to be incomplete, notify the prospective permittee within that 30 day period to request the additional information necessary to make the PCN complete. The request must specify the information needed to make the PCN complete. As a general rule, district engineers will request additional information necessary to make the PCN complete only once. However, if the prospective permittee does not provide all of the requested information, then the district engineer will notify the prospective permittee that the PCN is still incomplete and the PCN review process will not commence until all of the requested information has been received by the district engineer. The prospective permittee shall not begin the activity until either:

(1) He or she is notified in writing by the district engineer that the activity may proceed under the NWP with any special conditions imposed by the district or division engineer; or

(2) 45 calendar days have passed from the district engineer's receipt of the complete PCN and the prospective permittee has not received written notice from the district or division engineer. However, if the permittee was required to notify the Corps pursuant to general condition 18 that listed species or critical

habitat might be affected or are in the vicinity of the activity, or to notify the Corps pursuant to general condition 20 that the activity might have the potential to cause effects to historic properties, the permittee cannot begin the activity until receiving written notification from the Corps that there is "no effect" on listed species or "no potential to cause effects" on historic properties, or that any consultation required under Section 7 of the Endangered Species Act (see 33 CFR 330.4(f)) and/or section 106 of the National Historic Preservation Act (see 33 CFR 330.4(g)) has been completed. Also, work cannot begin under NWPs 21, 49, or 50 until the permittee has received written approval from the Corps. If the proposed activity requires a written waiver to exceed specified limits of an NWP, the permittee may not begin the activity until the district engineer issues the waiver. If the district or division engineer notifies the permittee in writing that an individual permit is required within 45 calendar days of receipt of a complete PCN, the permittee cannot begin the activity until an individual permit has been obtained. Subsequently, the permittee's right to proceed under the NWP may be modified, suspended, or revoked only in accordance with the procedure set forth in 33 CFR 330.5(d)(2).

(b) Contents of Pre-Construction Notification: The PCN must be in writing and include the following information:

(1) Name, address and telephone numbers of the prospective permittee;

(2) Location of the proposed activity;

(3) Identify the specific NWP or NWP(s) the prospective permittee wants to use to authorize the proposed activity;

(4) A description of the proposed activity; the activity's purpose; direct and indirect adverse environmental effects the activity would cause, including the anticipated amount of loss of wetlands, other special aquatic sites, and other waters expected to result from the NWP activity, in acres, linear feet, or other appropriate unit of measure; a description of any proposed mitigation measures intended to reduce the adverse environmental effects caused by the proposed activity; and any other NWP(s), regional general permit(s), or individual permit(s) used or intended to be used to authorize any part of the proposed project or any related activity, including other separate and distant crossings for linear projects that require Department of the Army authorization but do not require pre-construction notification. The description of the proposed activity and any proposed mitigation measures should be sufficiently detailed to allow the district engineer to determine that the adverse environmental effects of the activity will be no more than minimal and to determine the need for compensatory mitigation or other mitigation measures. For single and complete linear projects, the PCN must include the quantity of anticipated losses of wetlands, other special aquatic sites, and other waters for each single and complete crossing of those wetlands, other special aquatic sites, and other waters. Sketches should be provided when necessary to show that the activity complies with the terms of the NWP. (Sketches usually clarify the activity and when provided results in a quicker decision. Sketches should contain sufficient detail to provide an illustrative description of the proposed activity (e.g., a conceptual plan), but do not need to be detailed engineering plans);

(5) The PCN must include a delineation of wetlands, other special aquatic sites, and other waters, such as lakes and ponds, and perennial, intermittent, and ephemeral streams, on the project site. Wetland delineations must be prepared in accordance with the current method required by the Corps. The permittee may ask the Corps to delineate the special aquatic sites and other waters on the project site, but there may be a delay if the Corps does the delineation, especially if the project site is large or contains many wetlands, other special aquatic sites, and other waters. Furthermore, the 45 day period will not start until the delineation has been submitted to or completed by the Corps, as appropriate;

(6) If the proposed activity will result in the loss of greater than 1/10-acre of wetlands and a PCN is required, the prospective permittee must submit a statement describing how the mitigation requirement will be satisfied, or explaining why the adverse environmental effects are no more than minimal and why compensatory mitigation should not be required. As an alternative, the prospective permittee may submit a conceptual or detailed mitigation plan.

(7) For non-Federal permittees, if any listed species or designated critical habitat might be affected or is in the vicinity of the activity, or if the activity is located in designated critical habitat, the PCN must include the name(s) of those endangered or threatened species that might be affected by the proposed activity or utilize the designated critical habitat that might be affected by the proposed activity. For NWP activities that require pre-construction notification, Federal permittees must provide documentation demonstrating compliance with the Endangered Species Act;

(8) For non-Federal permittees, if the NWP activity might have the potential to cause effects to a historic property listed on, determined to be eligible for listing on, or potentially eligible for listing on, the National Register of Historic Places, the PCN must state which historic property might have the potential to be affected by the proposed activity or include a vicinity map indicating the location of the historic property. For NWP activities that require pre-construction notification, Federal permittees must provide documentation demonstrating compliance with section 106 of the National Historic Preservation Act;

(9) For an activity that will occur in a component of the National Wild and Scenic River System, or in a river officially designated by Congress as a "study river" for possible inclusion in the system while the river is in an official study status, the PCN must identify the Wild and Scenic River or the "study river" (see general condition 16); and

(10) For an activity that requires permission from the Corps pursuant to 33 U.S.C. 408 because it will alter or temporarily or permanently occupy or use a U.S. Army Corps of Engineers federally authorized civil works project, the pre-construction notification must include a statement confirming that the project proponent has submitted a written request for section 408 permission from the Corps office having jurisdiction over that USACE project.

(c) Form of Pre-Construction Notification: The standard individual permit application form (Form ENG 4345) may be used, but the completed application form must clearly indicate that it is an NWP PCN and must include all of the applicable information required in paragraphs (b)(1) through (10) of this general condition. A letter containing the required information may also be used. Applicants may provide electronic files of PCNs and supporting materials if the district engineer has established tools and procedures for electronic submittals.

(d) Agency Coordination:

(1) The district engineer will consider any comments from Federal and state agencies concerning the proposed activity's compliance with the terms and conditions of the NWPs and the need for mitigation to reduce the activity's adverse environmental effects so that they are no more than minimal.
(2) Agency coordination is required for: (i) all NWP activities that require pre-construction notification and result in the loss of greater than 1/2-acre of waters of the United States; (ii) NWP 21, 29, 39, 40, 42, 43, 44, 50, 51, and 52 activities that require pre-construction notification and will result in the loss of greater than 300 linear feet of stream bed; (iii) NWP 13 activities in excess of 500 linear feet, fills greater than one cubic yard per running foot, or involve discharges of dredged or fill material into special aquatic sites; and (iv) NWP 54 activities in excess of 500 linear feet, or that extend into the waterbody more than 30 feet from the mean low water line in tidal waters or the ordinary high water mark in the Great Lakes.
(3) When agency coordination is required, the district engineer will immediately provide (e.g., via e-mail, facsimile transmission, overnight mail, or other expeditious manner) a copy of the complete PCN to the appropriate Federal or state offices (FWS, state natural resource or water quality agency, EPA, and, if appropriate, the NMFS). With the exception of NWP 37, these agencies will have 10 calendar days from the date the material is transmitted to notify the district engineer via telephone, facsimile transmission, or e-mail that they intend to provide substantive, site-specific comments. The comments must explain why the agency believes the adverse environmental effects will be more than minimal. If so contacted by an agency, the district engineer will wait an additional 15 calendar days before making a decision on the pre-construction notification. The district engineer will fully consider agency comments received within the specified time frame concerning the proposed activity's compliance with the terms and conditions of the NWPs, including the need for mitigation to ensure the net adverse environmental effects of the proposed activity are no more than minimal. The district engineer will provide no response to the resource agency, except as provided below. The district engineer will indicate in the administrative record associated with each pre-construction notification that the resource agencies' concerns were considered. For NWP 37, the emergency watershed protection and rehabilitation activity may proceed immediately in cases where there is an unacceptable hazard to life or a significant loss of property or economic hardship will occur. The district engineer will consider any comments received to decide whether the NWP 37 authorization should be modified, suspended, or revoked in accordance with the procedures at 33 CFR 330.5.
(4) In cases of where the prospective permittee is not a Federal agency, the district engineer will provide a response to NMFS within 30 calendar days of receipt of any Essential Fish Habitat conservation recommendations, as required by section 305(b)(4)(B) of the Magnuson-Stevens Fishery Conservation and Management Act.
(5) Applicants are encouraged to provide the Corps with either electronic files or multiple copies of pre-construction notifications to expedite agency coordination.

DISTRICT ENGINEER'S DECISION:

1. In reviewing the PCN for the proposed activity, the district engineer will determine whether the activity authorized by the NWP will result in more than minimal individual or cumulative adverse environmental effects or may be contrary to the public interest. If a project proponent requests authorization by a specific NWP, the district engineer should issue the NWP verification for that activity if it meets the terms and conditions of that NWP, unless he or she determines, after considering mitigation, that the proposed activity will result in more than minimal individual and cumulative adverse effects on the aquatic environment and other aspects of the public interest and exercises discretionary authority to require an individual permit for the proposed activity. For a linear project, this determination will include an evaluation of the individual crossings of waters of the United States to determine whether they individually satisfy the terms and conditions of the NWP(s), as well as the cumulative effects caused by all of the crossings authorized by NWP. If an applicant requests a waiver of the 300 linear foot limit on impacts to streams or of an otherwise applicable limit, as provided for in NWPs 13, 21, 29, 36, 39, 40, 42, 43, 44, 50, 51, 52, or 54, the district engineer will only grant the waiver upon a written determination that the NWP activity will result in only minimal individual and cumulative adverse environmental effects. For those NWPs that have a waivable 300 linear foot limit for losses of intermittent and ephemeral stream bed and a 1/2-acre limit (i.e., NWPs 21, 29, 39, 40, 42, 43, 44, 50, 51, and 52), the loss of intermittent and ephemeral stream bed, plus any other losses of jurisdictional waters and wetlands, cannot exceed 1/2-acre.

2. When making minimal adverse environmental effects determinations the district engineer will consider the direct and indirect effects caused by the NWP activity. He or she will also consider the cumulative adverse environmental effects caused by activities authorized by NWP and whether those cumulative adverse environmental effects are no more than minimal. The district engineer will also consider site specific factors, such as the environmental setting in the vicinity of the NWP activity, the type of resource that will be affected by the NWP activity, the functions provided by the aquatic resources that will be affected by the NWP activity, the degree or magnitude to which the aquatic resources perform those functions, the extent that aquatic resource functions will be lost as a result of the NWP activity (e.g., partial or complete loss), the duration of the adverse effects (temporary or permanent), the importance of the aquatic resource functions to the region (e.g., watershed or ecoregion), and mitigation required by the district engineer. If an appropriate functional or condition assessment method is available and practicable to use, that assessment method may be used by the district engineer to assist in the minimal adverse environmental effects determination. The district engineer may add case-specific special conditions to the NWP authorization to address site-specific environmental concerns.
3. If the proposed activity requires a PCN and will result in a loss of greater than 1/10-acre of wetlands, the prospective permittee should submit a mitigation proposal with the PCN. Applicants may also propose compensatory mitigation for NWP activities with smaller impacts, or for impacts to other types of waters (e.g., streams). The district engineer will consider any proposed compensatory mitigation or other mitigation measures the applicant has included in the proposal in determining whether the net adverse environmental effects of the proposed activity are no more than minimal. The compensatory mitigation proposal may be either conceptual or detailed. If the district engineer determines that the activity complies with the terms and conditions of the NWP and that the adverse environmental effects are no more than minimal, after considering mitigation, the district engineer will notify the permittee and

include any activity-specific conditions in the NWP verification the district engineer deems necessary. Conditions for compensatory mitigation requirements must comply with the appropriate provisions at 33 CFR 332.3(k). The district engineer must approve the final mitigation plan before the permittee commences work in waters of the United States, unless the district engineer determines that prior approval of the final mitigation plan is not practicable or not necessary to ensure timely completion of the required compensatory mitigation. If the prospective permittee elects to submit a compensatory mitigation plan with the PCN, the district engineer will expeditiously review the proposed compensatory mitigation plan. The district engineer must review the proposed compensatory mitigation plan within 45 calendar days of receiving a complete PCN and determine whether the proposed mitigation would ensure the NWP activity results in no more than minimal adverse environmental effects. If the net adverse environmental effects of the NWP activity (after consideration of the mitigation proposal) are determined by the district engineer to be no more than minimal, the district engineer will provide a timely written response to the applicant. The response will state that the NWP activity can proceed under the terms and conditions of the NWP, including any activity-specific conditions added to the NWP authorization by the district engineer.

4. If the district engineer determines that the adverse environmental effects of the proposed activity are more than minimal, then the district engineer will notify the applicant either: (a) that the activity does not qualify for authorization under the NWP and instruct the applicant on the procedures to seek authorization under an individual permit; (b) that the activity is authorized under the NWP subject to the applicant's submission of a mitigation plan that would reduce the adverse environmental effects so that they are no more than minimal; or (c) that the activity is authorized under the NWP with specific modifications or conditions. Where the district engineer determines that mitigation is required to ensure no more than minimal adverse environmental effects, the activity will be authorized within the 45-day PCN period (unless additional time is required to comply with general conditions 18, 20, and/or 31, or to evaluate PCNs for activities authorized by NWPs 21, 49, and 50), with activity-specific conditions that state the mitigation requirements. The authorization will include the necessary conceptual or detailed mitigation plan or a requirement that the applicant submit a mitigation plan that would reduce the adverse environmental effects so that they are no more than minimal. When compensatory mitigation is required, no work in waters of the United States may occur until the district engineer has approved a specific mitigation plan or has determined that prior approval of a final mitigation plan is not practicable or not necessary to ensure timely completion of the required compensatory mitigation.

Further Information:

1. District Engineers have authority to determine if an activity complies with the terms and conditions of an NWP.
2. NWPs do not obviate the need to obtain other federal, state, or local permits, approvals, or authorizations required by law.
3. NWPs do not grant any property rights or exclusive privileges.
4. NWPs do not authorize any injury to the property or rights of others.
5. NWPs do not authorize interference with any existing or proposed Federal project (see general condition 31).

SECTION 401 WATER QUALITY CERTIFICATION (4/7/17):

The State Water Control Board issued conditional §401 Water Quality Certification for NWP 3 as meeting the requirements of the Virginia Water Protection Permit Regulation, which serves as the Commonwealth's §401 Water Quality Certification, provided that: (1) the deviations from the original configuration or filled area do not change the character, scope, or size of the original design or approved alternative design; (2) the discharge: a) would not increase the capacity of an impoundment, or b) would not reduce instream flows; (3) any compensatory mitigation meets the requirements in the Code of Virginia, Section 62. 1-44.15:23 A through C, except in the absence of same river watershed alternatives in Hydrologic Unit Codes (HUC) 02040303 and 02040304, single family dwellings or locality projects may use compensatory mitigation in HUC 02080102, 02080108, 02080110, or 02080111 in Virginia; (4) the Corps of Engineers shall provide DEQ an annual report of projects authorized by this Nationwide Permit that includes detailed information on physical changes to water withdrawal structures, such as the maintenance of an intake, dam, weir, or water diversion structure that are deviations from the original configuration, or are a change in the character, scope, or size of the original design, or where those deviations would otherwise reduce instream flows.

COASTAL ZONE MANAGEMENT ACT CONSISTENCY DETERMINATION (4/5/17):

Based on the comments submitted by the agencies administering the enforceable policies of the Virginia CZM Program, DEQ concurs that the 2017 NWPs and Virginia Regional Conditions as proposed, are consistent with the Virginia CZM Program provided the following conditions, discussed below, are satisfied:

1) Prior to construction, applicants shall obtain all required permits and approvals for activities to be performed that are applicable to the Virginia CZM Program's enforceable policies, and that applicants adhere to all the conditions contained therein.

The Virginia Marine Resources Commission's (VMRC) concurrence of consistency with regard to the fisheries management, subaqueous lands management, wetlands management, and dunes management enforceable policies is based on the recognition that prospective permittees may be required to obtain additional state and/or local approvals from the VMRC and/or the local wetlands board prior to commencement of work in both tidal and nontidal waters under the agency's jurisdiction. Such approvals must precede implementation of the projects.

2) The DEQ Office of Wetlands and Stream Protection (OWSP) has provided §401 Clean Water Act (CWA) Water Quality Certification for the 2017 NWPs and Regional Conditions, applicable to the wetlands management and point source pollution control enforceable policies of the Virginia CZM Program. The activities that qualify for the NWPs must meet the requirements of DEQ's Virginia Water Protection Permit Regulation (9 VAC 25-210-130) and the permittee must abide by the conditions of the NWP. DEQ-OWSP has identified specific NWP exceptions. DEQ will process an individual application for a permit or a certificate or otherwise take action pursuant to 9 VAC 25-210-80 et seq. for those activities covered by an NWPs that have not received blanket §401 CWA Water Quality Certification.

The Corps should forward pre-construction notifications to DEQ for applicants that do not comply with or cannot meet the conditions of the §401 CWA Water Quality Certification. Further, the Commonwealth reserves its right to require an individual application for a permit or a certificate or otherwise take action on any specific project that could otherwise be covered under any of the NWPs when it determines on a case-by-case basis that concerns for water quality and the aquatic environment so indicate.

In accordance with the Federal Consistency Regulations at 15 CFR Part 930, section 930. 4, this conditional concurrence is based on the applicants demonstrating to the Corps that they have obtained, or will obtain, all necessary authorizations prior to implementing a project which qualifies for a NWP. If the requirements of section 930. 4, sub-paragraphs (a)(1) through (a)(3) are not met, this conditional concurrence becomes an objection under 15 CFR Part 930, section 940.43.

Enclosure 6

ATTACHMENTS FOR RAI VAR-1

Virginia Electric and Power Company
(Dominion Energy Virginia or Dominion)
Surry Power Station Units 1 and 2

Dominion Energy Services, Inc.
5000 Dominion Boulevard, Glen Allen, VA 23060
DominionEnergy.com

Dominion Energy

BY U.S MAIL
RETURN RECEIPT REQUESTED

January 23, 2019

Mr. Joseph Bryan
Department of Environmental Quality
Piedmont Regional Office
4949-A Cox Road
Glen Allen, VA 23060

RE: Dominion Energy-Surry Power Station VPDES Permit No. VA0004090
CWIS- 2018 Annual Certification and Effectiveness of Control Measures

Dear Mr. Bryan:

In accordance with Part I.E.5 of the subject permit, Dominion Energy is hereby certifying that no substantial changes have occurred in the operations of any unit at the Surry Power Station that impacts cooling water withdrawals or operation of any cooling water intake structure (CWIS).

In accordance with Part I.E.6, Dominion is providing the following information:

a. The station maintained interim Best Technology Available (BTA) measures to minimize adverse impacts. Each operating cooling water intake structure utilized a modified traveling screen, low-pressure screen wash system, and a fish return system.

b. During 2018 no Federally-listed threatened or endangered species were observed or collected during station activities around the intake, such as removal of debris from the intake trash racks. Also, no impingement or entrainment samples were collected in 2018.

Should you require additional information, please contact Oula Shehab-Dandan at (804) 273-2697 or via email oula.k.shehab-dandan@dominionenergy.com.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sincerely,

Jason E. Williams
Director, Environmental

Please send electronic copy to:
Amanda Tornabene
Jason Williams
Barry Garber
Phyllis Wells
Ken Roller
Bob Graham
Karen Canody
Oula Shehab-Dandan
Beverly Wood
Jason Ericson

Documentum/Water-NPDES\/Compliance Documentation /Surry/**SU VA0004090 Cooling Water Intake Structures-2018 Annual Certification**

VIRGINIA POWER

CORRESPONDENCE REVIEW AND APPROVAL FORM

DOCUMENT SERIAL NUMBER	RESPONSE DUE TO THE DEQ (**FIRM DUE** in DEQ's hands) **1/10/2019** ***Review due to Corporate EES by 12/31/2018 for signature and submittal to DEQ***	PLANNED DOCUMENT APPROVAL (NOT FIRM DUE) **N/A**
	5-DAY (OR 3-DAY) RULE FOR STATION APPROVAL **12/27/18**	PLANNED STATION APPROVAL

DOCUMENT TITLE	Surry Power Station –**SPS Cooling Water Intake Structure 2018 Annual Certification Report – Management Approval for Submittal**

ACTION PLAN ATTACHED	YES		NO	x	REASON: N/A
VOA ATTACHED	YES		NO	x	REASON: N/A
COGNIZANT LICENSING ENGINEER:	**Phyllis G. Wells x2377**				

COMMENTS: There were no deviations or issues found during 2018 for the SPS Cooling Water Intake Structure, 316b Weekly Inspections, and that no Impingement or Entrainment Sampling had been completed during 2018.
The Annual Report is required by the VPDES Permit to be submitted annually to document our compliance with the 316b Intake Structure management regulations.

Need Management Approval for submittal of the 2018 316b Annual Certification Report.

The letter and required certification will be signed by the Director of Environmental Services at Corporate on January 2, 2018. Corporate Environmental had wanted us to obtain Station Management Review and Approval prior to my retirement on December 31, to ensure that the report will be able to be submitted to the VA DEQ on time.

	REVIEWERS	INITIAL	DATE RECEIVED	DATE INITIALED
x	LICENSING LEAD –Senior Environmental Compliance Coordinator (Wells)	PGW	12/10/18	12/10/18
	DIRECTOR – SITE ENGINEERING			
	MANAGER - MAINTENANCE			
	MANAGER - OPERATIONS			
	MANAGER – RAD PROTECTION/CHEMISTRY			
	MANAGER – OUTAGE & PLANNING			
	MANAGER – NUCLEAR SITE SERVICES			
	MANAGER - TRAINING			
x	MANAGER – LICENSING (Garber)	BAG	12/10/18	12/11/18
x	DIRECTOR - SAFETY & LICENSING (Garver)	RMG		12/13/18
	PLANT MANAGER – NUCLEAR			
x	SITE VICE PRESIDENT (Garver for Mladen)	RMG FOR		12/18/18

Dominion Energy Services, Inc.
5000 Dominion Boulevard, Glen Allen, VA 23060
DominionEnergy.com

BY U.S MAIL
RETURN RECEIPT REQUESTED

January 29, 2018

Ms. Emilee Adamson
Department of Environmental Quality
Piedmont Regional Office
4949-A Cox Road
Glen Allen, VA 23060

RE: Dominion Energy-Surry Power Station VPDES Permit No. VA0004090
CWIS- 2017 Annual Certification and Effectiveness of Control Measures

Dear Ms. Emilee Adamson:

In accordance with Part I.E.5 of the subject permit, Dominion Energy is hereby certifying that no substantial changes have occurred in the operations of any unit at the Surry Power Station that impacts cooling water withdrawals or operation of any cooling water intake structure (CWIS).

In accordance with Part I.E.6, Dominion is providing the following information:

a. The station maintained interim Best Technology Available (BTA) measures to minimize adverse impacts. Each operating cooling water intake structure utilized a modified traveling screen, low-pressure screen wash system, and a fish return system.

b. During 2017 no Federally-listed threatened or endangered species were collected while sampling for the 316(b) biological studies.

   Entrainment samples were generally collected from the Unit 1B intake bay twice a month from January through July 2017. Samples consisted of approximately 100 m^3 of water pumped from the near-surface, mid-water, and near-bottom and filtered through 330 µm plankton nets approximately every 6 hours over a 24-hour period. Taxa identifications were made in the laboratory. A total of 168 entrainment samples were collected in 2017. No impingement samples were collected in 2017.

c. During 2017 no Federally-listed threatened or endangered species were observed or collected during station activities around the intake, such as removal of debris from the intake trash racks; therefore no Federally-listed threatened or endangered species were impacted by injury or death.

Should you require additional information, please contact Oula Shehab-Dandan at (804) 273-2697 or via email oula.k.shehab-dandan@dominionenergy.com.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sincerely,

Jason E Williams
Director, Environmental

Please send electronic copy to:

Pamela Faggert
Jason Williams
Fred Mladen
Barry Garber
Phyllis Wells
Ken Roller
Bob Graham
Karen Canody
Oula Shehab-Dandan
Amelia Boschen

Documentum/Water-NPDES\/Compliance Documentation /Surry/**SU VA0004090 Cooling Water Intake Structures-2017 Annual Certification**

VIRGINIA POWER

CORRESPONDENCE REVIEW AND APPROVAL FORM

DOCUMENT SERIAL NUMBER	RESPONSE DUE TO THE DEQ (**FIRM DUE** in DEQ's hands) **2/10/2018** ***Review due to Corporate EES by 2/7/2018 for signature and submittal to DEQ***	PLANNED DOCUMENT APPROVAL (NOT FIRM DUE) **N/A**
	5-DAY (OR 3-DAY) RULE FOR STATION APPROVAL **2/7/18**	PLANNED STATION APPROVAL
DOCUMENT TITLE	Surry Power Station –**SPS Cooling Water Intake Structure 2017 Annual Certification Report – Management Approval for Submittal**	

ACTION PLAN ATTACHED	YES		NO	x	REASON: N/A
VOA ATTACHED	YES		NO	x	REASON: N/A
COGNIZANT LICENSING ENGINEER:		**Phyllis G. Wells x2377**			

COMMENTS: There were no deviations or issues found during 2017 for the SPS Cooling Water Intake Structure, 316b Weekly Inspections or the Entrainment Sampling.
The Annual Report is required by the VPDES Permit to be submitted to document our compliance with the 316b Intake Structure management regulations.

Need Management Approval for submittal of the 316b Annual Certification Report.

The cover letter and required certification will be signed by the Director of Environmental Services at Corporate.

	REVIEWERS	INITIAL	DATE RECEIVED	DATE INITIALED
x	LICENSING LEAD –Senior Environmental Compliance Coordinator	PW	1/16/18	1/16/18
	DIRECTOR – SITE ENGINEERING			
	MANAGER - MAINTENANCE			
	MANAGER - OPERATIONS			
	MANAGER – RAD PROTECTION/CHEMISTRY			
	MANAGER – OUTAGE & PLANNING			
	MANAGER – NUCLEAR SITE SERVICES			
	MANAGER - TRAINING			
	MANAGER – NUCLEAR OVERSIGHT			
	MANAGER – PROTECTIVE SERVICES			
	MANAGER - MATERIALS			
x	SUPERVISOR – LICENSING	[illegible]	1/22/18	1/22/18
x	DIRECTOR - SAFETY & LICENSING	[illegible]	1/23/18	1/25/18
	PLANT MANAGER – NUCLEAR			
x	SITE VICE PRESIDENT	[illegible]	1/25/2018	1/26/18

Pamela F. Faggert
Vice President and Chief Environmental Officer

Dominion Resources Services, Inc.
5000 Dominion Boulevard, Glen Allen, VA 23060
Phone: 804-273-3467

Dominion®

<u>Certified Mail</u>
<u>Return Receipt Requested</u>

December 29, 2008

Mr. Ray Jenkins
Virginia Department of Environmental Quality
Piedmont Regional Office
4949-A Cox Road
Glen Allen, VA 23060

RE: Surry Power Station VPDES Permit VA0004090
Section 316(b) Phase II Requirement
Entrainment Characterization Report

Dear Mr. Jenkins:

Please find enclosed the Entrainment Characterization Report submittal for the Surry Power Station as required by the VPDES permit VA0004090, Part I.C.17.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine, and imprisonment for knowing violations.

If you have any questions, please contact Ms. Oula Shehab-Dandan at (804) 273-2697.

Sincerely,

Pamela F. Faggert

Pamela F. Faggert

Enclosure

Scan and Name: IM & E Characterization Study Results (SU)

ebc (electronic distribution):

Barry Garber (w/ attachment) 11/2/09 verbal
Cathy Taylor CT
Karen Canody KC
Bill Bolin
Oula Shehab OS 11/25

File (hard copy and electronic): Surry/ENV55/CORRESPONDENCE

Entrainment Characterization Report
Surry Power Station
June 2005 – May 2006

Prepared for

Dominion Resources Services, Inc.
5000 Dominion Boulevard
Glen Allen, Virginia 23060

Prepared by

EA Engineering, Science, and Technology, Inc.
15 Loveton Circle
Sparks, Maryland 21152

FINAL Report
August 2007

CONTENTS

LIST OF FIGURES

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1.0 INTRODUCTION

Surry Power Station is located on Gravel Neck peninsula on the James River, approximately 30 miles upstream of the confluence with the Chesapeake Bay (Figure1).

The Proposal for Information Collection (PIC) Surry Power Station (Dominion 2005) was submitted to the Virginia Department of Environmental Quality (VDEQ) in March 2005 and subsequently approved by VDEQ.

An entrainment characterization study for the Surry Power Station was initiated in June 2005 in accordance with the approved PIC and completed in May 2006 and is the subject of this report. Impingement studies were not required in the PIC because the Ristroph screens at Surry Power Station are deemed to be Best Technology Available for reduction of impingement mortality (Dominion 2005).

This report represents the results of the Entrainment Characterization Study for Surry Power Station based on field collections made between June 2005 and May 2006.

2.0 GENERATING STATION DESCRIPTION

2.1 SITE DESCRIPTION

Surry Power Station is located in southeastern Virginia on Gravel Neck Peninsula on the James River in Surry County (Figure 1). The site is approximately 30 miles upstream of the confluence of the James River with the Chesapeake Bay, and 44 miles to the southeast of Richmond, Virginia.

2.2 STATION DESCRIPTION

Surry Power Station began commercial operation in 1972. The station comprises two generating units with a combined electrical output of 1,710.8 MW. The station uses once-through cooling with a shoreline intake structure and a discharge canal. The intake is located on the downstream side of the Gravel Neck peninsula (Figure 1), and is oriented parallel to the river flow (Dominion 2005; White and Brehmer 1976). Cooling water for both units is withdrawn through a common low-level intake structure. This intake is protected first by trash racks, then by eight Ristroph traveling water screens, each 15-feet wide and constructed of 1/8 by 1/2-inch mesh screening. The screens are designed to operate continuously. Downstream of the Ristroph screens there are eight circulating-water pumps that convey the screened intake water to a common high level intake canal that serves both units. At full operation, the total station pump capacity is 6,662 M^3/minute. Cooling water in the high level intake canal enters a second screen house with conventional traveling screens, is routed to the condensers and is ultimately discharged back to the river on the upstream side of the peninsula.

The Ristroph screens in the low-level intake are considered state-of-the-art for protection of impinged fish and other aquatic organisms. Installed in 1974, they are designed for continuous operation to minimize contact (impingement) time of organisms. Other protective features include low pressure screen-wash systems, troughs on the screens to hold fish in water as the screens rotate, and a fish return system to route impinged organisms back to the river. The Ristroph screens originally had 3/8-inch mesh screening, but were subsequently retrofitted with 1/8 by 1/2-inch rectangular mesh.

2.3 HABITAT AND BIOLOGICAL COMMUNITY

The James River at Surry Power Station is approximately 3.7 miles wide with main channel depths ranging from 21 to 90 feet (Dominion 2005). There are extensive shallow areas (< 6 feet) on both the upstream and downstream sides of the peninsula. The river is tidal and estuarine in nature, with an oligohaline salinity regime (typically 0.5-5 parts per thousand). The area is a transitional zone between freshwater and seawater and thus freshwater, estuarine, and marine organisms may all be found there at certain times. Bottom substrates vary from mud, clay, sand, pebbles, and oyster beds.

A diverse assemblage of fishes has been recorded from the area, with 80 species downstream of the station in brackish water, and 40 freshwater species upstream (Dominion 2005). Common estuarine and marine species include bay anchovy, striped bass, white perch, weakfish, spot, American eel, and Atlantic menhaden. Typical freshwater species include blue catfish, channel catfish, and common carp. Numerous aquatic invertebrate species are also found in the area, including zooplankton (primarily copepods), amphipods (e.g., *Gammarus*), and benthic organisms such as polychaete worms and shellfish. The latter include soft-shell clams (*Rangia*), American oyster, blue crab, spider crab, several species of shrimp, and other forms.

3.0 ENTRAINMENT STUDY AT SURRY POWER STATION

3.1 METHODS

3.1.1 Entrainment Sampling and Laboratory Processing

Entrainment sampling was carried out at Surry Power Station twice a month (except for sampling events missed due to weather or mechanical problems) from June 2005 through May 2006. Samples were collected from a boat positioned in front of the cooling-water intake. During each sampling event, duplicate 10-minute samples were collected from near bottom, mid-depth, and near surface locations four times during the 24-hour period, centered around: 1000, 1600, 2200, and 0400 hours. Samples were collected with 0.5-m diameter mouth plankton nets constructed of 505-µm netting, each affixed in a double-net bongo frame. A General Oceanics 2030R or 2030R6 (low flow) mechanical flowmeter was suspended in the mouth of each net. Flowmeter calibration was periodically checked with a General Oceanics Model 2030CF Flowmeter Calibration Frame.

Samples were preserved in 5 percent buffered formalin containing Rose Bengal dye and transported to the laboratory for processing. Samples were sorted with the aid of lighted magnifying rings to separate organisms from debris. Extremely abundant samples were split with a Folsom plankton splitter to obtain manageable portions for sorting. Subsequent to sorting, some samples containing large numbers of a single organism were subsampled with a Henson-Stempel pipette. All fish eggs, larvae, and commercially important shellfish were stored in labeled vials for subsequent identification.

Entrained organisms were identified under magnification. Taxonomic resources included Fuiman et al. (1983), USFWS (1978), Wang and Kernehan (1979), Bullard (2003), and Gosner (1971). For each sample, up to 20 fish larvae of each taxon were measured to the nearest 0.1 mm with an ocular micrometer.

3.1.2 Ambient Ichthyoplankton Sampling

In conjunction with each entrainment sample, samples were also collected from the James River upstream, downstream, and adjacent to the intake centered around 1000, 1600, 2200 and 0400 hours. These samples were collected with a single 0.5-meter diameter plankton net consisting of 505-µm netting, and with a General Oceanic 2030R flowmeter affixed in the net mouth. Tows were made at mid-depth for 4.5 minutes against the prevailing tide. Sampling locations are illustrated in Figure 2. Sample processing and data handling were as described for entrainment.

3.1.3 Ambient Juvenile and Adult Fish Sampling

Dominion Resources personnel conducted quarterly sampling of juvenile and adult fish in the vicinity of Surry Power Station. Three stations were sampled by otter trawl and beach haul seines, one station upstream, one downstream, and one near the intakes. At each station, 30.5 meters of shoreline were seined and one otter trawl tow was conducted for a ten minute period. Larger fish were identified, measured, weighed and released in the field, and smaller fish were preserved and subsequently processed in the laboratory.

3.1.4 Water Quality

Water quality measurements were made with a YSI Model 556 water quality analyzer that was calibrated prior to each sampling event. All water quality parameters (water temperature, dissolved oxygen, pH, and salinity) were measured at mid-depth in front of the intake in association with each of the 4 entrainment samples during the 2-hour sampling event. During ambient ichthyoplankton sampling in the river, water quality was measured at the mid-point of each sampling transect at surface, mid-depth, and bottom.

3.1.5 Data Analysis

All data were entered into an SQL Server database using an Access-based, "front-end" data-entry template. Reports were then printed out and proofed against the original data sheets, and electronic corrections made as necessary. All data manipulations, calculations, and summaries included in this report were performed within the database.

An example of the entrainment calculation sequence is provided in Figure 3 using actual data from one of the sampling events at Surry Power Station. The density of Atlantic silverside larvae in each individual sample (24 per 24-hour event) is displayed by depth and sampling time. Densities were averaged over the four sampling times, and then averaged again to produce an average density for the 24-hour sampling period. This 24-hour average density was then multiplied by the maximum station cooling-water flow in cubic meters, and then divided by 100 to calculate the total number of bay anchovy larvae entrained during the 24-hour period. This value was then multiplied by the number of calendar days represented by the 4/12-13/2006 sampling event to project the total number of larvae entrained during that period. This value was then added to the analogous values from the other 22 extrapolation periods during the study year to estimate the total number of Atlantic silverside larvae entrained during the study year, under maximum cooling-water flow conditions. Additional calculation details are provided in Appendix A.

3.2 RESULTS

3.2.1 Composition and Abundance

During the 2005-2006 study, 46 different taxa and life stages were identified from entrainment samples (Tables 1 – 3). Not unexpectedly, young life stages of invertebrates composed the majority of organisms, nearly 97 percent, based on average annual density (Table 2). Considering only young life stages of fish, gobies and bay anchovy were most abundant; together they composed nearly 85 percent of all ichthyoplankton entrained on an annual average basis (Table 3). As indicated above, young life stages of bay anchovy and naked goby were also most abundant in entrainment samples in the 1976-1978 study.

On a monthly basis, common species of ichthyoplankton and macroinvertebrates exhibited typical density patterns (Table 4 and Appendix B). Atlantic croaker are fall spawners (USFWS 1978) and consequently peak densities were in December (larvae) and January (juveniles). The peak density of Atlantic silverside in April is consistent with the species' known spawning period. The blue crab, bay anchovy, and goby species are all late spring-early summer spawners and this is reflected in Table 4.

Overall, entrainment densities were much greater during the nighttime. This was driven largely by the abundant taxa entrained (Figure 4). Early morning (0400 hrs) densities were from 2 to 5 times greater than daytime densities for the most abundant taxa. For larvae this may represent swim-up activity at night. The day-night pattern for bay anchovy eggs is consistent with their documented spawning habits. Typically, spawning occurs during the early evening hours (USFWS 1978), thus higher densities may be expected in late evening and early morning.

3.2.2 Length Frequency

Length-frequency distributions for several common species are displayed in Tables 5 – 7. All life stages of bay anchovy were captured during entrainment sampling. Post-yolk sac larvae were evident from less than 4.9 mm to approximately 25 mm. Juveniles were in the 25 – 40 mm range, and all larger individuals were likely adults. The growth progress of the 2005-year class of bay anchovy can clearly be seen progressing from the upper left in Table 5 (early season smaller individuals) to the lower right (larger individuals caught during winter/spring). The length-frequency distribution for Atlantic croaker (Table 6) is consistent with their offshore (oceanic) spawning location. Nearly all specimens collected (10 – 55 mm) were juveniles that had metamorphosed from the larval form by the time they had drifted into the site vicinity. No pattern is evident in the length distribution of naked gobies (Table 7). This may be a result of their protracted spawning habit, i.e., similar size larvae are available throughout the summer.

Water quality measurements during the study exhibited typical seasonal patterns (Table 8). As water temperature decreased into the winter period, dissolved oxygen increased. Salinity was higher during the fall when there was less freshwater inflow.

3.2.3 Monthly and Annual Estimates of Total Entrainment

Entrainment density data were used in conjunction with station cooling-water flow data to estimate the total number of each fish and invertebrate taxon entrained, both on a monthly and an annual basis (Table 9). The temporal distribution mirrors that discussed above on a density basis. An estimated 53 billion organisms were entrained during the study year. The largest total numbers of fish entrained were young life stages of bay anchovy and naked goby. For all life stages combined, a total of 656.25 X 10^6 bay anchovy and 390.15 X 10^6 naked goby were entrained during the survey year. Goby sp. were among the highest numbers entrained at 440.16 X 10^6 for the year. Many of these were likely naked goby also, but could not be confidently assigned to a specific species. Young life stages of Atlantic silverside (60.94 X 10^6) and Atlantic croaker (111.98 X 10^6) were also entrained in relatively high numbers.

Invertebrate species are typically much more abundant in the estuarine environment than fish, and this is reflected in Table 9. Young life stages of bivalves (2,927.1 X 10^6), shrimp (35,690.5 X 10^6), and crabs (13,337.1 X 10^6) were the most abundant organisms entrained. These are largely small forage species such as mud crabs and mysid shrimp. As Lippson and Lippson (1984) pointed out, the opossum shrimp *Neomysis americana* "occur in dense populations throughout the" Bay. Only the blue crab forms (73.18 X 10^6 for the year) represent a commercially important species.

3.2.4 Comparison of Entrainment and Ambient (River) Ichthyoplankton and Shellfish Densities

Mean densities for key ichthyoplankton and invertebrates collected in both entrainment and ambient samples from the James River are displayed in Tables 10 and 11, respectively. The data in the tables are means of all entrainment samples and river ambient samples during each sampling event. (Appendix C contains monthly ambient river densities for all taxa.) Notwithstanding the fact the entrainment and river samples were collected at the same time and in the near vicinity of each other, there are some clear differences between the two programs. For one, the difference in bay anchovy eggs early in the study stands out. The data in Tables 10 and 11 were plotted to provide a simpler comparison of densities in the two programs (Figures 5 – 10). With the exception of bay anchovy eggs, there is a consistent pattern of higher densities in the entrainment samples. The reason for this is not readily apparent from the data. It could simply be a reflection of the natural "patchiness" that has been documented for plankton populations. It is also possible that the shallow channel leading into, and the deeper depression in front of the intake, concentrate larvae, in contrast to the shallow shelf over which the ambient samples were collected (Figure 2). Also likely, mysid shrip and mud crabs are near-shoreline inhabitors and therefore would not be present at the off-shore ambient sampling stations. These organisms represented the bulk of the entrainment collection.

Mean water quality measurements associated with ambient ichthyoplankton sampling are displayed in Table 12.

3.2.5 Comparison of Entrainment Data and Ambient Juvenile and Adult Data

Dominion biologists collected quarterly sampling of juvenile and adult fish and also some shellfish at three locations in the James River near Surry Power Station. Otter trawls and beach seines were used in the program. The results of these surveys are displayed in Table 13. Twenty-four species of finfish and blue crab were collected during the survey, with Atlantic silverside, bay anchovy, blue catfish, hogchoker, and spot being the most common. Although relatively few in number in the ambient program (Table 13), Atlantic croaker were more abundant during winter and this is also reflected in the entrainment data (Table 10). Atlantic silverside were abundant in the area, as reflected in the early season densities of larvae (Table 10) and September abundance of juveniles and adults (Table 13). Eggs and larvae of bay anchovy were common early in the season, and throughout much of the study year as juveniles and adults (Tables 10 and 13). Several species common as juveniles and adults—blue catfish, hogchoker, and spot—were present in low densities or absent as young life stages (Appendices B and C). Conversely, naked goby were quite commonly entrained during summer (Table 10) but were not collected in the juvenile/adult program (Table 13).

The abundance of a species as young life stages and scarcity as juvenile/adults, and the converse, cannot always be explained, but several observations are possible in the present study. Blue catfish—first stocked in the James River in 1975 (Jenkins and Burkhead 1993)—spawn on nests and provide parental protection, possibly in less saline water upstream of Surry Power Station, and thus the young life stages would not likely be entrained. Hogchokers can spawn at any salinity up to 24 parts per thousand (ppt), but prefer 10 – 16 ppt, which is generally higher than that found at Surry Power Station. It is not uncommon for naked goby larvae and juveniles to be common in entrainment samples, but juveniles and adults are absent from ambient sampling programs because the adults prefer oyster bars as habitat.

3.2.6 Historical Studies

Entrainment sampling was conducted at Surry Power Station during 1976-1978 (Vepco 1980). Samples were collected from the intake forebay and in the discharge canal using paired, 0.5-meter plankton nets with 505μm mesh. Discrete samples were collected from near bottom, mid-depth, and near surface locations. A total of 1,080 entrainment samples were collected during this study period.

Although 39 taxa of fish larvae and/or eggs were documented during this study, abundance was overwhelmingly dominated by bay anchovy eggs and larvae, and naked goby larvae (91.1 percent of all organisms collected). Maximum concentrations of the larvae of these forms occurred during early to mid-summer. Bay anchovy egg concentrations peaked in mid-spring. The average maximum concentrations measured over the three study years were:

bay anchovy eggs	$62.6/M^3$
bay anchovy larvae	$7.0/M^3$
naked goby larvae	$25.7/M^3$

Although in much lower densities than bay anchovy or naked goby, other ichthyoplankton that were regularly collected were larval and juvenile Atlantic croaker and spot; larval and juvenile Atlantic menhaden; all life stages of Atlantic, inland, and rough silverside; and eggs and larvae of white perch. Shellfish were not required to be evaluated in the earlier studies, therefore the historical and current studies are not directly comparable.

Bay anchovy eggs and goby larvae also dominated the 2005-2006 entrainment samples.

3.2.7 Summary

- An entrainment and ambient (river) ichthyoplankton study was carried out at Surry Power Station from June 2005 through May 2006. Sampling was scheduled twice per month and included four sample periods in 24-hours, each consisting of two samples each from surface, mid-depth, and bottom in front of the intakes for entrainment, and a single, mid-depth tow at each of three locations in the river ambient program.

- Forty-six different taxa and life stages of fish and invertebrates were entrained during the study. Young life stages of invertebrates (e.g., crabs, shrimp) accounted for the bulk of the samples, nearly 97 percent. Considering only fish, the eggs, larvae, and juveniles of gobies and bay anchovy were most abundant, accounting for 85 percent of the remaining 3 percent.

- Temporal abundance in both entrainment and river samples reflected the unique reproductive strategies of the species. Early life stages of Atlantic silverside, bay anchovy, and gobies were most abundant in spring and/or early summer. In contrast, juveniles of the fall-spawning Atlantic croaker were most abundant in winter, with a peak in January.

- Entrainment densities were markedly higher during nighttime.

- Based on maximum cooling-water flow at Surry Power Station, an estimated 53 billion organisms were entrained during the study year, the vast majority of which were small invertebrates, primarily mysid shrimp. Annual estimates for common ichthyoplankton ranged from 94 million Atlantic croaker juveniles to 448 million bay anchovy eggs.

- Measurements of dissolved oxygen, pH, salinity, and water temperature were typical for the region and gave no indication of environmental stress.

- Comparison of densities of common fish taxa and blue crab megalopae between entrainment and ambient river collections indicated a tendency for greater densities in entrainment, with the exception of bay anchovy eggs. This phenomenon is unexplained, but may be related to "patchiness" of plankton distributions.

- Many of the same taxa of ichthyoplankton entrained were recorded in Dominion's juvenile and adult river sampling program.

- The fish and shellfish collected in all of the studies in 2005-2006 were considered representative for that year.

4.0 REFERENCES

Bullard, S.G. 2003. Larvae of Anomuran and Brachyuran Crabs of North Carolina. *Crustaceana Monographs* 1.

Dominion. 2005. *Proposal for Information Collection, Final Rule for Phase II Facilities Cooling Water Intake Structures, Surry Power Station*. Prepared by Dominion Resources Services, Inc. Submitted to Virginia Department of Environmental Quality. 1 March 2005.

Fuiman, L., J. Conner, B. Lathrop, G. Bunyak, D. Snyder, and J. Loss. 1983. State of the art of identification for cyprinid fish larvae from eastern North America. *Trans. Amer. Fish. Soc.* 112:319-332.

Gosner (1971). *Guide to Identification of Marine and Estuarine Invertebrates*. Wiley-Interscience.

Jenkins, R. and N. Burkhead. 1994. *Freshwater Fishes of Virginia.* American Fisheries Society, Bethesda, MD.

Lippson, A. and R. Lippson. 1984. *Life in the Chesapeake Bay.* The Johns Hopkins University Press, Baltimore, MD. 229 pp.

Nelson, J., E. Crossman, H. Espinosa-Perez, L. Findley, C. Gilbert, R. Lea, and J. Williams. 2004. *Common and Scientific Names of Fishes from the United States, Canada, and Mexico.* Sixth Edition. American Fisheries Society Special Publication 29, Bethesda, MD.

USFWS. 1978. *Development of Fishes of the Mid-Atlantic Bight: An Atlas of Egg, Larval, and Juvenile Stages*, Vols. I-VI. U.S. Dept. of Interior.

Virginia Electric and Power Company (Vepco). 1980. *Surry Power Station – Units 1 and 2 Cooling Water Intake Studies*. Vepco Environmental Services Department, Richmond, VA.

Wang and Kernehan. 1979. *Fishes of the Delaware Estuaries: A guide to the Early Life Histories*. EA Communications, Towson, MD.

White, J., Jr. and M. Brehmer. 1976. Eighteen-Month Evaluation of the Ristroph Traveling Fish Screens. pp. 367-380 in: Third *National Workshop on Entrainment & Impingement, Section 316(b) Research and Compliance* (L. Jensen, editor). Communications Division, Ecological Analysts, Inc., Melville, NY.

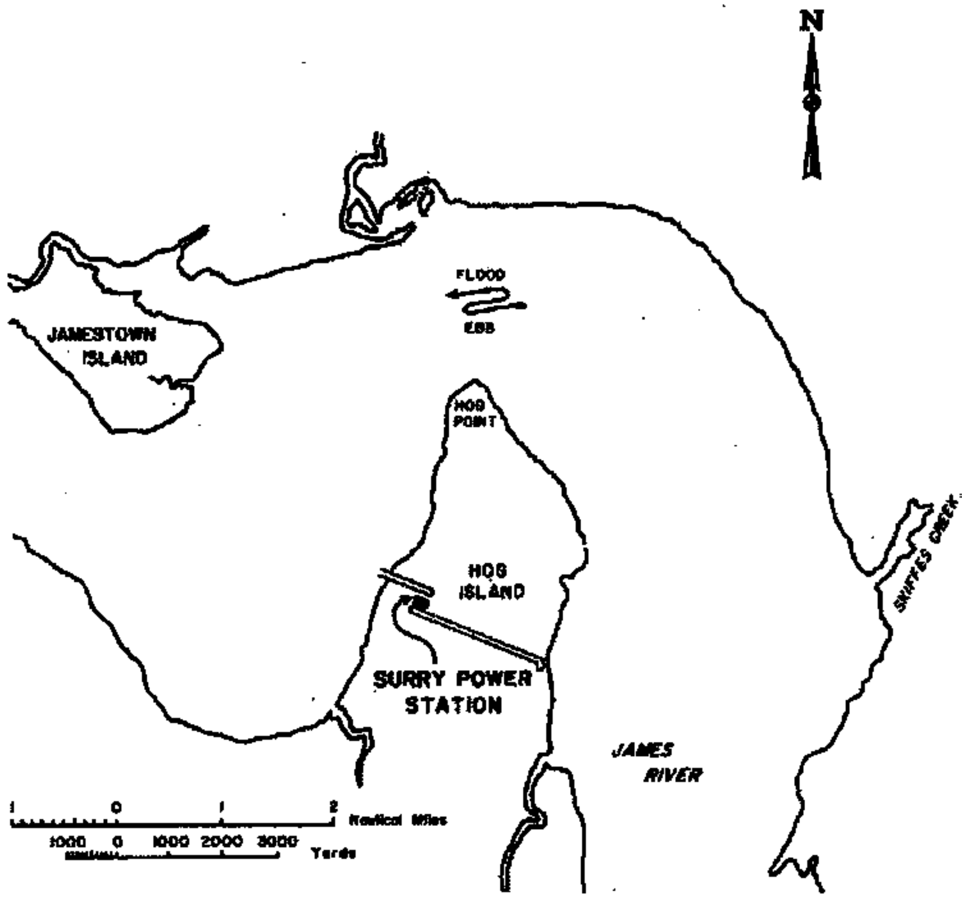


Figure 1. Location of the Surry Power Station near Hog Island on the James River, Virginia, (from White and Brehmer 1976).

Figure 2

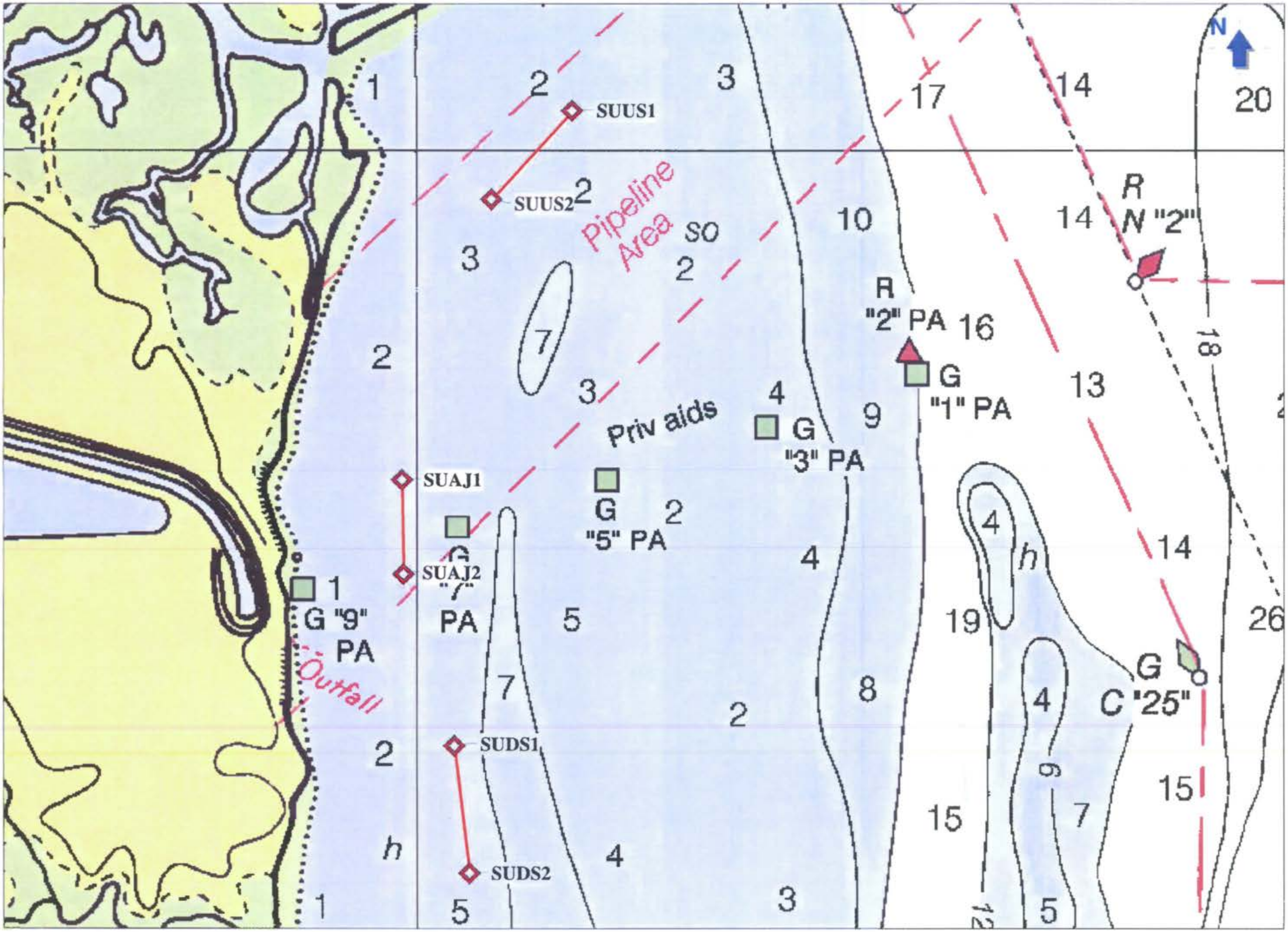
Location of Ambient Ichthyoplankton Tow Tracks at Surry Power Station

Tow tracks shown as red lines with red diamonds marking either end

Endpoints designated as:

SUUS1 (Upstream)
SUUS2 (Upstream)
SUAJ1 (Adjacent)
SUAJ2 (Adjacent)
SUDS1 (Downstream)
SUDS2 (Downstream)

JAMES RIVER NEWPORT NEWS TO JAMESTOWN ISLAND
Chart 12248_1 (BSB Electronic Charts) Depth Units: FEET Datum:



DO NOT USE FOR NAVIGATION PURPOSES
Printed by ChartView™ from Nobeltec Corporation (503) 579-1414

Nautical Miles
0.00 0.10 0.20 0.30 0.40

Number Entrained per 100 Cubic Meters

Sample Set:
Atlantic silverside larvae
4/12-13/2006

	Surface		Middle		Bottom		Average by Sampling Period
	Left	Right	Left	Right	Left	Right	
10am	5	0	0	0	0	0	0.8
4PM	0	0	0	0	0	0	0.0
10PM	6	0	11	15	12	0	7.3
4AM	9	3	9	33	13	0	11.2
					24-HOUR AVERAGE=		4.8

Maximum plant flow in 24 hours = 9,160,999 M^3

Total larvae entrained in the 24-hour period= 9,160,999 M^3 X 4.8/100 M^3 = 439,728 larvae

Calendar days represented by the 4/12-13/2006 sample set = 18 days

Total larvae entrained during the 18-day period represented by the 4/12-13/2006 sample set = 18 days X 439,728 larvae = 7,915,104 larvae

Total larvae entrained during the study year = 7,915,104 larvae entrained in 4/12-13/2006 18-day extrapolation period

PLUS

50,304,896 larvae entrained during remaining 22 extrapolation periods

= 58,220,000 larvae entrained during the study year

Figure 3 Entrainment Calculation Schematic: Extrapolation of Atlantic Silverside Larvae Numbers from a Single Sampling Event to the Annual total, Surry Power Station

Figure 4 Annual Average Density of Common Species Entrained at Surry Power Station During Different Diel Periods

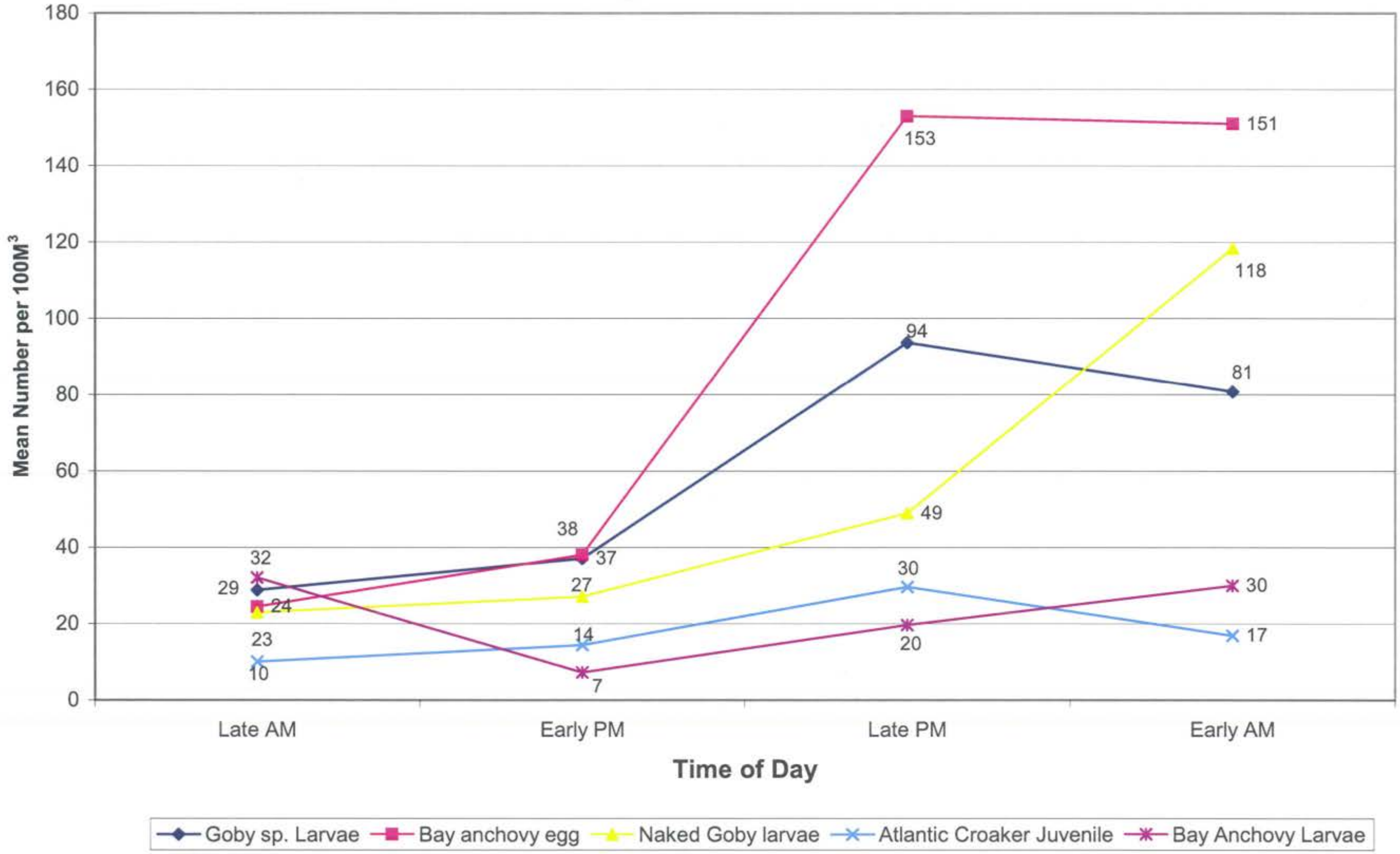


Figure 5 Comparison of Entrainment and Ambient Ichthyoplankton Densities of Atlantic Croaker Juveniles, Surry Power Station

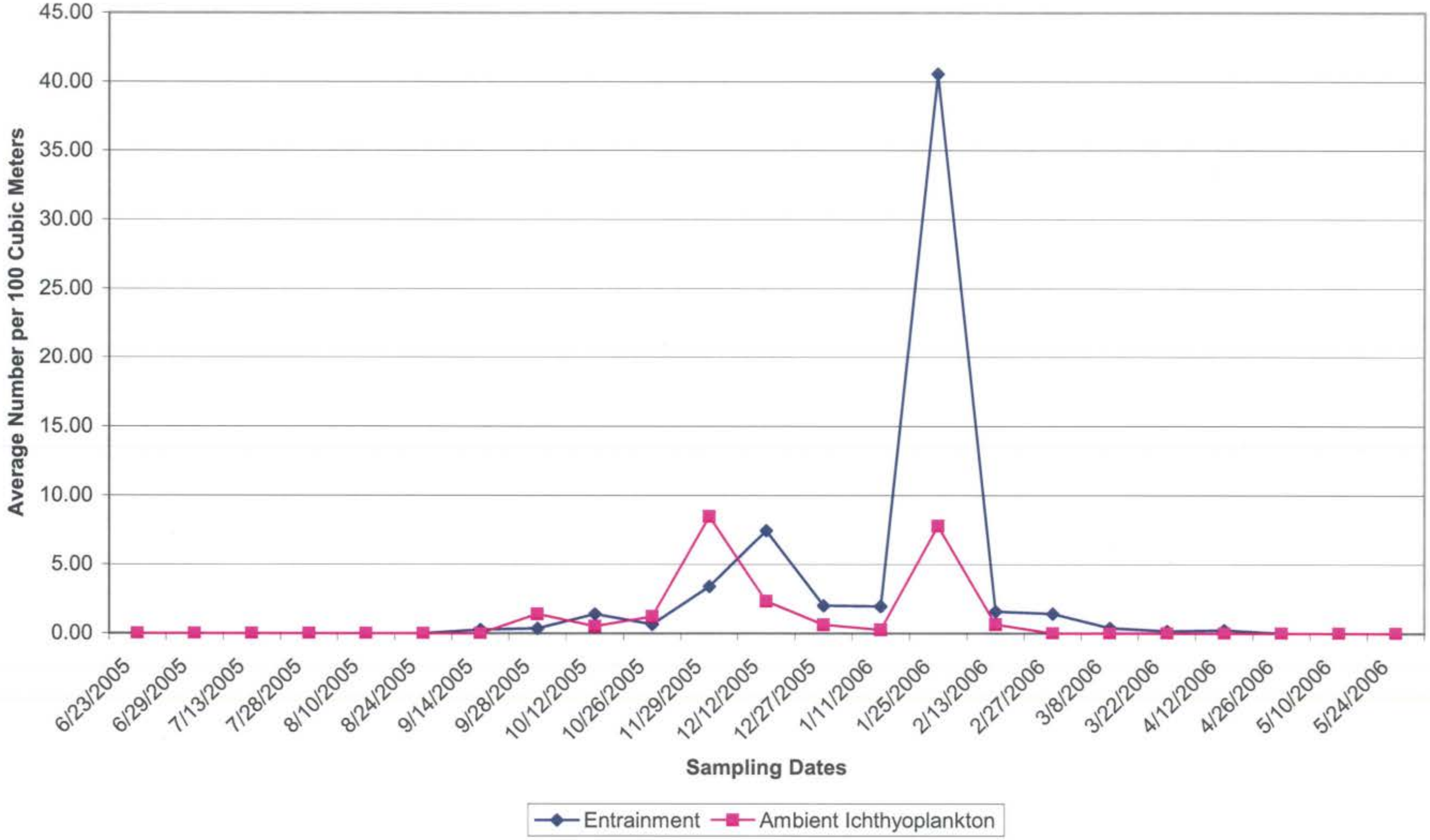


Figure 6 Comparison of Entrainment and Ambient Ichthyoplankton Densities of Atlantic Silverside Larvae, Juveniles, and Adults, Surry Power Station

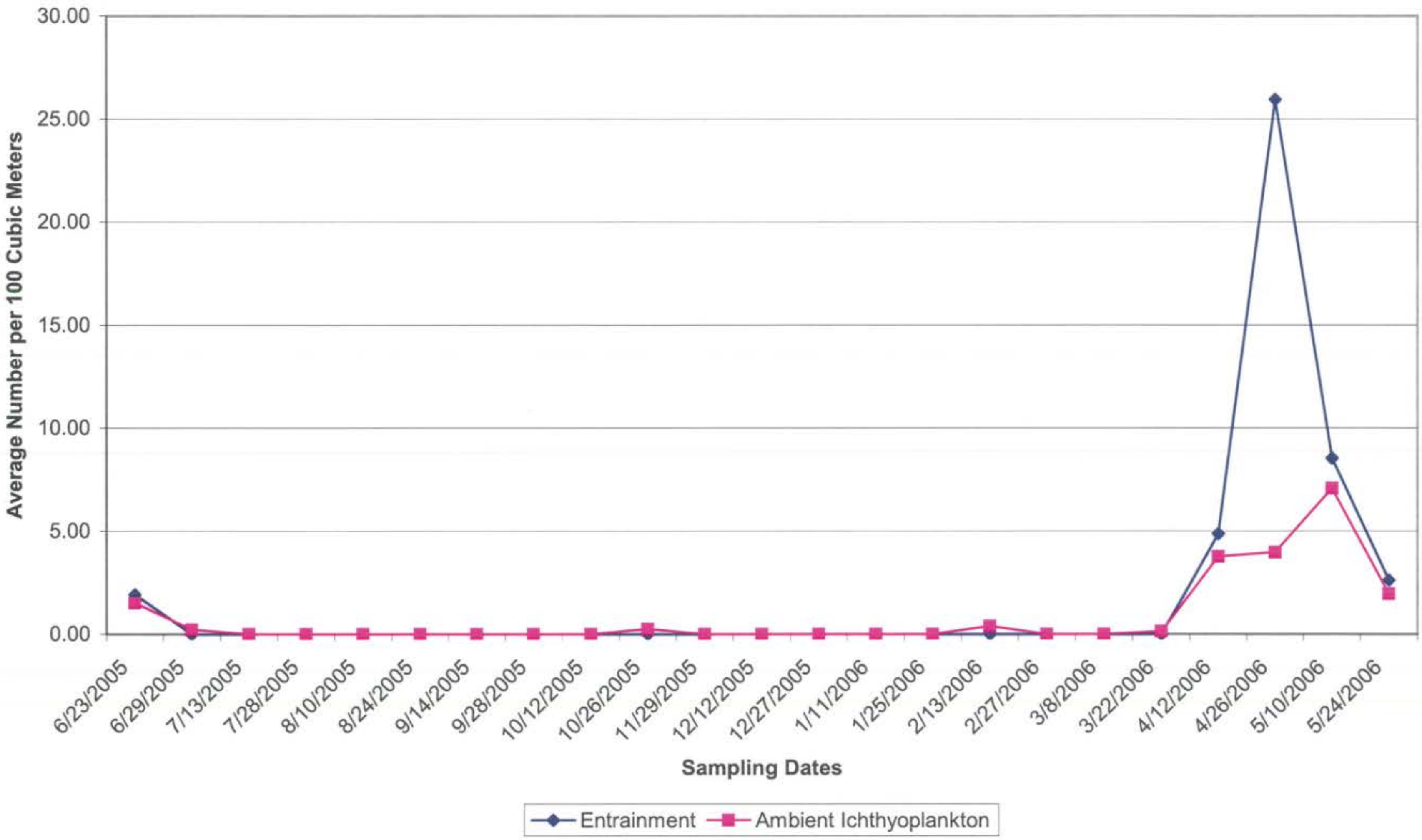


Figure 7 Comparison of Entrainment and Ambient Ichthyoplankton Densities of Bay Anchovy Eggs, Surry Power Station

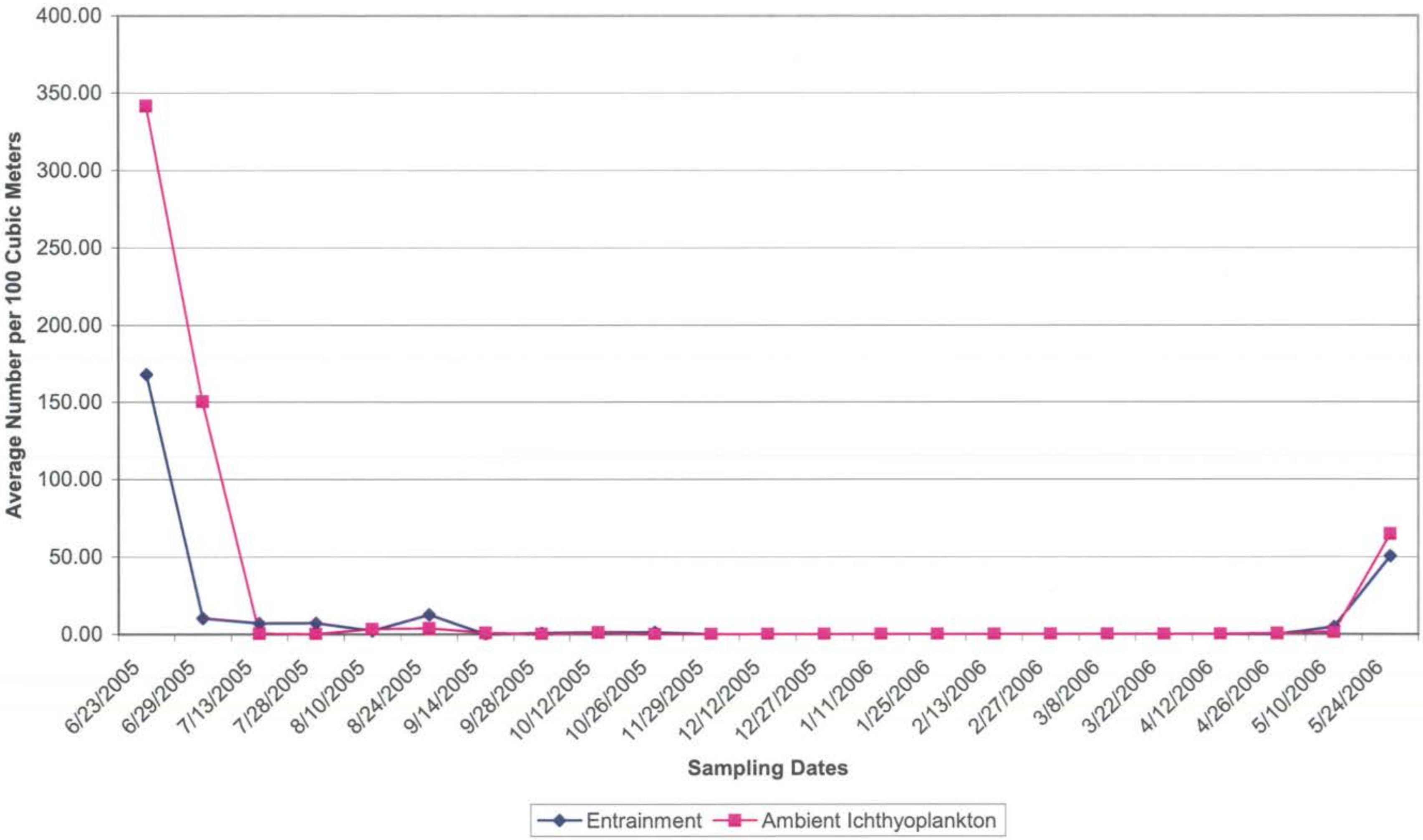


Figure 8 Comparison of Entrainment and Ambient Ichthyoplankton Densities of Bay Anchovy Larvae, Juveniles, and Adults, Surry Power Station

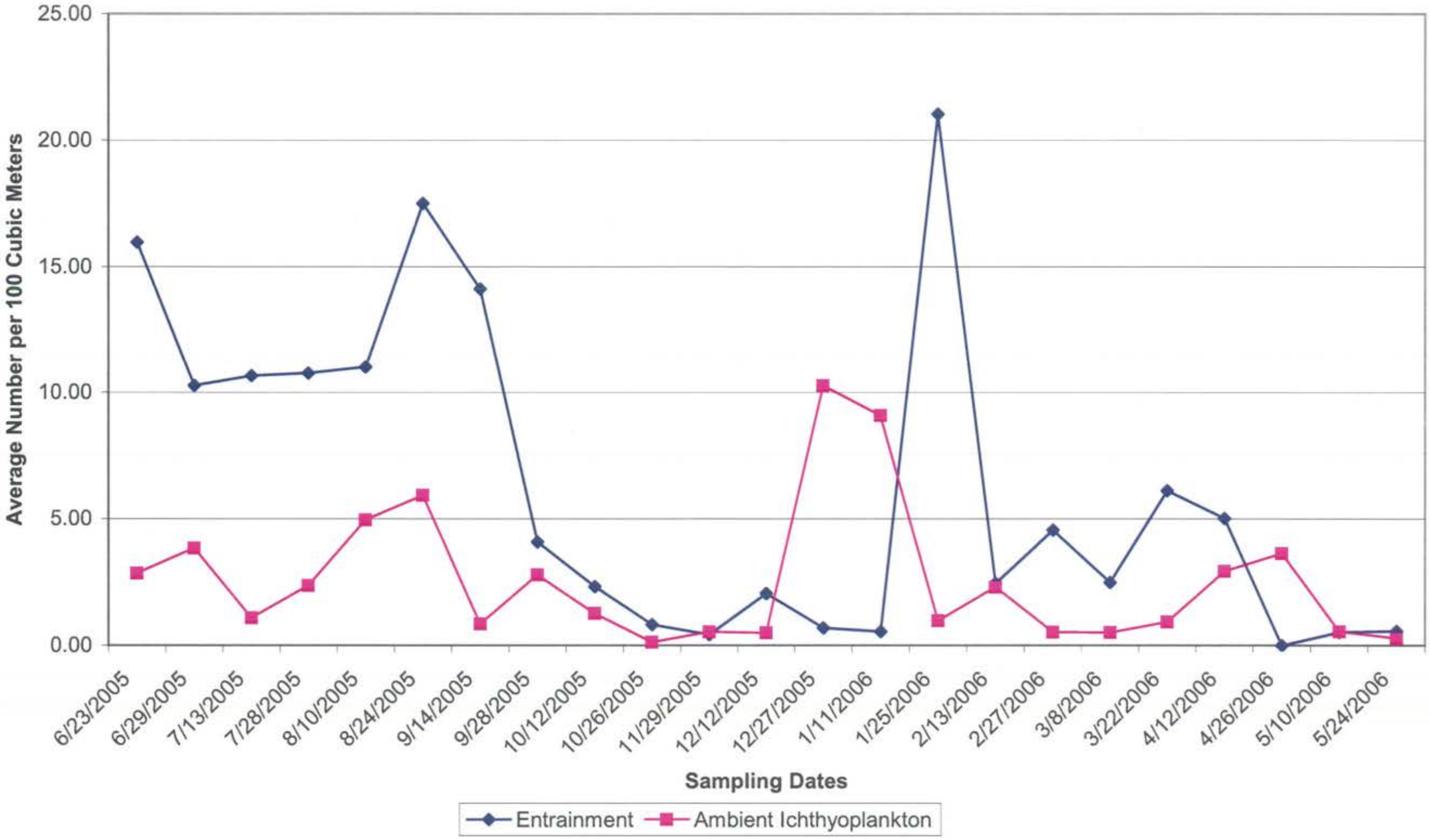


Figure 9 Comparison of Entrainment and Ambient Ichthyoplankton Densities of Naked Goby Larvae and Juveniles, Surry Power Station

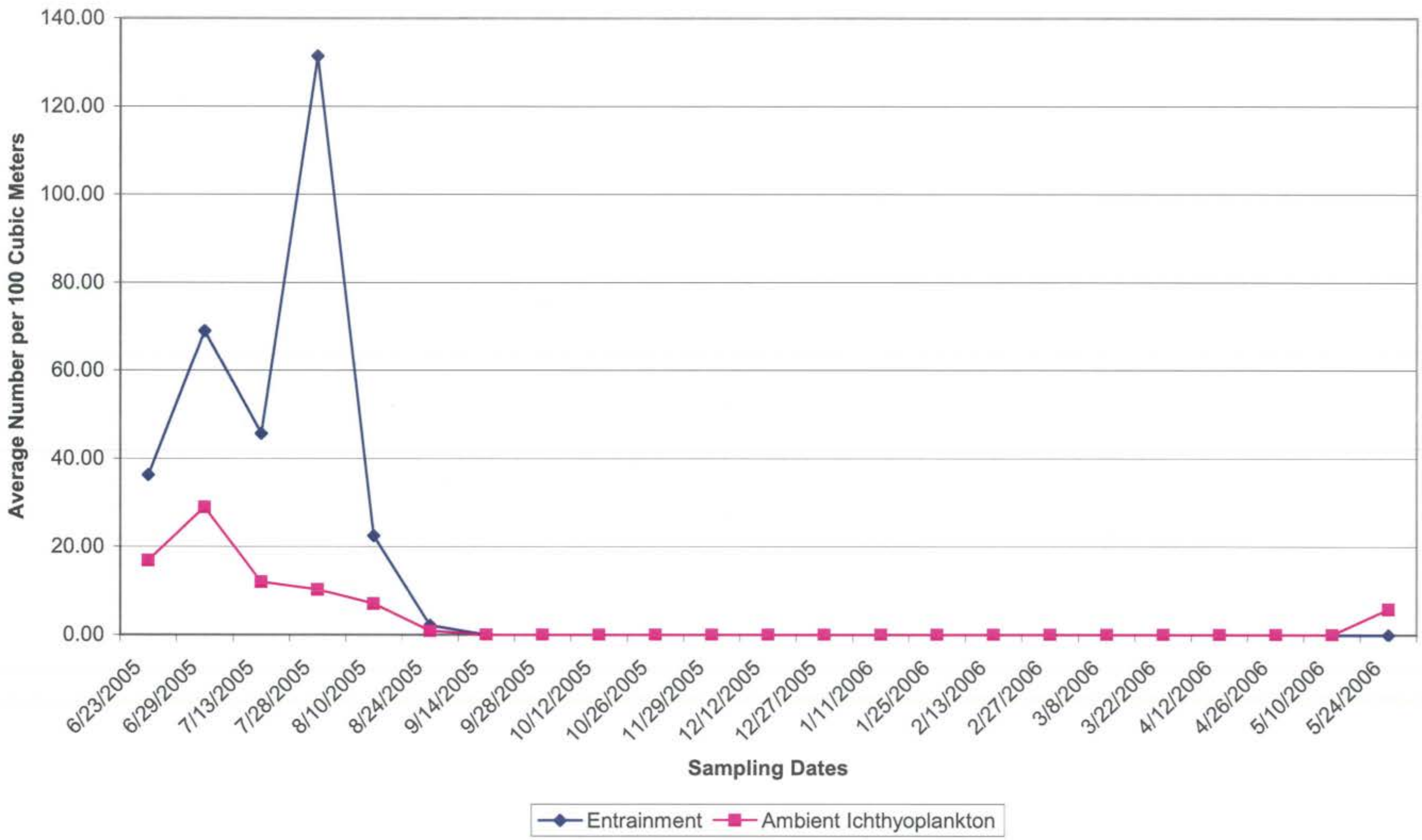


Figure 10 Comparison of Entrainment and Ambient Plankton Densities of Blue Crab Megalopae, Surry Power Station

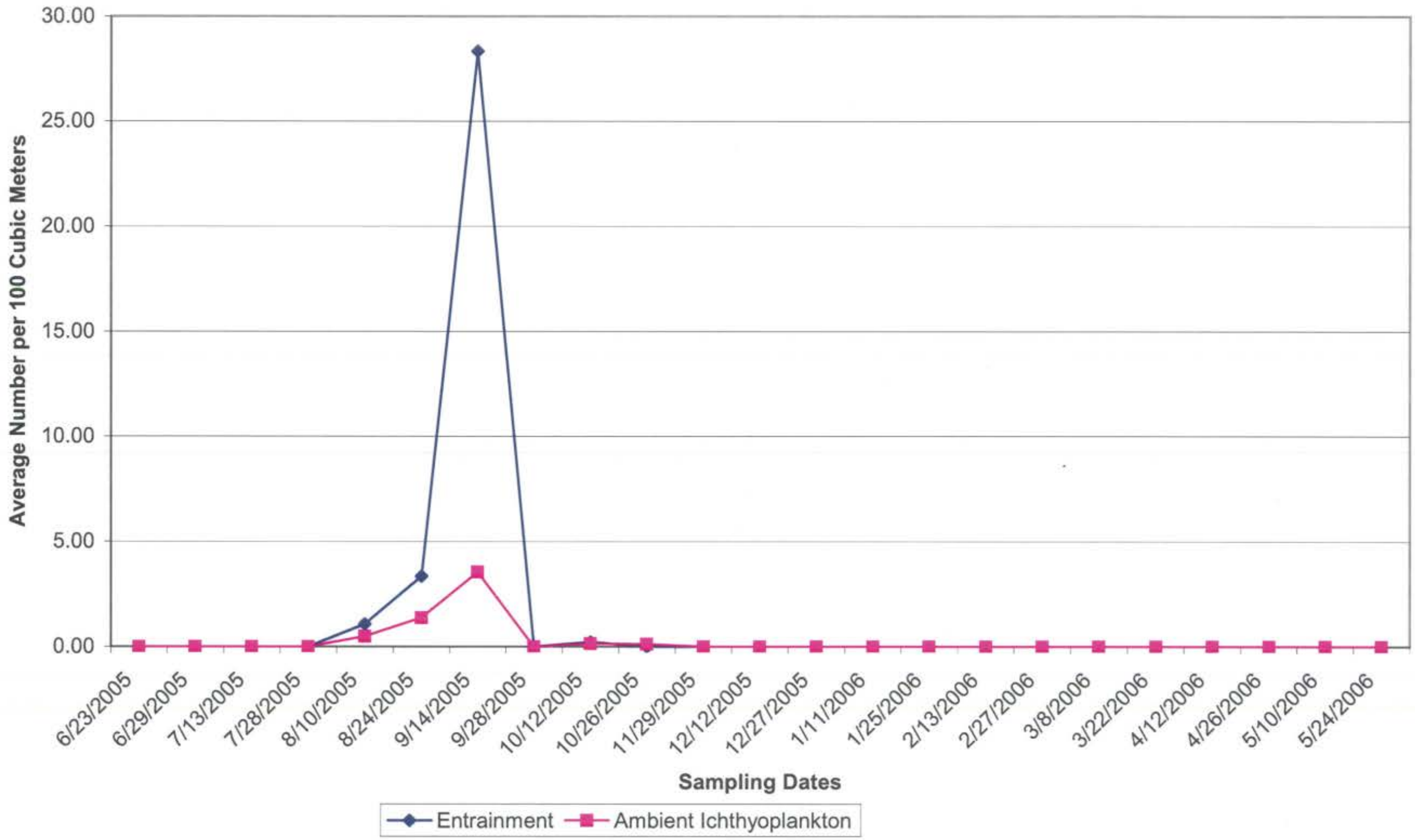


TABLE 1 LIST OF COMMON AND SCIENTIFIC NAMES OF FISH AND SHELLFISH MENTIONED IN THIS REPORT

Family		Common Name	Scientific name
Anguillidae	Freshwater eels	American eel	Anguilla rostrata
Engraulidae	Anchovies	Bay anchovy	Anchoa mitchilli
Clupeidae	Herrings	Alewife	Alosa pseudoharengus
		Blueback herring	Alosa aestivalis
		Hickory shad	Alosa mediocris
		Gizzard shad	Dorosoma cepedianum
		Atlantic menhaden	Brevoortia tyrannus
Cyprinidae	Carps and minnows	Common carp	Cyprinus carpio
Ictaluridae	North American catfishes	Blue catfish	Ictalurus furcatus
		Channel catfish	Ictalurus punctatus
		White catfish	Ameiurus catus
Mugilidae	Mullets	White mullet	Mugil cephalus
Atherinopsidae	New World silversides	Rough silverside	Membras martinica
		Inland silverside	Menidia beryllina
		Atlantic silverside	Menidia menidia
Belonidae	Needlefishes	Atlantic needlefish	Strongylura marina
Syngnathidae	Pipefishes	Northern pipefish	Sygnathus fuscus
Moronidae	Temperate basses	White perch	Morone americana
		Striped bass	Morone saxatilis
Centrarchidae	Sunfishes	Bluespotted sunfish	Enneacanthus gloriosus
Pomatomidae	Bluefishes	Bluefish	Pomatomus saltitrix
Sciaenidae	Drums and croakers	Silver perch	Bairdiella chrysoura
		Weakfish	Cynoscion regalis
		Spot	Leiostomus xanthurus
		Atlantic croaker	Micropogonias undulatus
Blenniidae	Combtooth blennies	Feather blenny	Hypsoblennius hentz
Gobiidae	Gobies	Naked goby	Gobiosoma bosc
		Green goby	Microgobius thalassinus
Gobiesocidae	Clingfishes	Skilletfish	Gobiesox strumosus
Stromateidae	Butterfishes	Harvestfish	Peprilus paru

TABLE 1 (Continued)

	Family	Common Name	Scientific name
Paralichthyidae	Sand flounders	Summer flounder	Paralichthys dentatus
Achiridae	American soles	Hogchoker	Trinectes maculatus
Cynoglossidae	Tonguefishes	Blackcheek tonguefish	Symphurus plagiusa
Xanthidae	Mud crabs	Depressed mud crab	Eurypanopeus depressus
Portunidae	Swimming crabs	Blue crab	Callinectes sapidus

Note: Common and scientific names of finfish follow Nelson et al. (2004); shellfish names based on Gosner (1971)

TABLE 2 AVERAGE DENSITY OF ICHTHYOPLANKTON AND MACROINVERTEBRATES ENTRAINED AT SURRY POWER STATION, JUNE 2005 -- MAY 2006

Species/Taxon	No./100M^3		Percent		Cumulative Percent
Shrimp*	1004.78		65.77		65.77
Other crab zoea	376.68		24.66		90.43
Bivalve young	83.26		5.45		95.88
Goby sp. larvae	12.22		0.80		96.68
Other crab megalopae	11.12		0.73		97.41
Bay anchovy egg	11.12		0.73		98.14
Naked goby larvae	8.67		0.57		98.70
Bay anchovy juvenile/adult	4.44		0.29		98.99
Naked goby juvenile	4.13		0.27		99.26
Atlantic croaker juvenile	2.72		0.18		99.44
Atlantic silverside larvae	1.81		0.12		99.56
Bay anchovy larvae	1.67		0.11		99.67
Blue Crab megalopae	1.37		0.09		99.76
Blue Crab juvenile	0.58		0.04		99.80
Atlantic croaker larvae	0.49		0.03		99.83
Fish egg: undetermined/damaged	0.48		0.03		99.86
Dorsoma sp. egg	0.45		0.03		99.89
Invertebrate - undetermined	0.24		0.02		99.91
Rough silverside larvae	0.20		0.01		99.92
Inland silverside larvae	0.19		0.01		99.93
Feather blenny larvae	0.13		0.01		99.94
Silver perch juvenile	0.12		0.01		99.95
Atlantic menhaden juvenile	0.12		0.01		99.96
Fish larvae: undetermined/damaged	0.11		0.01		99.96
Spot juvenile	0.09		0.01		99.97
Anchoa sp. juvenile	0.07		<0.01		99.97
Depressed mud crab juvenile	0.06		<0.01		99.98
Gizzard shad larvae	0.05		<0.01		99.98
Anchoa sp. larvae	0.04		<0.01		99.98
White perch juvenile/adult	0.04		<0.01		99.99
Atherinopsidae sp. egg	0.03		<0.01		99.99
Hogchoker larvae	0.03		<0.01		99.99
Atlantic silverside juvenile	0.02		<0.01		99.99
Atlantic menhaden egg	0.02		<0.01		99.99
Silver perch larvae	0.01		<0.01		99.99
Clupeidae sp. juvenile/adult	0.01		<0.01		99.99
Atherinopsidae sp. larvae	0.01		<0.01		99.99
Clupeidae sp. larvae	0.01		<0.01		100.00
Northern pipefish juvenile	0.01		<0.01		100.00
American eel juvenile	0.01		<0.01		100.00
Blackcheek tonguefish juvenile	0.01		<0.01		100.00
Spot larvae	0.01		<0.01		100.00
Sciaenidae sp. egg	0.01		<0.01		100.00
Bluespotted sunfish juvenile	0.01		<0.01		100.00
Atlantic menhaden larvae	0.01		<0.01		100.00

* Primarily mysid shrimp

TABLE 3 AVERAGE DENSITY AND PERCENT COMPOSITION OF ICHTHYOPLANKTON ENTRAINED AT SURRY POWER STATION, JUNE 2005 -- MAY 2006

Species/Taxon	No./100M^3		Percent		Cumulative Percent
Goby sp. larvae	12.22		24.65		24.65
Bay anchovy egg	11.12		22.44		47.09
Naked goby larvae	8.67		17.49		64.58
Bay anchovy juvenile/adult	4.44		8.96		73.53
Naked goby juvenile	4.13		8.33		81.86
Atlantic croaker juvenile	2.72		5.50		87.36
Atlantic silverside larvae	1.81		3.65		91.01
Bay anchovy larvae	1.67		3.37		94.38
Atlantic croaker larvae	0.49		0.99		95.37
Fish egg: undetermined/damaged	0.48		0.96		96.33
Dorsoma sp. egg	0.45		0.90		97.23
Rough silverside larvae	0.20		0.41		97.64
Inland silverside larvae	0.19		0.39		98.03
Feather blenny larvae	0.13		0.26		98.29
Silver perch juvenile	0.12		0.24		98.53
Atlantic menhaden juvenile	0.12		0.24		98.78
Fish larvae: undetermined/damaged	0.11		0.23		99.00
Spot juvenile	0.09		0.18		99.18
Anchoa sp. juvenile	0.07		0.14		99.32
Gizzard shad larvae	0.05		0.09		99.41
Anchoa sp. larvae	0.04		0.08		99.49
White perch juvenile/adult	0.04		0.07		99.56
Atherinopsidae sp. egg	0.03		0.06		99.62
Hogchoker larvae	0.03		0.05		99.68
Atlantic silverside juvenile	0.02		0.04		99.72
Atlantic menhaden egg	0.02		0.04		99.76
Silver perch larvae	0.01		0.03		99.78
Clupeidae sp. juvenile/adult	0.01		0.03		99.81
Atherinopsidae sp. larvae	0.01		0.03		99.84
Clupeidae sp. larvae	0.01		0.03		99.87
Northern pipefish juvenile	0.01		0.02		99.89
American eel juvenile	0.01		0.02		99.91
Blackcheek tonguefish juvenile	0.01		0.02		99.94
Spot larvae	0.01		0.02		99.96
Sciaenidae sp. egg	0.01		0.02		99.97
Bluespotted sunfish juvenile	0.01		0.01		99.99
Atlantic menhaden larvae	0.01		0.01		100.00

TABLE 4 AVERAGE MONTHLY DENSITY (NO./100M^3) OF COMMON SPECIES OF ICHTHYOPLANKTON AND SHELLFISH ENTRAINED AT SURRY POWER STATION, 2005 -- 2006

Species/Taxon	Jun 2005	Jul 2005	Aug 2005	Sep 2005	Oct 2005	Nov 2005	Dec 2005	Jan 2006	Feb 2006	Mar 2006	Apr 2006	May 2006
Bay anchovy juvenile/adult	8.80	8.10	3.96	6.78	1.58	0.43	1.26	10.21	3.32	4.31	2.51	0.00
Bay anchovy egg	89.18	7.19	7.50	0.55	1.38	0.00	0.00	0.00	0.00	0.00	0.00	27.67
Bay anchovy larvae	4.32	2.61	10.30	0.66	0.00	0.00	0.12	0.59	0.19	0.00	0.00	0.55
Atlantic silverside juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00
Atlantic silverside larvae	0.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.16	6.35
Naked goby juvenile	21.05	25.31	3.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Naked goby larvae	31.75	57.14	8.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic croaker juvenile	0.00	0.00	0.00	0.35	1.04	3.42	4.73	21.27	1.50	0.27	0.12	0.00
Atlantic croaker larvae	0.00	0.00	0.11	0.77	2.16	0.00	2.77	0.00	0.08	0.00	0.00	0.00
Goby sp. larvae	37.50	31.54	13.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	63.95
Blue Crab juvenile	0.00	0.00	1.85	1.79	2.78	0.56	0.00	0.00	0.00	0.00	0.00	0.00
Blue Crab megalopae	0.00	0.00	2.22	9.45	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TABLE 5 LENGTH-FREQUENCY DISTRIBUTION OF BAY ANCHOVY LARVAE, JUVENILES, AND ADULTS

Date	Mean Length (mm)	N	0 to 4.9 mm	5 to 9.9 mm	10 to 14.9 mm	15 to 19.9 mm	20 to 24.9 mm	25 to 29.9 mm	30 to 34.9 mm	35 to 39.9 mm	40 to 44.9 mm	45 to 49.9 mm	50 to 54.9 mm	55 to 59.9 mm	60 to 64.9 mm	65 to 69.9 mm	70 to 74.9 mm
06/23/05	13.8	22		5	10	4	3										
06/29/05	16.3	23		5	5	5	6	2									
07/13/05	13.7	14		2	5	6	1										
07/28/05	11.3	22	1	5	14	1	1										
08/10/05	10.3	34	2	15	16	1											
08/24/05	11.1	34	1	17	9	4	2	1									
09/14/05	11.1	39		8	31												
09/28/05	16.9	22		1	5	11	4	1									
10/12/05	19.4	11			3	2	6										
10/26/05	19.8	3			1		2										
11/29/05	30.0	2						1	1								
12/12/05	37.2	7				1			2		2	1	1				
12/27/05	34.8	4						1	1	1	1						
01/11/06	40.3	3								2		1					
01/25/06	44.1	121						2	4	26	46	20	10	8	3	2	
02/13/06	46.7	13					1		1	1	1	2	5		2		
02/27/06	46.3	31								7	11	4	6	1		1	1
03/08/06	41.8	12							1	3	4	3	1				
03/22/06	47.5	32							1	5	8	7	4	3	3	1	
04/12/06	46.4	38								4	15	11	4	1	1	2	
04/26/06	-----	0															
05/10/06	4.6	1	1														
05/24/06	5.0	2		2													
Totals:		490	5	60	99	35	26	8	11	49	88	49	31	13	9	6	1

TABLE 6 LENGTH-FREQUENCY DISTRIBUTION OF ATLANTIC CROAKER LARVAE AND JUVENILES

Date	Mean Length (mm)	N	0 to 4.9 mm	5 to 9.9 mm	10 to 14.9 mm	15 to 19.9 mm	20 to 24.9 mm	25 to 29.9 mm	30 to 34.9 mm	35 to 39.9 mm	40 to 44.9 mm	45 to 49.9 mm	50 to 54.9 mm
06/23/05	-----	0											
06/29/05	-----	0											
07/13/05	-----	0											
07/28/05	-----	0											
08/10/05	2.20	1	1										
08/24/05	-----	0											
09/14/05	10.30	1			1								
09/28/05	11.86	8		5	1	1	1						
10/12/05	11.55	13		4	7	2							
10/26/05	10.02	16		8	8								
11/29/05	16.22	20			6	11	3						
12/12/05	16.29	43			21	16	2	1	3				
12/27/05	14.66	26			15	9	1	1					
01/11/06	14.99	9			4	4	1						
01/25/06	16.82	151			76	48	14	4	2	2	1	3	1
02/13/06	22.98	11		1	5	1			1	1	1		1
02/27/06	26.43	9			1	2	1	2	2			1	
03/08/06	29.40	2					1		1				
03/22/06	25.50	1						1					
04/12/06	31.60	1							1				
04/26/06	-----	0											
05/10/06	-----	0											
05/24/06	-----	0											
	Totals:	**312**	**1**	**18**	**145**	**94**	**24**	**9**	**10**	**3**	**2**	**4**	**2**

TABLE 7 LENGTH-FREQUENCY DISTRIBUTION OF NAKED GOBY LARVAE AND JUVENILES

Date	Mean Length (mm)	N	3 to 4.9 mm	5 to 6.9 mm	7 to 8.9 mm	9 to 10.9 mm	11 to 12.9 mm	13 to 14.9 mm	15 to 16.9 mm	17 to 18.9 mm	19 to 20.9 mm
06/23/05	8.75	65	4	10	9	36	6				
06/29/05	8.56	115	3	33	18	45	15				1
07/13/05	9.02	70	2	15	7	39	6		1		
07/28/05	8.22	201	2	43	93	57	6				
08/10/05	8.91	83	1	10	26	41	5				
08/24/05	12.00	5				1	3	1			
09/14/05	-----	0									
09/28/05	-----	0									
10/12/05	-----	0									
10/26/05	-----	0									
11/29/05	-----	0									
12/12/05	-----	0									
12/27/05	-----	0									
01/11/06	-----	0									
01/25/06	-----	0									
02/13/06	-----	0									
02/27/06	-----	0									
03/08/06	-----	0									
03/22/06	-----	0									
04/12/06	-----	0									
04/26/06	-----	0									
05/10/06	-----	0									
05/24/06	-----	0									
	Totals:	539	12	111	153	219	41	1	1	0	1

TABLE 8 MEAN WATER QUALITY VALUES ASSOCIATED WITH ENTRAINMENT SAMPLING, SURRY POWER STATION

Sampling Event	DO (mg/L)	pH (pH units)	Salinity (ppt)	Temperature (Degrees C)
6/23/2005	7.5	7.7	8.5	27.0
6/29/2005	5.7	7.6	6.3	26.8
7/13/2005	6.5	7.8	7.4	29.0
7/28/2005	7.0	7.9	5.9	31.4
8/10/2005	5.9	7.7	8.2	30.1
8/24/2005	5.6	7.6	10.3	29.2
9/14/2005	8.3	8.2	10.7	26.5
9/28/2005	8.6	8.2	9.8	25.5
10/12/2005	9.7	7.6	9.6	22.0
10/26/2005	8.9	7.4	9.0	15.4
11/29/2005	10.0	7.8	12.3	12.6
12/12/2005	12.4	7.8	4.4	7.5
12/27/2005	12.9	7.7	3.7	6.8
1/11/2006	11.9	7.6	3.4	8.2
1/25/2006	11.4	7.6	3.5	8.1
2/13/2006	12.5	7.7	5.7	6.5
2/27/2006	12.6	8.1	5.5	6.8
3/8/2006	ND	8.7	6.3	8.5
3/22/2006	12.3	8.5	9.6	10.4
4/12/2006	9.6	7.7	9.2	16.2
4/26/2006	7.3	7.2	7.1	19.1
5/10/2006	6.7	7.5	7.2	19.7
5/24/2006	8.3	7.5	6.8	20.9

ND=no data due to instrument malfunction

TABLE 9 MONTHLY AND ANNUAL ENTRAINMENT ESTIMATES (X 10^6) FOR SURRY POWER STATION

Taxon-Life Stage	6-2005	7-2005	8-2005	9-2005	10-2005	11-2005	12-2005	1-2006	2-2006	3-2006	4-2006	5-2006	6-2006	Annual Total
American eel-juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	**0.3**
Bay anchovy-adult	0.0	0.0	0.0	0.0	0.0	0.0	22.1	2.7	5.6	1.8	0.0	0.0	0.0	**32.1**
Bay anchovy-fertilized egg	296.8	21.9	21.2	4.2	3.7	1.4	0.0	0.0	0.0	0.0	0.0	71.4	27.8	**448.5**
Bay anchovy-juvenile	21.1	22.7	11.9	23.6	5.5	1.6	4.3	0.7	6.8	11.4	8.3	0.0	0.0	**117.9**
Bay anchovy-larvae	11.4	7.5	27.6	6.9	0.1	0.0	1.5	0.3	0.6	0.1	0.0	1.5	0.3	**57.8**
Anchoa sp.-juvenile	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**2.0**
Anchoa sp.- larvae	0.0	0.8	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1.4**
Atlantic menhaden-fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	**0.6**
Atlantic menhaden-juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.8	0.2	0.0	**3.6**
Atlantic menhaden-larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	**0.2**
Gizzard shad-larvae	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1.9**
Dorsoma sp.-fertilized egg	4.4	9.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**14.2**
Clupeidae sp.-adult	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	**0.2**
Clupeidae sp.-juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	**0.3**
Clupeidae sp.-larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.1	0.0	0.0	0.0	0.0	**0.5**
Atlantic silverside-juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.1	0.0	**0.6**
Atlantic silverside-undetermined life stage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	**2.1**
Atlantic silverside-larvae	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.7	19.7	1.4	**58.2**
Inland silverside-larvae	4.7	1.0	0.7	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	**7.2**
Rough silverside-larvae	1.1	5.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**6.2**
Atherinopsidae sp.-fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.4	**1.3**
Atherinopsidae sp.-larvae	0.0	0.0	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.5**
Northern pipefish-juvenile	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.3**
White perch-adult	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	**0.3**
White perch-juvenile	0.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.8**
Bluespotted sunfish-juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	**0.3**
Silver perch-juvenile	0.0	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**3.5**
Silver perch-larvae	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.4**
Spot-juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.5	0.9	0.0	0.0	**3.1**
Spot-larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	**0.4**
Atlantic croaker-juvenile	0.0	0.0	0.0	0.8	2.8	6.6	55.1	13.3	14.7	1.0	0.4	0.0	0.0	**94.7**
Atlantic croaker-larvae	0.0	0.0	0.3	1.1	5.6	2.7	0.9	6.5	0.2	0.0	0.0	0.0	0.0	**17.3**
Sciaenidae sp-fertilized egg	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.2**
Feather blenny-larvae	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**5.3**
Naked goby-juvenile	26.1	77.3	15.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**118.9**
Naked goby-larvae	68.7	149.7	52.3	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**271.2**

TABLE 9 (Continued)

Taxon-Life Stage	6-2005	7-2005	8-2005	9-2005	10-2005	11-2005	12-2005	1-2006	2-2006	3-2006	4-2006	5-2006	6-2006	Total
Naked goby-undetermined/damaged	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.3**
Goby sp.-larvae	62.5	99.5	42.6	1.1	0.0	0.0	0.0	0.0	0.0	0.0	1.1	164.0	68.8	**439.6**
Goby sp.-undetermined/damaged	0.0	0.0	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.5**
Hogchoker-larvae	0.0	0.0	0.8	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.9**
Blackcheek tonguefish-juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	**0.3**
Fish eggs: undetermined	11.4	4.6	0.3	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**17.5**
Fish larvae/juveniles: undetermined	0.0	1.4	1.9	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**3.7**
Blue Crab-juvenile	0.0	0.0	4.7	6.4	7.5	3.2	0.0	0.3	0.0	0.0	0.0	0.0	0.0	**22.2**
Blue Crab-megalop	0.0	0.0	5.7	45.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**51.0**
Other crab-megalopae	0.0	12.9	290.5	75.0	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**383.3**
Other crab-zoeae	528.6	714.6	9948.9	1323.6	37.9	0.8	0.0	0.2	0.0	0.0	39.7	255.4	27.5	**12877.3**
Depressed mud crab - juvenile	0.0	0.0	0.0	0.0	0.4	0.7	0.0	2.1	0.0	0.0	0.0	0.0	0.0	**3.3**
Bivalves	1.7	2.2	12.3	10.4	21.5	82.9	130.8	195.1	165.0	215.3	1929.0	154.7	6.3	**2927.1**
Shrimp	649.2	114.5	1064.3	524.8	940.5	894.2	97.3	1150.0	321.5	7873.8	10623.5	10216.6	1220.4	**35690.5**
Total=	1699.0	1251.2	11503.6	2024.6	1032.2	994.1	313.1	1371.6	515.2	8106.5	12639.5	10888.2	1353.0	**53691.9**

Note: June 2005 and 2006 are each partial months

TABLE 10 DENSITY (#/100 M^3) OF ICHTHYOPLANKTON AND BLUE CRAB LARVAE ENTRAINED AT SURRY POWER STATION JUNE 2005 -- MAY 2006

Sample date	Atlantic croaker juvenile	Atlantic silverside larvae/ juvenile	Bay anchovy egg	Bay anchovy larvae/ juvenile/ adult	Naked goby larvae/ juvenile	Blue crab megalopae
6/23/05	0.0	1.9	167.9	16.0	36.3	0.0
6/29/05	0.0	0.0	10.5	10.3	69.0	0.0
7/13/05	0.0	0.0	7.1	10.7	45.7	0.0
7/28/05	0.0	0.0	7.3	10.8	131.4	0.0
8/10/05	0.0	0.0	2.3	11.0	22.5	1.1
8/24/05	0.0	0.0	12.7	17.5	2.2	3.4
9/14/05	0.3	0.0	0.0	14.1	0.0	28.3
9/28/05	0.4	0.0	0.8	4.1	0.0	0.0
10/12/05	1.4	0.0	1.4	2.3	0.0	0.2
10/26/05	0.7	0.0	1.4	0.8	0.0	0.0
11/29/05	3.4	0.0	0.0	0.4	0.0	0.0
12/12/05	7.4	0.0	0.0	2.1	0.0	0.0
12/27/05	2.0	0.0	0.0	0.7	0.0	0.0
1/11/06	2.0	0.0	0.0	0.6	0.0	0.0
1/25/06	40.6	0.0	0.0	21.0	0.0	0.0
2/13/06	1.6	0.0	0.0	2.5	0.0	0.0
2/27/06	1.4	0.0	0.0	4.6	0.0	0.0
3/8/06	0.4	0.0	0.0	2.5	0.0	0.0
3/22/06	0.2	0.0	0.0	6.1	0.0	0.0
4/12/06	0.2	4.9	0.0	5.0	0.0	0.0
4/26/06	0.0	25.9	0.0	0.0	0.0	0.0
5/10/06	0.0	8.5	4.7	0.5	0.0	0.0
5/24/06	0.0	2.6	50.6	0.6	0.0	0.0

TABLE 11 DENSITY (#/100 M^3) OF ICHTHYOPLANKTON AND BLUE CRAB LARVAE IN THE AMBIENT JAMES RIVER SAMPLES NEAR SURRY POWER STATION, JUNE 2005 -- MAY 2006

Sample date	Atlantic croaker juvenile	Atlantic silverside larvae/ juvenile/ adult	Bay anchovy egg	Bay anchovy larvae/ juvenile/ adult	Naked goby larvae/ juvenile	Blue crab megalopae
6/23/05	0.0	1.5	341.7	2.9	16.8	0.0
6/29/05	0.0	0.2	150.2	3.8	29.0	0.0
7/13/05	0.0	0.0	0.4	1.1	12.0	0.0
7/28/05	0.0	0.0	0.0	2.4	10.3	0.0
8/10/05	0.0	0.0	3.2	5.0	7.1	0.5
8/24/05	0.0	0.0	3.8	5.9	0.9	1.4
9/14/05	0.0	0.0	0.9	0.8	0.0	3.5
9/28/05	1.4	0.0	0.1	2.8	0.0	0.0
10/12/05	0.5	0.0	1.2	1.3	0.0	0.1
10/26/05	1.2	0.2	0.0	0.1	0.0	0.1
11/29/05	8.5	0.0	0.0	0.5	0.0	0.0
12/12/05	2.3	0.0	0.0	0.5	0.0	0.0
12/27/05	0.6	0.0	0.0	10.3	0.0	0.0
1/11/06	0.3	0.0	0.0	9.1	0.0	0.0
1/25/06	7.8	0.0	0.0	1.0	0.0	0.0
2/13/06	0.7	0.4	0.0	2.3	0.0	0.0
2/27/06	0.0	0.0	0.0	0.5	0.0	0.0
3/8/06	0.0	0.0	0.0	0.5	0.0	0.0
3/22/06	0.0	0.1	0.0	0.9	0.0	0.0
4/12/06	0.0	3.8	0.0	2.9	0.0	0.0
4/26/06	0.0	4.0	0.5	3.6	0.0	0.0
5/10/06	0.0	7.1	1.3	0.5	0.0	0.0
5/24/06	0.0	1.9	64.6	0.3	5.8	0.0

TABLE 12. MEAN WATER QUALITY VALUES ASSOCIATED WITH AMBIENT ICHTHYOPLANKTON SAMPLING, SURRY POWER STATION

Sampling Event	Sampling Station	DO (mg/L) Middle	pH (pH units) Middle	Salinity (ppt) Middle	Temperature (Degrees C) Middle
06/23/05	ADJACENT	7.4	7.7	8.5	26.2
	DOWNSTREAM	6.9	7.5	9.0	25.9
	UPSTREAM	6.9	7.6	8.0	26.0
06/29/05	ADJACENT	5.7	7.6	6.2	26.7
	DOWNSTREAM	5.5	7.5	6.5	26.9
	UPSTREAM	5.6	7.6	6.2	26.9
07/13/05	ADJACENT	5.8	7.6	7.7	29.2
	DOWNSTREAM	6.2	7.7	7.7	29.0
	UPSTREAM	5.9	7.7	7.7	29.1
07/28/05	ADJACENT	7.3	7.9	6.0	31.8
	DOWNSTREAM	7.5	7.9	5.9	32.0
	UPSTREAM	7.2	7.9	6.0	31.8
08/10/05	ADJACENT	5.4	7.6	8.6	29.5
	DOWNSTREAM	5.4	7.6	8.7	29.4
	UPSTREAM	5.2	7.6	8.4	29.6
08/24/05	ADJACENT	5.5	7.6	10.3	29.3
	DOWNSTREAM	5.3	7.6	10.4	29.1
	UPSTREAM	5.6	7.6	9.9	29.3
09/14/05	ADJACENT	8.4	8.3	10.4	26.7
	DOWNSTREAM	8.7	8.3	11.0	26.6
	UPSTREAM	8.1	8.3	10.2	26.6
09/28/05	ADJACENT	8.8	8.3	9.8	25.6
	DOWNSTREAM	8.3	8.1	9.9	25.5
	UPSTREAM	8.6	8.3	9.5	25.6
10/12/05	ADJACENT	10.4	7.6	9.6	22.2
	DOWNSTREAM	10.6	7.6	10.1	22.2
	UPSTREAM	10.7	7.6	9.2	22.3
10/26/05	ADJACENT	8.9	7.5	8.9	16.1
	DOWNSTREAM	8.8	7.6	9.1	16.4
	UPSTREAM	8.9	7.5	8.6	16.1
11/29/05	ADJACENT	10.1	7.9	12.2	12.1
	DOWNSTREAM	10.4	7.8	12.6	12.2
	UPSTREAM	10.1	7.9	12.2	12.4
12/12/05	ADJACENT	12.5	7.8	4.2	7.7
	DOWNSTREAM	12.6	7.8	4.6	7.5
	UPSTREAM	12.4	7.9	3.7	8.3

TABLE 12 (Continued)

Sampling Event	Sampling Station	DO (mg/L) Middle	pH (pH units) Middle	Salinity (ppt) Middle	Temperature (Degrees C) Middle
12/27/05	ADJACENT	12.9	7.6	3.6	6.8
	DOWNSTREAM	13.1	7.6	3.8	6.9
	UPSTREAM	12.9	7.7	3.5	6.8
01/11/06	ADJACENT	11.6	7.6	3.3	8.1
	DOWNSTREAM	12.0	7.6	4.1	8.0
	UPSTREAM	10.2	7.6	2.6	8.6
01/25/06	ADJACENT	11.4	7.7	3.0	8.4
	DOWNSTREAM	11.5	7.6	4.0	8.0
	UPSTREAM	11.3	7.7	2.3	9.0
02/13/06	ADJACENT	12.1	7.5	6.2	6.6
	DOWNSTREAM	12.4	7.6	6.0	6.6
	UPSTREAM	12.0	7.6	5.9	6.6
02/27/06	ADJACENT	12.5	8.1	5.7	6.9
	DOWNSTREAM	12.4	8.1	6.1	7.0
	UPSTREAM	12.4	8.1	5.5	7.0
03/08/06	ADJACENT	14.9	8.6	6.4	8.4
	DOWNSTREAM	14.8	8.5	6.5	8.4
	UPSTREAM	14.5	8.6	6.5	8.7
03/22/06	ADJACENT	11.8	8.4	9.7	10.6
	DOWNSTREAM	11.9	8.4	10.6	10.5
	UPSTREAM	11.6	8.3	9.3	10.8
04/02/06	ADJACENT	9.5	7.6	9.3	16.1
	DOWNSTREAM	9.3	7.6	9.3	16.0
	UPSTREAM	9.4	7.6	9.3	16.3
04/26/06	ADJACENT	7.6	7.3	6.9	19.3
	DOWNSTREAM	7.6	7.3	7.2	19.3
	UPSTREAM	7.6	7.3	6.9	19.4
05/10/06	ADJACENT	7.1	7.5	7.4	19.5
	DOWNSTREAM	7.1	7.4	7.6	19.5
	UPSTREAM	7.0	7.5	7.4	19.6
05/24/06	ADJACENT	8.8	7.5	6.8	20.9
	DOWNSTREAM	9.0	7.5	7.3	20.8
	UPSTREAM	9.2	7.5	6.5	21.0

TABLE 13 RESULTS OF DOMINION RESOURCES' QUARTERLY SAMPLING OF JUVENILE AND ADULT FISH AND SHELLFISH IN THE VICINITY OF SURRY POWER STATION, 2005 - 2006

Species	September (1 survey)	November (1 survey)	January (1 survey)	June (1 survey)
American eel		1		
Bay anchovy	127	46	69	47
Alewife			6	
Blueback herring			3	2
Hickory shad		1		
Gizzard shad			7	2
Atlantic menhaden	2	13	3	
Common carp	3	4	2	1
Blue catfish	160	110	30	140
Channel catfish				1
White catfish	8	1	1	
White mullet	2			
Atlantic silverside	211	5	31	
Inland silverside				135
Atlantic needlefish				2
White perch	24	31	69	10
Striped bass	3	3	5	2
Bluefish	1			1
Atlantic croaker	2	1	14	49
Silver perch	17	5		
Spot	75	109		15
Weakfish	1	3		
Harvestfish	3			
Hogchoker	30	14	126	9
Blue Crab		4		2
Total Organisms	**669**	**351**	**366**	**418**

APPENDIX A

Entrainment and Ambient Ichthyoplankton Calculation Procedures

A.1. INTRODUCTION

The Dominion Resources 316b database stores plant operating conditions, water quality data, and organism data collected for three main types of sampling events: entrainment, impingement, and ambient ichthyoplankton ("ich") sampling. Data for quarterly juvenile/adult sampling events, which occur at off-site sampling locations, are also stored in the database. One of the main project objectives is to generate estimates of monthly and annual organism estimates, based on the collected organism data. This appendix describes the entrainment and ambient ichthyoplankton calculation procedures for Surry Power Station.

A.2. SAMPLING SCHEDULE AND EXTRAPOLATION RANGE

The sampling schedule consisted of two parent sampling events per month. Each parent event was considered a 24-hour sampling period.

Each Parent Event date has an assigned "date range" where each date in the range was assigned the same organism estimate that was measured during the parent event date. The date range is established by counting halfway back to the prior parent event, and halfway forward to the subsequent parent event. A small example for three parent dates is presented below:

Parent Date	Range Start	Range End	Day Count
6/23/2005	6/7/2005	6/25/2005	19
6/29/2005	6/26/2005	7/5/2005	10
7/13/2005	7/6/2005	7/20/2005	15

A.3. ENTRAINMENT DATA

A.3.1 Overview

The entrainment samples were collected in front of an operating unit at the plant intake. The sample volume, water quality data, and organism collection occurred at each of the 12 entrainment events, each consisting of a pair of plankton samples at a specific depth. Usually three entrainment events (a sample pair at each of three depths) occurred in a designated "sampling hour." The 12 entrainment events, numbered 1 to 12, grouped three to an hour, typically occurred at the following times for a 24-hour parent event:

Hour Group A: events 1-3 in the 10a.m. hour (10:00)
Hour Group B: events 4-6 in the 4 p.m. hour (16:00)
Hour Group C: events 7-9 in the 10 p.m. hour (22:00)
Hour Group D: events 10-12 in the 4a.m. hour (04:00 – the following day)

Each entrainment event typically had two organism samples and corresponding sample volume measurements collected at a given depth (bottom, middle, or surface) in each of the left and right sampling nets. So for each Hour Group, consisting of three entrainment events, there were usually six samples/volume measurements taken. Below is an example sample listing for events 1,2,3 (Hour Group A):

Example of Entrainment Hourly Group A (3 events, 2 samples each):

Site	Parent Event Date	Ent Date	Ent Time	Event Number	Depth	Right/ Left	FlowMeter	SampleName	FlwNet Count
Surry	10/26/2005	10/26/2005	1106	1	Bottom	L	GO 2030R6 LoFlow	S-1026-01-LB	1676
Surry	10/26/2005	10/26/2005	1106	1	Bottom	R	GO 2030R6 LoFlow	S-1026-01-RB	1620
Surry	10/26/2005	10/26/2005	1121	2	Middle	L	GO 2030R6 LoFlow	S-1026-01-LM	1999
Surry	10/26/2005	10/26/2005	1121	2	Middle	R	GO 2030R6 LoFlow	S-1026-01-RM	1933
Surry	10/26/2005	10/26/2005	1135	3	Surface	L	GO 2030R6 LoFlow	S-1026-01-LS	2030
Surry	10/26/2005	10/26/2005	1135	3	Surface	R	GO 2030R6 LoFlow	S-1026-01-RS	1998

Therefore, there were typically six samples collected in each of four hourly sampling groups, resulting in 24 total entrainment samples collected in a 24-hour parent event period.

A.3.2 Organism Data:

In each sample collected, the organisms were identified by species or lowest practicable taxonomic level and life stage (egg, larvae, juvenile, etc). For individual fish larvae, the length (0.1 mm) was recorded for 20 specimens of each taxon. If large numbers of a particular organism/life stage were collected, the organisms in excess of the 20 measured organisms were combined as a "batch count." Thus a given sample could have individual and batch organism counts associated with it.

A.3.3 Entrainment Sample-Volume Calculations

Each sample collected had a corresponding sample volume measurement. The sample flow through the net was measured with one of two flow meters. For each flow measurement the flow meter initial, final, and net "counts" were recorded. The net count was used in a formula, specific to each meter, to calculate the water sample volume (in cubic meters) associated with a sample. The flow meters and volume formulas are as follows:

Meter Name	Formula	Factor1	Factor2
GO 2030R	NetCount/9480.774 * 50 = cubic meters	9,480.77	50.00
GO 2030R6 LoFlow	NetCount/4426.282 * 50 = cubic meters	4,426.28	50.00

Using the flow meter ID, formula, and net counts recorded, the final sample volume in cubic meters (M^3) was calculated for each sample, as: (net count / factor1) * factor 2.

A.3.4 Impact of Low Net Flow Counts on Calculations

Occasionally during sampling, one or both flow meters recorded noticeably low counts for the 10-minute sample. Whereas typical flow meter counts could be as high as 3 or 4 thousand, some counts were recorded well below 500. Once all the data were collected and assembled, the low flow counts were investigated by running a series of simulations with different flow meter counts and raw organism counts. These test showed that at counts below 100, organism densities were overestimated by at least 20 percent. For Surry Station, 14 of 534 samples, or 2.6 percent, had flow meter counts below 100. To address this at Surry, all net counts below 300 were identified, and totaled 30, or 4.7 percent of the total. Typically, one net count of a pair would be below 300 and the other above 300. In these cases, the low net count was set equal to the higher count. On a few occasions, both net counts of a pair were less than 300, and these were set equal to the average of all net counts that were greater than 300 during the sampling event.

A.3.5 Entrainment Parent 24-hour Average Organism Densities

For each species/ life stage of organism, the objective was to calculate a 24-hour average organism density (#/100 M^3 sample volume). This would be considered the final organism density for the 24-hour parent event.

The 24-hour final density for each parent event was calculated in steps as follows:

1. Adjust each organism/life stage count in each sample to the standard "100 M^3" sample density.

2. The standard densities of the four "Hour Groups" (A, B, C, D) were averaged.

3. The four averages were averaged to yield a final "24-hour" average density.

An example calculation for bay anchovy eggs from the Surry 6/23/05 parent date is presented in the Table A-1.

A.3.6 Calculation of Entrainment Final (Annual) Organism Estimates

Twenty-four parent sampling events were scheduled (2 per month), however, one was missed at Surry due to severe weather. Therefore, there were 23 parent events at Surry over the year cycle. Each parent event is assigned a date range, to each date of which the 24-hour final organism estimate for the parent date is applied. The date range for a parent event may span across two different months. Below is a tabulation of parent date ranges for Surry Station:

Surry Parent Event dates and Applied Ranges:

Parent Date	Range Start	Range End	Day Count
6/23/2005	6/7/2005	6/25/2005	19
6/29/2005	6/26/2005	7/5/2005	10
7/13/2005	7/6/2005	7/20/2005	15
7/28/2005	7/21/2005	8/3/2005	14
8/10/2005	8/4/2005	8/17/2005	14
8/24/2005	8/18/2005	9/3/2005	17
9/14/2005	9/4/2005	9/20/2005	17
9/28/2005	9/21/2005	10/4/2005	14
10/12/2005	10/5/2005	10/19/2005	15
10/26/2005	10/20/2005	11/11/2005	23
11/29/2005	11/12/2005	12/5/2005	24
12/12/2005	12/6/2005	12/19/2005	14
12/27/2005	12/20/2005	1/3/2006	15
1/11/2006	1/4/2006	1/17/2006	14
1/25/2006	1/18/2006	2/3/2006	17
2/13/2006	2/4/2006	2/20/2006	17
2/27/2006	2/21/2006	3/3/2006	11
3/8/2006	3/4/2006	3/14/2006	11
3/22/2006	3/15/2006	4/1/2006	18

4/12/2006	4/2/2006	4/19/2006	18
4/26/2006	4/20/2006	5/2/2006	13
5/10/2006	5/3/2006	5/17/2006	15
5/24/2006	5/18/2006	6/6/2006	20

An annual organism estimate at maximum flow operation was calculated in three steps:

1. The final 24-hour organism density (#/100 M^3) for each parent event was used with the maximum daily circulating-water flow to calculate the estimated number of organisms entrained during the 24-hour parent event. For example, the maximum 24-hour flow at Surry is 9,160,999 M^3. The bay anchovy egg density for the Surry 6/23/2005 parent event was 167.9/100 M^3 (Table A-1). The 24-hour estimate adjusted for the maximum flow volume is 15,381,317 ([9,160,999/100]*167.9) total eggs entrained.

2. The final 24-hour organism estimate at maximum flow volume was applied to each day in the parent date range. For example, the bay anchovy egg 24-hour estimate for the Surry 6/23/05 parent event was 15,381,317 at maximum flow. The 6/23/05 parent date range was 6/7/05 to 6/25/05 (19 days), therefore the 24-hour maximum flow estimate for the parent event would be multiplied by 19 to get the final maximum estimated number entrained for that date range.

3. The sums of 24-hour organism estimates (at maximum flow volume) for each date range were then summed to yield the final annual entrained organism estimate, for maximum flow conditions.

A.3.7 Monthly Organism Estimates

For monthly estimates, the parent-event estimate data are still used to assign the fish estimates to each day in the month. For example, the monthly estimate for June 2005 required the use of three parent events as shown below:

Parent date	Start date	End Date
6/09/05	05/27/05	06/12/05
6/15/05	06/13/05	06/25/05
07/0505	06/26/05	07/11/05

The 6/09/05 event spans 12 days in June, the 6/15/05 event spans 13 days in June, and the 7/05/05 event spans 5 days in June. Therefore the June 2005 monthly total for an organism would be calculated as the sum of:

06/09/05 parent 24-hour organism estimate * 12 days
06/15/05 parent 24-hour organism estimate * 13 days
07/05/05 parent 24-hour organism estimate * 5 days.

The yearly totals are simply the sum of all the parent, or monthly, total estimates.

Note that the date ranges assigned to each parent event span exactly 365 days for the year.

A.4. AMBIENT ICHTHYOPLANKTON DATA

A.4.1 Overview

The ambient ichthyoplankton ("amb ich") samples were collected at designated locations upstream, downstream, and adjacent to the plant intake. During each parent event there were usually 12 samples collected. The 12 sample events, numbered 1 to 12, grouped three to an hour, typically occurred at the following times for a 24-hour parent event, in concert with in-plant entrainment samples:

Hour Group A: events 1-3 in the 10a.m. hour (10:00)
Hour Group B: events 4-6 in the 4 p.m. hour (16:00)
Hour Group C: events 7-9 in the 10 p.m. hour (22:00)
Hour Group D: events 10-12 in the 4a.m. hour (04:00 – the following day)

The samples consisted of mid-depth tows at each of three locations. Sample volume calculations were based on counts from flow meters affixed in the mouth of each net.

Example of 12 Ambient Ich Sample Events

Site	Loc	Event Number	Group	Samp Date	Evnt Time	SampName	Depth	Samp Start Time	Samp End Time	Flow-Meter	Net Flow Count
Surry	Downstream	1	A	7/20/2005	1051	S-0720-01-DS	N/A	1051	1057	GO 2030R	13061
Surry	Adjacent	2	A	7/20/2005	1115	S-0720-01-AJ	N/A	1115	1121	GO 2030R	13141
Surry	Upstream	3	A	7/20/2005	1140	S-0720-01-US	N/A	1140	1146	GO 2030R	13050
Surry	Upstream	4	B	7/20/2005	1653	S-0720-02-US	N/A	1653	1659	GO 2030R	5199
Surry	Adjacent	5	B	7/20/2005	1717	S-0720-02-AJ	N/A	1717	1723	GO 2030R	12789
Surry	Downstream	6	B	7/20/2005	1738	S-0720-02-DS	N/A	1738	1744	GO 2030R	12378
Surry	Downstream	7	C	7/20/2005	2240	S-0720-03-DS	N/A	2240	2246	GO 2030R	13081
Surry	Adjacent	8	C	7/20/2005	2310	S-0720-03-AJ	N/A	2310	2316	GO 2030R	14073
Surry	Upstream	9	C	7/20/2005	2332	S-0720-03-US	N/A	2332	2338	GO 2030R	11297
Surry	Downstream	10	D	7/21/2005	0454	S-0721-04-DS	N/A	0454	0500	GO 2030R	11291
Surry	Adjacent	11	D	7/21/2005	0514	S-0721-04-AJ	N/A	0514	0520	GO 2030R	9661
Surry	Upstream	12	D	7/21/2005	0529	S-0721-04-US	N/A	0529	0535	GO 2030R	11244

A.4.2 Organism Data

In each sample collected, the organisms were identified by species and life stage (egg, larvae, juvenile, etc). For individual fish larvae, the length (0.1 mm) was recorded. If large numbers of a particular organism/life stage were collected, the organisms were combined as a "batch count." Thus a given sample could have individual and batch organism counts associated with it.

A.4.3 Ambient Ich Sample-Volume Calculations

Each sample collected had a corresponding water flow (volume) measurement. The flow was measured with a General Oceanics (GO) mechanical flow meter. For each flow measurement the flow meter initial, final, and net "counts" were recorded. The net count was used in a formula to calculate the water sample volume (in cubic meters) associated with a sample. The flow meter and volume formula is as follows:

Meter Name	Formula	Factor1	Factor2
GO 2030R	NetCount/9480.774 * 50 = cubic meters	9,480.77	50.00

Using the flow meter ID, formula, and net counts recorded, the final sample volume in cubic meters (M^3) was calculated for each sample, as: (net count / factor1) * factor 2.

A.4.4 Final Organism Density Calculations

Unlike the entrainment data, the ambient ich data were not processed into final "yearly estimates." The organism counts for each organism/life stage were presented as average organism densities in a standard 100 M^3 sample volume for each 24-hour parent event.

The time duration of the sample is not a factor in the calculations. The 4.5-minute tow time was established, based on experience, to generate a sample volume of roughly 40-60 cubic meters of water. So it is only the flow meter net count (and associated formula) that figures in the calculations.

The process for obtaining the average density was as follows. For each parent event, usually consisting of 12 samples, the raw organism counts were adjusted to account for a 100 M^3 standard sample volume. Most actual sample volumes were 40-60 M^3 volume. For example, for a sample volume of 46.7 M^3, and a raw count of 85 bay anchovy larvae, the sample density of bay anchovy larvae is calculated as ([100/46.7]*85= 182 bay anchovy larvae per 100 M^3. When averaged with the remaining 11 samples from the parent event, the result is the organism density representing the entire 24-hour period.

TABLE A-1 CALCULATION SEQUENCE FOR 24-HOUR ENTRAINMENT DENSITY ESTIMATE FOR BAY ANCHOVY EGGS, 6/23/05 PARENT EVENT

Dominion Power - Entrainment Organism Density (24 Hour)

Site	Date	Organism
Surry	6/23/2005	Bay anchovy - fertilized egg

Event Group: A

Event #	Depth	Left/Right	Sample Vol M3	Count in Sample	Indiv or Batch		Density (#/100 M3)
1	Surface	L	7.811	0			0.000
1	Surface	R	7.811	1	IND	IND	12.803
2	Middle	L	11.507	6	IND	IND	52.140
2	Middle	R	3.296	1	IND	IND	30.338
3	Bottom	L	14.287	2	IND	IND	13.999
3	Bottom	R	14.245	7	IND	IND	49.141
					Event Group Average:		26.404

Event Group: B

Event #	Depth	Left/Right	Sample Vol M3	Count in Sample	Indiv or Batch		Density (#/100 M3)
4	Surface	L	7.905	10	IND	IND	126.495
4	Surface	R	2.162	2	IND	IND	92.495
5	Middle	L	17.514	1	IND	IND	5.710
5	Middle	R	8.929	0			0.000
6	Bottom	L	13.775	6	IND	IND	43.556
6	Bottom	R	10.880	4	IND	IND	36.765
					Event Group Average:		50.837

Event Group: C

Event #	Depth	Left/Right	Sample Vol M3	Count in Sample	Indiv or Batch		Density (#/100 M3)
7	Bottom	L	6.935	31	BATCH	IND	447.002
7	Bottom	R	4.688	16	IND	IND	341.265
8	Middle	L	8.132	4	IND	IND	49.187
8	Middle	R	4.209	19	IND	IND	451.465
9	Surface	L	8.132	7	IND	IND	86.077
9	Surface	R	8.132	6	IND	IND	73.780
					Event Group Average:		241.463

Event Group: D

Event #	Depth	Left/Right	Sample Vol M3	Count in Sample	Indiv or Batch		Density (#/100 M3)
10	Bottom	L	18.427	82	BATCH	IND	445.005
10	Bottom	R	16.444	84	BATCH	IND	510.831
11	Middle	L	12.821	31	BATCH	IND	241.797
11	Middle	R	11.001	16	IND	IND	145.439
12	Surface	L	4.177	19	IND	IND	454.886
12	Surface	R	5.632	18	IND	IND	319.577
					Event Group Average:		352.922

Bay anchovy - fertilized egg	Average 24-hour Density at Max Flow in 100 M3:	167.906

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APPENDIX B

Monthly Entrainment Densities

TABLE B-1 AVERAGE DENSITIES (#/PER 100M³) OF ICHTHYOPLANKTON AND MACROINVERTEBRATES ENTRAINED AT SURRY POWER STATION, JUNE 2005-MAY 2006

	2005													2006									
Taxon-Life Stage	23-Jun	29-Jun	13-Jul	28-Jul	10-Aug	24-Aug	14-Sep	28-Sep	12-Oct	26-Oct	29-Nov	12-Dec	27-Dec	11-Jan	25-Jan	13-Feb	27-Feb	8-Mar	22-Mar	12-Apr	26-Apr	10-May	24-May
American eel - juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bay anchovy - fertilized egg	167.9	10.5	7.1	7.3	2.3	12.7	0.0	0.6	1.4	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7	50.6
Bay anchovy - yolk-sac larvae	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bay anchovy - post-yolk sac larvae	5.8	2.8	1.3	4.3	3.4	17.0	1.2	0.4	0.0	0.0	0.0	0.2	0.0	0.0	1.2	0.0	0.4	0.0	0.0	0.0	0.0	0.5	0.6
Bay anchovy - juvenile	10.1	7.5	9.3	6.5	7.4	0.6	12.9	3.7	2.3	0.8	0.4	0.2	0.2	0.0	3.3	2.1	3.6	2.5	5.1	5.0	0.0	0.0	0.0
Bay anchovy - adult	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.5	0.6	16.5	0.3	0.7	0.0	1.0	0.0	0.0	0.0	0.0
Anchoa sp. - post-yolk sac larvae	0.0	0.0	0.0	0.8	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Anchoa sp. - juvenile	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Atlantic menhaden - fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0
Atlantic menhaden - post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Atlantic menhaden - juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.4	0.5	1.1	0.0	0.0
Gizzard shad - post-yolk sac larvae	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dorosoma sp. - fertilized egg	2.5	0.0	7.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Clupeidae sp. - post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Clupeidae sp. - juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Clupeidae sp. - adult	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Atlantic silverside - yolk-sac larvae	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	15.7	0.0	0.0
Atlantic silverside - post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	9.7	8.5	2.6
Atlantic silverside - juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0
Atlantic silverside - undetermined/damaged	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0
Inland silverside - post-yolk sac larvae	2.6	0.3	0.6	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0
Rough silverside - yolk-sac larvae	0.0	0.0	1.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rough silverside - post-yolk sac larvae	0.5	0.4	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Atherinopsidae sp. - fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
Atherinopsidae sp. - post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Northern pipefish - juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
White perch - juvenile	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
White perch - adult	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bluespotted sunfish - juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Silver perch - post-yolk sac larvae	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Silver perch - juvenile	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spot - post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
Spot - juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.0	0.9	0.4	0.3	0.0	0.0
Atlantic croaker - post-yolk sac larvae	0.0	0.0	0.0	0.0	0.2	0.0	0.0	1.2	1.7	2.6	0.0	2.3	3.2	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Atlantic croaker - juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.4	1.4	0.7	3.4	7.4	2.0	2.0	40.6	1.6	1.4	0.4	0.2	0.2	0.0	0.0	0.0
Sciaenidae sp - fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feather blenny - post-yolk sac larvae	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Naked goby - post-yolk sac larvae	31.0	32.2	16.7	111.1	16.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Naked goby - juvenile	5.3	36.8	29.0	20.3	7.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Naked goby - undetermined/damaged	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Goby sp. - post-yolk sac larvae	21.9	53.1	32.6	30.1	23.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.8	2.8	125.1
Goby sp. - undetermined/damaged	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hogchoker - post-yolk sac larvae	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blackcheek tonguefish - juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Unidentified/Damaged eggs	6.5	0.0	3.4	0.0	0.2	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unidentified/Damaged fish	0.0	0.0	1.0	0.0	0.5	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blue Crab - juvenile	0.0	0.0	0.0	0.0	0.4	3.3	2.8	1.3	3.4	2.2	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blue Crab - megalop	0.0	0.0	0.0	0.0	1.1	3.4	28.3	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blue Crab - zoea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6
Depressed mud crab - juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other crab - megalop	0.0	0.0	2.8	9.0	111.7	113.2	20.6	12.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other crab - zoea	292.8	40.5	269.4	323.7	3918.3	3769.5	133.3	86.9	4.1	0.8	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	39.0	133.9	48.4
Bivalve - young	0.3	2.5	0.5	0.3	5.2	4.3	4.3	2.8	3.6	14.2	39.4	126.9	12.7	11.1	88.3	48.0	94.3	76.8	71.7	985.4	303.1	61.6	11.5
Invertebrate - undetermined	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	0.0
Shrimp	370.2	11.3	39.8	55.9	474.3	344.2	135.8	237.8	557.1	79.6	467.4	584.4	169.8	6.6	30.8	60.3	259.4	242.5	4853.4	5032.8	2306.7	5054.7	2220.3

APPENDIX C

Monthly Ambient River Densities

TABLE C-1 AVERAGE DENSITIES (#/100M³) OF ICHTHYOPLANKTON AND MACROINVERTEBRATES COLLECTED DURING AMBIENT TOWS AT SURRY POWER STATION, JUNE 2005 – MAY 2006

	2005													2006									
Species - Life Stage	23-Jun	29-Jun	13-Jul	28-Jul	10-Aug	24-Aug	14-Sep	28-Sep	12-Oct	26-Oct	29-Nov	12-Dec	27-Dec	11-Jan	25-Jan	13-Feb	27-Feb	6-Mar	22-Mar	12-Apr	26-Apr	10-May	24-May
American eel-juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.4	0.1	0.4	0.0	0.4	0.1	0.0	0.0	0.0
Bay anchovy-fertilized egg	341.7	150.2	0.4	0.0	3.2	3.8	0.9	0.1	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.3	64.6
Bay anchovy-post-yolk sac larvae	1.8	2.2	1.0	1.0	2.5	5.8	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Bay anchovy-juvenile	0.8	1.8	0.1	1.4	2.5	0.0	0.8	2.4	1.0	0.1	0.3	0.1	0.1	1.0	0.0	1.5	0.5	0.4	0.9	2.8	3.5	0.4	0.3
Bay anchovy-adult	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.2	0.0	0.3	0.2	10.1	5.1	1.0	0.8	0.0	0.1	0.0	0.1	0.1	0.0	0.0
Bay anchovy-undetermined/damaged	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Anchoa sp.-post-yolk sac larvae	0.0	0.0	0.0	0.0	0.1	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Anchoa sp.-juvenile	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Anchoa sp.-undetermined/damaged	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Atlantic menhaden-fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.0
Atlantic menhaden-post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.1	0.0	0.0	0.0
Atlantic menhaden-juvenile	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.1	1.1	0.7	0.8	3.0	0.0	0.1
Atlantic menhaden-adult	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gizzard shad-post-yolk sac larvae	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blueback herring-juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Clupeidae sp.-yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Clupeidae sp.-post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Clupeidae sp.-juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Clupeidae sp.-adult	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Atlantic silverside-yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	2.2	0.0	0.0
Atlantic silverside-post-yolk sac larvae	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	1.6	6.1	1.5
Atlantic silverside-juvenile	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.9	0.3
Atlantic silverside-adult	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.0	0.1
Inland silverside-post-yolk sac larvae	0.3	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Inland silverside-juvenile	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rough silverside-yolk-sac larvae	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rough silverside-post-yolk sac larvae	0.4	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Atherinopsidae sp.-yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Atherinopsidae sp.-post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Atherinopsidae sp.-juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Skilletfish-post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.1
Skilletfish-juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Northern pipefish-post-yolk sac larvae	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Northern pipefish-juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Centrarchidae -post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Silver perch-post-yolk sac larvae	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spot-post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Spot-juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.1	0.3	0.2	0.0	0.0	0.0	0.0
Atlantic croaker-post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	1.7	0.3	0.9	1.9	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Atlantic croaker-juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.5	1.2	8.5	2.3	0.6	0.3	7.8	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sciaenidae sp-fertilized egg	0.0	0.3	0.0	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Naked goby-juvenile	0.3	14.9	2.8	2.1	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Naked goby-post-yolk sac larvae	7.6	14.1	9.2	8.2	5.5	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.8
Naked goby - undetermined/damaged	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Green goby-juvenile	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Goby sp.-post-yolk sac larvae	9.0	17.0	4.6	4.5	27.3	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	1.9	77.0
Goby sp.-juvenile	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hogchoker-fertilized egg	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hogchoker-post-yolk sac larvae	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hogchoker-juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Summer flounder-post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Summer flounder-juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Undetermined/Damaged eggs	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Undtermined/Damaged fish	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Bivalve-N/A	0.3	0.0	0.0	0.0	0.1	4.3	4.8	1.3	0.4	3.2	5.7	7.8	1.0	12.3	4.6	12.5	44.7	32.1	34.5	300.4	267.9	46.2	3.4
Blue Crab-juvenile	0.0	0.0	0.0	0.1	0.5	1.8	0.1	0.4	0.3	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
Blue Crab-megalop	0.0	0.0	0.0	0.0	0.5	1.4	3.5	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blue Crab-undetermined/damaged	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other crab-megalop	0.0	5.7	3.7	1.2	36.8	71.8	5.2	11.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other crab - zoea	101.0	73.3	187.1	170.5	1996.2	1158.8	49.9	103.8	2.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	97.1	68.8	134.1
Bivalve - young	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shrimp	127.9	21.8	42.8	14.3	68.9	174.1	13.6	115.7	148.0	44.7	62.1	584.4	196.0	6.7	33.6	55.5	182.2	285.0	4988.0	203.0	437.6	2037.0	1130.1

DRAFT Entrainment Characterization Study Plan

Prepared for:
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May 29, 2016

Surry Power Station

Surry, VA 23883

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1 Introduction

1.1 Regulatory Background

Clean Water Act §316(b) was enacted under the 1972 Clean Water Act, which also introduced the National Pollutant Discharge Elimination System (NPDES) permit program. Facilities with NPDES permits are subject to §316(b), which requires that the location, design, construction and capacity of cooling water intake structures (CWIS) reflect best technology available (BTA) for minimizing adverse environmental impacts. Cooling water intakes can cause adverse environmental impacts by drawing early life-stage fish and shellfish into and through cooling water systems (entrainment), or trapping juvenile or adult fish against the screens at the opening of an intake structure (impingement).

On August 15, 2014, the final §316(b) Rule for existing facilities was published in the Federal Register. The Rule applies to existing facilities that withdraw more than 2 million gallons per day (MGD) from Waters of the United States, use at least 25 percent of that water exclusively for cooling purposes, and have or require an NPDES permit. The Rule supersedes the Phase II Rule, which regulated large electrical generating facilities until it was remanded in 2007, and the remanded existing-facility portion of the previously promulgated Phase III Rule.

Facilities subject to the new Rule are required to develop and submit technical material, identified at §122.21(r)(2)-(13), that will be used by the NPDES Director (Director) to make a BTA determination for the facility (Table 1-1). The specific material required to be submitted and compliance schedule are dependent on actual intake flow rates at the facility and NPDES permit renewal date, respectively. Facilities are to submit their §316(b) application material to their Director along with their next permit renewal, unless that permit renewal takes place prior to July 14, 2018, in which case an alternate schedule may be negotiated.

Dominion’s Surry Power Station (SPS) is subject to the existing facility Rule and based on its current configuration and operation is anticipated to be required to develop and submit each of the §122.21(r)(2)-(13) submittal requirements with its next permit renewal in accordance with the Rule’s technical and schedule requirements. Within the §122.21(r)(2)-(13) requirements, (r)(4), (7), (9) and (11) have specific requirements related to entrainment data and evaluations (refer to Table 1-1 for additional detail). This document provides an Entrainment Characterization Study Plan to support §316(b) compliance at the facility with consideration of these specific requirements. Notably, this Entrainment Characterization Study Plan is not explicitly required by the Rule.

Table 1-1. §316(b) Rule for Existing Facilities Submittal Requirements Summary

Submittal Requirements at §122.21(r)		Submittal Descriptions
(2)	Source Water Physical Data	Characterization of the source water body including intake area of influence
(3)	Cooling Water Intake Structure Data	Characterization of cooling water system; includes drawings and narrative; description of operation; water balance
(4)	Source Water Baseline Biological Characterization data	Characterization of biological community in the vicinity of the intake; life history summaries; susceptibility to impingement and entrainment; must include existing data; identification of missing data; threatened and endangered species and designated critical habitat summary for action area; identifies fragile fish and shellfish species list (<30 percent impingement survival)
(5)	Cooling Water System Data	Narrative description of cooling water system and intake structure; proportion of design flow used; water reuse summary; proportion of source water body withdrawn (monthly); seasonal operation summary; existing impingement mortality and entrainment reduction measures; flow/MW efficiency
(6)	Chosen Method of Compliance with Impingement Mortality Standard	Provides facility's proposed approach to meet the impingement mortality requirement (chosen from seven available options); provides detailed study plan for monitoring compliance, if required by selected compliance option; addresses entrapment where required
(7)	Entrainment Performance studies	Provides summary of relevant entrainment studies (latent mortality, technology efficacy); can be from the facility or elsewhere with justification; studies should not be more than 10 years old without justification; new studies are not required.
(8)	Operational Status	Provides operational status for each unit; age and capacity utilizations for the past five years; upgrades within last 15 years; uprates and Nuclear Regulatory Committee relicensing status for nuclear facilities; decommissioning and replacement plans; current and future operation as it relates to actual and design intake flow
(9)	Entrainment Characterization Study	Requires at least two years of data to sufficiently characterize annual, seasonal, and diel variations in entrainment, including variations related to climate, weather, spawning, feeding, and water column migration; facilities may use historical data that are representative of current operation of the facility and conditions at the site with documentation regarding the continued relevance of the data to document total entrainment and entrainment mortality; includes identifications to the lowest taxon possible; data must be representative of each intake; must document how the location of the intake in the water body and water column are accounted for; must document intake flows associated with the data collection; documentation in the study must include the method in which latent mortality would be identified (including QAQC); sampling and data must be appropriate for a quantitative survey
(10)	Comprehensive Technical Feasibility & Cost Evaluation Study	Provides an evaluation of technical feasibility and incremental costs of entrainment technologies; Net Present Value of facility compliance costs and social costs to be provided; requires peer review
(11)	Benefits Valuation Study	Provides a discussion of monetized and non-monetized water quality benefits of candidate entrainment technologies from (r)(10) using data in (r)(9); benefits to be quantified physical or biological units and monetized using appropriate economic valuation methods; includes changes in fish stock and harvest levels and description of monetization; must evaluate thermal discharges, facility capacity, operations, and reliability; discussion of previous mitigation efforts and affects; benefits to environment and community; social benefits analysis based on principle of willingness-to-pay; requires peer review
(12)	Non-Water Quality Environmental and Other Impacts Assessment	Provides a discussion of non-water quality factors (air emissions and their health and environmental impacts, energy penalty, thermal discharge, noise, safety, grid reliability, consumptive water use, etc.) attributable to the entrainment technologies; requires peer review
(13)	Peer Review	Documentation of external peer review, by qualified experts, of submittals (r) (10), (11), and (12). Peer Reviews must be approved by the NPDES Director and present their credentials. The applicant must explain why it disregarded any significant peer reviewer recommendations.

1.2 Study Plan Objectives and Document Organization

The Entrainment Characterization Study Plan provided in this report was developed to create a site-specific entrainment study plan that meets and exceeds the requirements of the §316(b) Rule with the following key objectives in mind:

1. Collect data to supplement the submission of data required under §122.21(r)(4), including a list of species and life stages most susceptible to entrainment at the facility[1];
2. Collect data to support development of §122.21(r)(7) which allows for summaries of relevant technology efficacy studies conducted at the facility[2];
3. Collect data to support development of §122.21(r)(9) which requires at least two years of entrainment studies be conducted at the facility;
4. Collect data to support Dominion's objective of having data sufficient to evaluate biological efficacy of potential alternative intake technologies that may require site specific evaluation at the facility as a part of the §122.21(r)(10)-(13) compliance evaluations.

To meet these objectives, this document provides summaries of the station's configuration and operations (Section 2), historical biological sampling efforts conducted at the facility that are relevant to cooling water intake evaluations (Section 3), a summary of Threatened and Endangered Species identified in the vicinity of the facility (Section 4), a sampling program design justification based on this information (Section 5), and the recommended study methods including key parameters of gear, schedule, frequency, and quality control procedures (Section 6).

2 Generating Station Description

2.1 Site and Environmental Description

The two nuclear power-generating units at SPS use a once-through cooling water system. Cooling water for both units is withdrawn from the James River through a common Low-level CWIS oriented parallel to, and flush with, the western shore of the James River. SPS is located on the estuarine portion of the James River on the Hog Island peninsula in Surry County Virginia, approximately 25 miles upstream of the river's confluence with the Chesapeake Bay (Figure 2-1). SPS is located approximately 44 miles southeast of Richmond and 9 miles south of Williamsburg. The SPS Low-level CWIS for the two units is located on the east side of the peninsula (Figure 2-2).

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[1] 40 C.F.R. §122.21(r)(4) requires applicant to submit available Source Water Baseline Biological Characterization data.

[2] SPS is expected to reduce entrainment at the facility due to at least the following factors: 1) the 1/8-inch by 1/2-inch Ristroph screens with fish return, and 2) flow reduction relative to design flow (e.g., reduced winter pumping and unit outages). This study plan will collect data to support calculation of these and potentially other entrainment reduction attributes at the facility.

Map Source: USGS Topographic Map of Williamsburg, VA; Map ID #37076-A1-TB-100 (1984)

Figure 2-1. Surry Power Station Regional Location Map

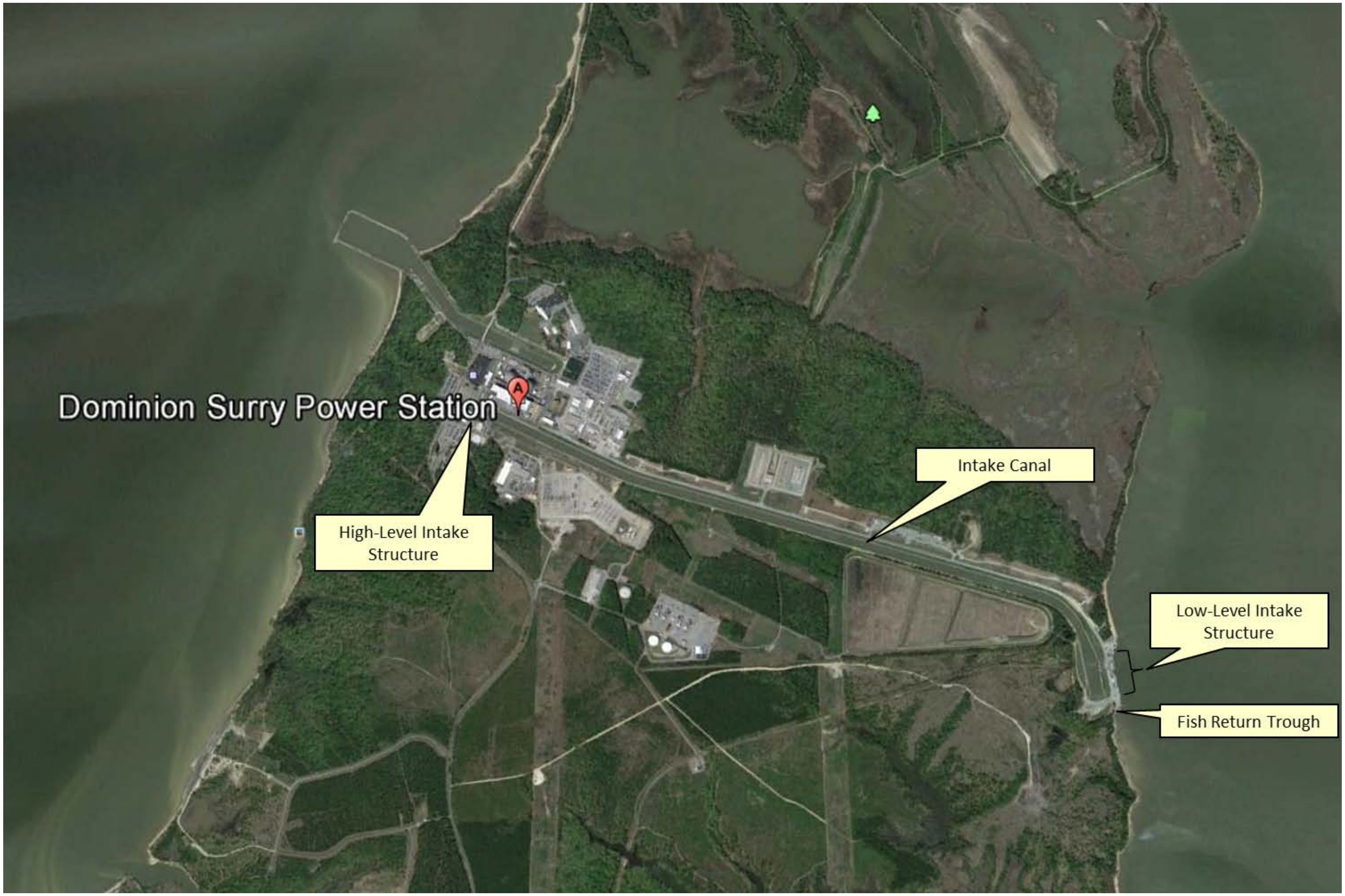
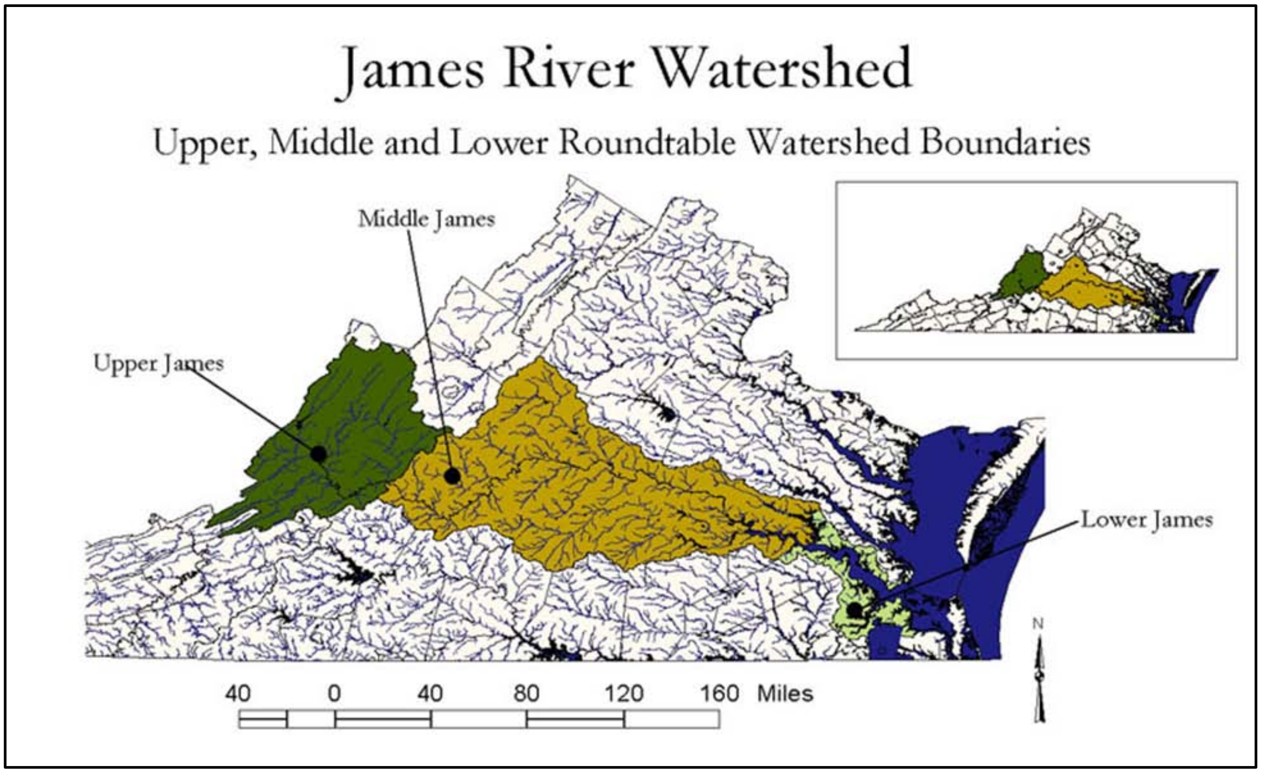


Image Source: Google Earth Retrieved September 8, 2014

Figure 2-2. Aerial View of Surry Power Station

The James River watershed encompasses approximately 10,000 square miles, which makes up almost 25 percent of the state. The James River watershed covers about one-third of the Chesapeake Bay drainage area in Virginia. The river flows approximately 340 miles from the Alleghany Mountains of western Virginia to the Chesapeake Bay. The watershed is comprised of three sections: the Upper James watershed begins in Allegheny County and travels through the Allegheny and Blue Ridge Mountains until Lynchburg, the Middle James watershed runs from Lynchburg to Richmond, while the Lower James watershed stretches from Richmond to the Chesapeake Bay (Figure 2-3).



Source: Middle James Roundtable

Figure 2-3. The James River Watershed

SPS is located on the Lower James River section in the Coastal Uplands Physiographic Province. The James River is approximately 3 miles wide at the SPS location. The land surface is generally flat with steep banks sloping down to the river. Land surface elevations at SPS range from sea level to approximately elevation (EL.) +39 feet. Water elevations at SPS are affected by tides with a mean low tide water level of EL. -1.0 foot and a high tide level of EL. 1.1 feet, resulting in a mean tidal range of 2.1 feet and a mean spring tidal range of 2.5 feet. The average water depth in front of the SPS intakes is 26 feet deep. The average maximum ebb and flood tidal currents at SPS are 2.23 ft/s (0.68 m/s) and 1.90 ft/s (0.58 m/s), respectively. The maximum James River flow at the site is approximately 420,000 cubic feet per second (cfs), with a monthly mean range of 857 cfs to 39,778 cfs.

A navigation channel is maintained at 24.9 feet and generally courses through the middle of the river. In the vicinity of the SPS CWIS, the river has an abbreviated littoral or shoreline zone as a result of steep bank elevations and the channelized river bottom. The river bed in the vicinity of

SPS is composed of soft mud, clay, sand, and pebbles with no single bottom type predominating. General river depths in the region of SPS are provided in the navigational chart provided in Figure 2-4.

Salinity concentrations in the James River in the vicinity of SPS characterize the area as the transition region between salt and freshwater. Depending primarily on river discharge, salinity concentrations in the vicinity of SPS can range from 0 ppt to approximately 21 ppt. Despite the large range in salinity covering several salinity zone classifications, for the purposes of this report an oligohaline zone classification (salinity range 0.5-5.0 ppt) is considered representative. River temperatures in the vicinity of the station ranged from 1.8 °C to 33.8 °C, during 1975-1976 (VEPCO 1977).

2.2 Station Description

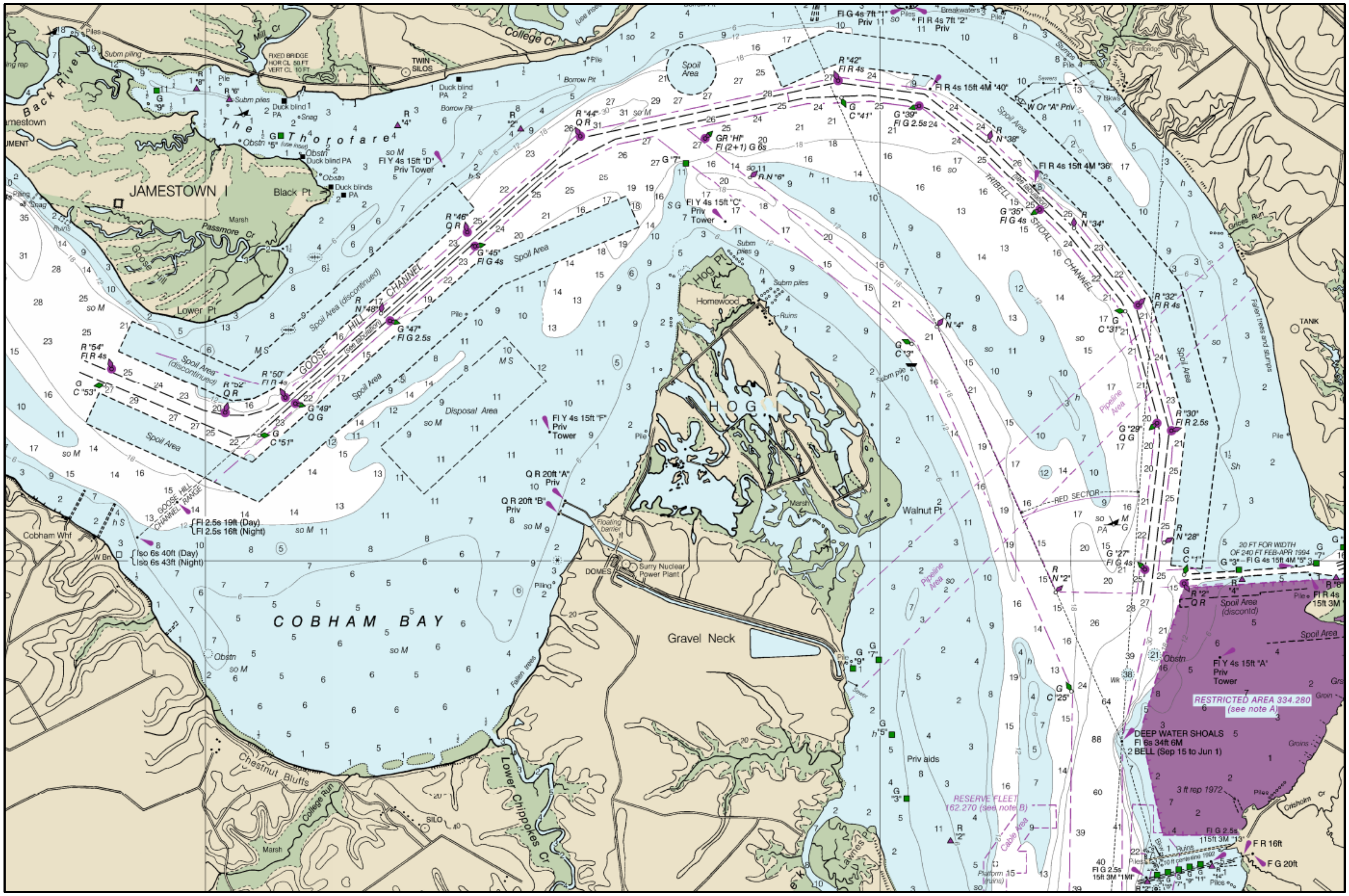
2.2.1 Station Operational History

SPS is a base-load facility which means the facility serves as one of Dominion's primary means of generating the minimum amount of power necessary to meet customer demands. Accordingly, the facility generally operates twenty-four hours per day, seven days per week, although there is seasonal variation in its operations and maintenance. In the summer months, all pumps are in operation to meet thermal transfer requirements. Generally, in the winter not all eight circulating water pumps operate. Maintenance outages on the generating units are scheduled at regular intervals. The duration of the maintenance outages depends on the type of outage and the scheduled work that needs to be done on the units.

2.2.2 Intake Structure

The two nuclear power-generating units at SPS use a once-through cooling water system. When the facility is generating power, the circulating cooling water system is in operation. Cooling water for both units is withdrawn from the James River through a common Low-level CWIS oriented parallel to, and flush with, the western shore of the James River (Figure 2-5). The total design flow at SPS with all pumps working to capacity is approximately 2,535 million gallons per day (MGD) [i.e., 3,922 cfs] to meet the water requirements of the power station. Approximately 95 percent of the flow withdrawn from the James River is used for cooling water purposes. The remaining water withdrawn is used in the sluice, seals, and screen wash.

At the Low-level CWIS, the James River is approximately 3 miles wide and 26 feet deep and flows in a generally southerly direction. The Low-level CWIS consists of eight screen bays and is equipped with eight Ristroph traveling water screens. Eight circulating water pumps, located downstream of each low-level screen, convey screened water flow to a common high-level intake canal for both units. Water flows down the high-level intake canal to a secondary screen house at the facility with conventional traveling water screens.



Source: NOAA Office of Coast Survey Chart 12248 (noaa.gov) Retrieved September 7, 2014

Figure 2-4. General River Depths in the Vicinity of Surry Power Station (Soundings in Feet at Mean Lower Low Water)

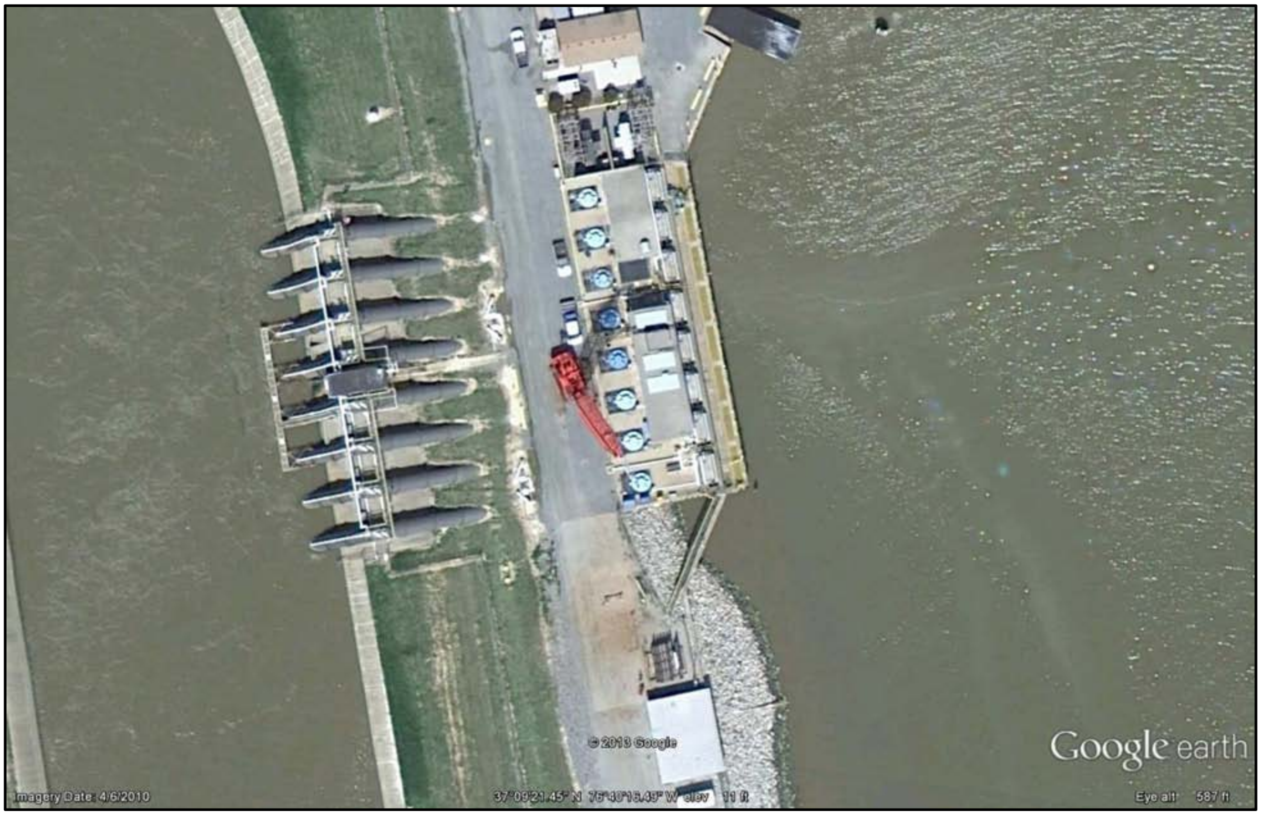
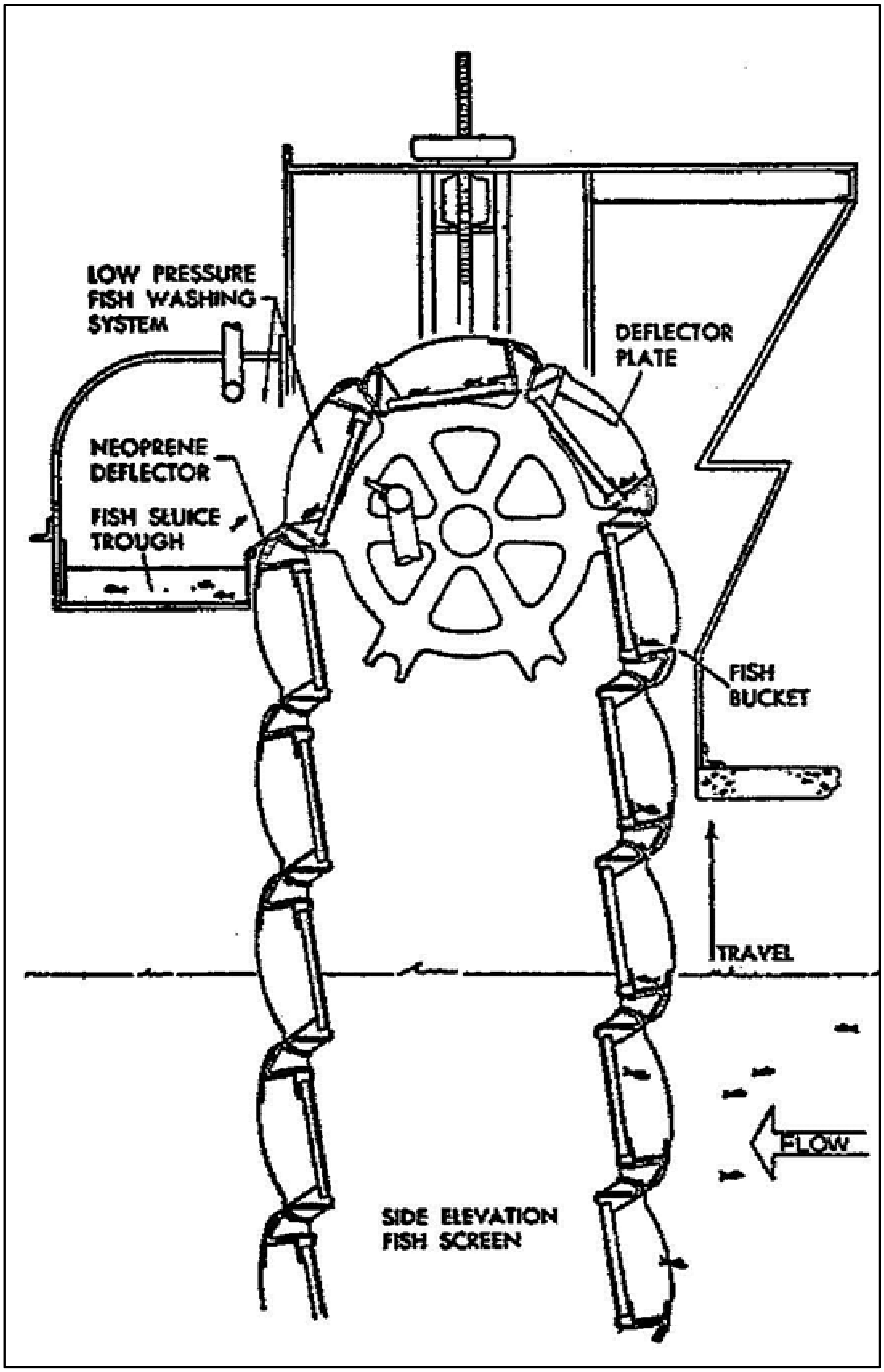


Figure 2-5. Surry Power Station Low-level Cooling Water Intake Structure Location (37˚09'22" N, 76˚40'16" W)

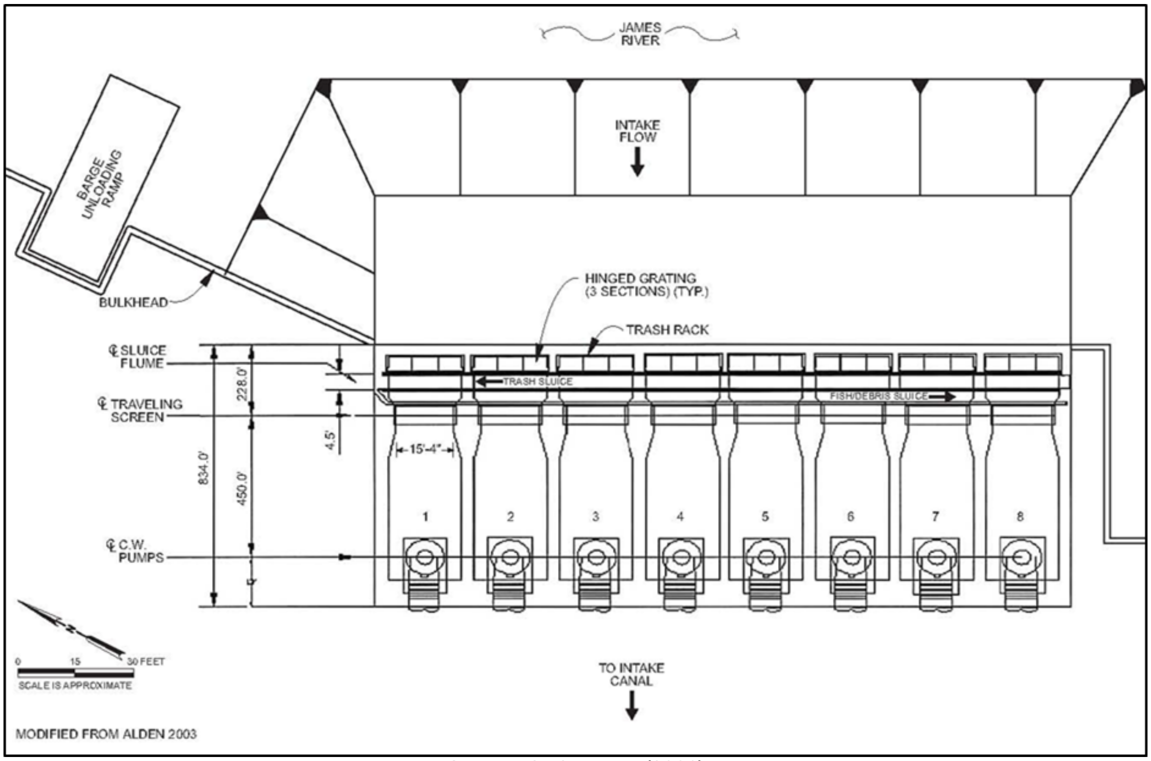
Trash racks extend across each of the eight intake bays to prevent debris from entering the Low-level intakes. Each trash rack has 1/2-inch-wide fiberglass reinforced plastic bars with 4.0-inch spacing, providing a 3.5-inch clear opening. The trash racks have a 1H:12V slope and are 18 feet wide. A curtain wall extends down to El. -8.5 feet, approximately 3.8 feet below the minimum water level, approximately 6 feet downstream of each trash rack. The intake contains eight screen bays (15.3 feet wide), equipped with Ristroph traveling water screens (See Figure 2-6) located approximately 17 feet downstream from the bottom of each trash rack. The Low-level CWIS is the §316(b) compliance point at SPS. Plan and section drawings of the Low-level CWIS are provided on Figures 2-7 and 2-8, respectively.

The screens at SPS have been modified substantially from their original design. Prior to 1974, SPS had conventional traveling screens at the high-level intake structure and no screens at the Low-level intake structure. Starting in 1974, the Low-level intake was fitted with Ristroph traveling water screens to maximize fish impingement survival potential. These Ristroph traveling water screens contained 2 foot-high and 14 foot-wide baskets with 3/8-inch [0.146 square inch (in^2)] square mesh openings.



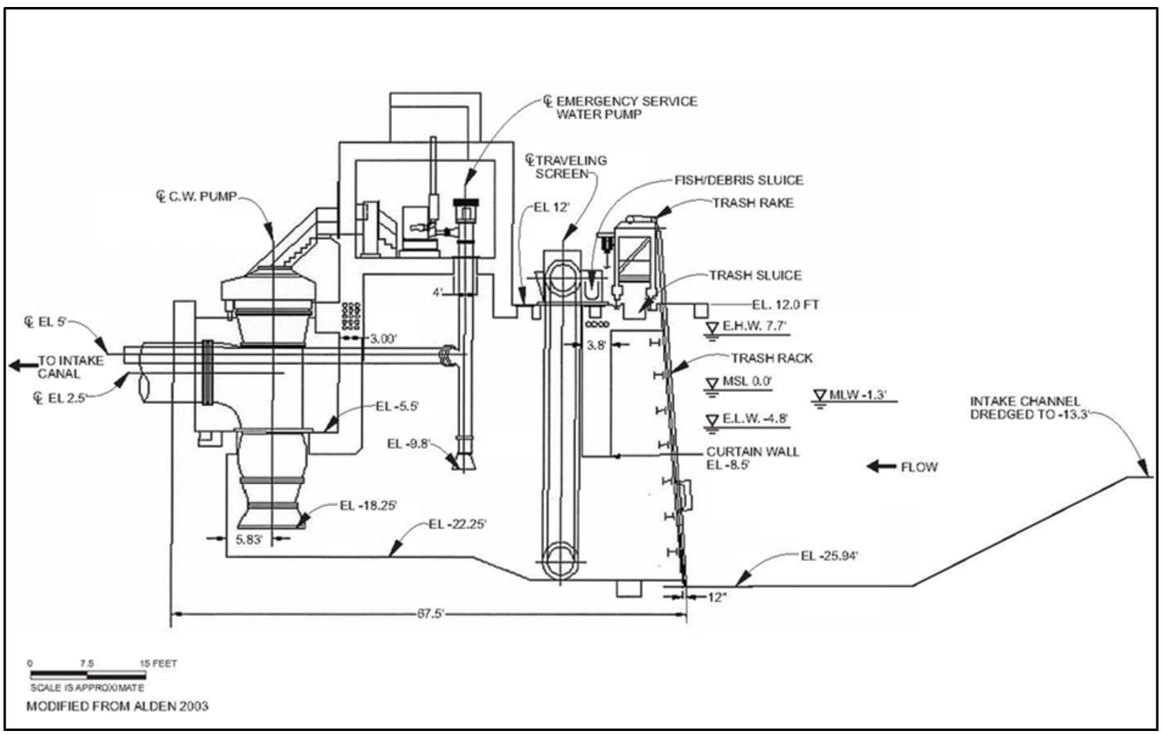
Source: VEPCO (1980)

Figure 2-6. Details of Surry Power Station Ristroph Traveling Water Screen at Low-level CWIS



Source: CH2M HILL (2006)

Figure 2-7. Plan View of Surry Power Station Low-level Cooling Water Intake Structure



Source: CH2M HILL (2006)

Figure 2-8. Typical Section View of Surry Power Station Low-level Cooling Water Intake Structure

In the early 1990s, the original Ristroph traveling water screens were modified to include 1/8-inch by 1/2-inch rectangular mesh openings. Each screen basket has a 2 inch-deep by 5.5 inch-wide steel fish bucket. The screens are designed for continuous operation and can rotate at a slow speed (approximately 5 feet per minute (ft/min)) or a fast speed (approximately 10 ft/min) in a manual mode. At times of high fish abundance or low river levels, the screens can be rotated at fast speed, reducing impingement time to approximately 1.5 minutes or less.

The outside spray wash has 12 spray nozzles. A single return trough located upstream of the screens transports organisms and debris back to the river approximately 1,000 feet south (downstream) of the intake structure and approximately 300 feet from the shore. Transported organisms are therefore discharged away from the hydrodynamic zone of influence of the Low-level CWIS.

3 Historical Studies

Past fisheries studies conducted at SPS which are pertinent to §316(b) include the following:

- June 2005 – May 2006 entrainment studies (EA 2007)
- May 1974 to May 1983 impingement studies (CH2M HILL 2006)
- September 2005 – June 2006 adult and juvenile finfish sampled by beach seine and otter trawl (EA 2007)
- June 2005 – May 2006 ambient ichthyoplankton studies (EA 2007)
- 1970 – 1978 adult and juvenile finfish sampled by haul seine and otter trawl (VEPCO 1980)

For the purposes of development of this Study Plan, the June 2005 – May 2006 entrainment study and ambient ichthyoplankton studies (EA 2007) are summarized in the sub-sections below.

3.1 Entrainment Study, 2005-2006

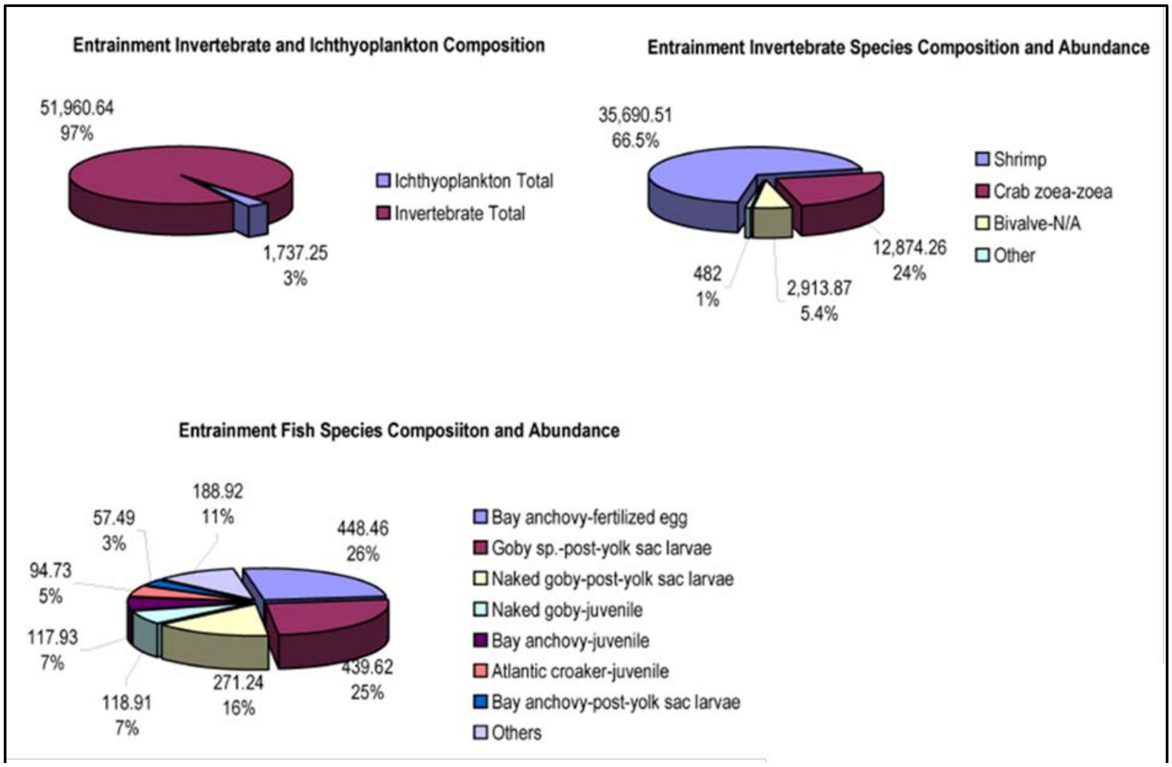
Entrainment data were collected at SPS from June 2005 through May 2006 as a part of a series of studies conducted to meet the requirements of the §316(b) Phase II Rule. Entrainment samples were collected in front of the SPS Low-level CWIS using paired conical plankton nets deployed from a boat. A total of 46 ichthyoplankton taxa were identified in the 24 entrainment samples. The studies were conducted bi-monthly and included four sample periods in 24 hours. Details of June 2005 – May 2006 entrainment sampling program are presented in Table 3-1.

Table 3-1. Surry Power Station June 2005 – May 2006 Entrainment Sampling Methods Summary

Entrainment	Details
Units Sampled	Units 1 and 2
Sampling Location	In front of SPS Low-level CWIS
Surveys from June 2005 to May 2006	2 surveys per month for 12 months
Daily Collection Schedule	Every 6 hours in a 24-hr period (4 collections / 24-hr period) centered around 1000, 1600, 2200 and 0400 hours
Depths Sampled	Near surface, mid-depth and near bottom
Number of Samples Collected per Depth	2 samples per depth using paired bongo nets (duplicate samples at each depth)
Sample Duration	10 minutes
Sampling Gear	0.5-m diameter mouth plankton nets constructed of 505-µm mesh netting, each affixed in a double-net bongo frame; General Oceanics 2030R or 2030R6 (low flow) mechanical flowmeter suspended in the mouth of each net
Water Quality Measurements	Temperature, dissolved oxygen, pH, and conductivity measured with YSI Model 556 water quality analyzer at mid-depth during each entrainment sampling event

Young life stages of invertebrates comprised approximately 97 percent of the total entrainment, while finfish comprised approximately 3 percent of the total entrainment (Figure 3-1). The finfish component of the entrainment data was represented primarily by Goby sp. larvae, Bay Anchovy egg, Naked Goby larvae, Bay Anchovy juvenile/adult, Naked Goby juvenile, Atlantic Croaker juvenile and Atlantic Silverside larvae, which accounted for approximately 91 percent of the finfish component and approximately 3 percent of the entrainment total. Percent composition of fish and shellfish entrained at SPS during 2005 – 2006 is shown Figure 3-1.

Average monthly density for the most commonly entrained finfish species are presented in Table 3-2. The entrained ichthyoplankton was largely comprised of Bay Anchovy eggs and Goby sp. larvae and which were most often entrained in May to July.



Source: CH2M HILL (2006)

Figure 3-1. Percent Entrainment of Fish and Shellfish at Surry Power Station, 2005 – 2006

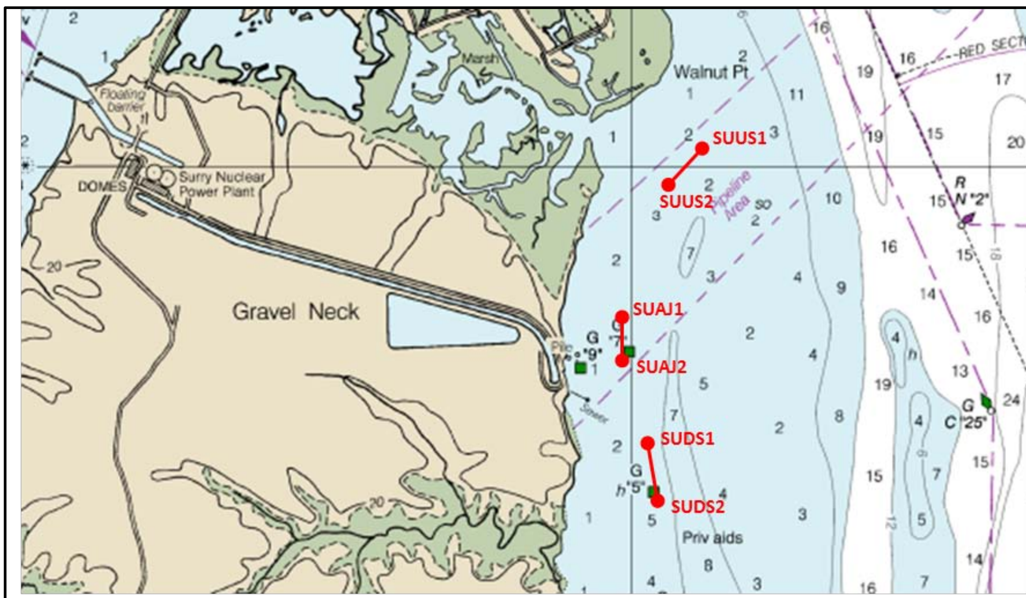
Table 3-2. Average Monthly Density (No./100m^3) of Common Species of Ichthyoplankton and Shellfish Entrained at Surry Power Station, 2005 – 2006

Species/Taxon	Life Stage	2005							2006				
		Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Atlantic Croaker	juvenile	0.00	0.00	0.00	0.35	1.04	3.42	4.73	21.27	1.50	0.27	0.12	0.00
Atlantic Croaker	larvae	0.00	0.00	0.11	0.77	2.16	0.00	2.77	0.00	0.08	0.00	0.00	0.00
Atlantic Silverside	juvenile	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00
Atlantic Silverside	larvae	0.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.16	6.35
Bay Anchovy	juvenile/adult	8.80	8.10	3.96	6.78	1.58	0.43	1.26	10.21	3.32	4.31	2.51	0.00
Bay Anchovy	egg	89.18	7.19	7.50	0.55	1.38	0.00	0.00	0.00	0.00	0.00	0.00	27.67
Bay Anchovy	larvae	4.32	2.61	10.30	0.66	0.00	0.00	0.12	0.59	0.19	0.00	0.00	0.55
Blue Crab	juvenile	0.00	0.00	1.85	1.79	2.78	0.56	0.00	0.00	0.00	0.00	0.00	0.00
Blue Crab	megalopae	0.00	0.00	2.22	9.45	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Goby sp.	larvae	37.50	31.54	13.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	63.95
Naked Goby	juvenile	21.05	25.31	3.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Naked Goby	larvae	31.75	57.14	8.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Source: Table 4 of EA 2007													

3.2 Ambient Ichthyoplankton Bongo Net Sampling, 2005-2006

Ambient ichthyoplankton sampling conducted on a bimonthly basis June 2005 - May 2006 provided additional information on larval fish and pelagic invertebrates. The James River upstream, downstream, and adjacent to the intake was sampled at 0400, 1000, 1600 and 2200 hours on a bi-weekly basis (Figure 3-2). These samples were collected with a single ½-meter diameter plankton net consisting of 505 µm mesh netting and a General Oceanic 2030R flowmeter affixed in the net mouth. Stepped-oblique tows were made at mid-depth for 4.5 minutes against the prevailing tide.

Only six taxa were collected in ambient ichthyoplankton samples conducted during June 2005 - May 2006. These were, in order of abundance, Bay Anchovy eggs, Naked Goby larvae/adults, Bay Anchovy larvae/juvenile/adults, Atlantic Croaker juveniles, Atlantic Silverside larvae/juvenile/adults and Blue Crab megalopae (Table 3-3). Higher densities of most ichthyoplankton species were found in the entrainment samples rather than ambient river samples, with the exception of Bay Anchovy eggs, dominant in June 2005 (See Table 3-4.) The reason for the higher abundance of entrainment numbers versus ambient numbers is not known, but may be related to a patchy distribution of organisms.



Map Source: NOAA Coast Survey Chart of James River, Newport News to Jamestown Island (8/30/2014); Map #12248, Retrieved September 8, 2014

Note: Tow tracks shown as red lines with red dots marking either end.
Endpoints designated as: SUUS1 (Upstream), SUUS2 (Upstream);
SUAJ1 (Adjacent), SUAJ2 (Adjacent);
SUDS1 (Downstream), SUDS2 (Downstream)

Figure 3-2. Ambient Ichthyoplankton Sampling Locations near Surry Power Station, 2005 – 2006

Table 3-3. Density (No./m^3) of Ichthyoplankton and Blue Crab Larvae in the Ambient James River near Surry Power Station, June 2005 – May 2006

Sample Date	Atlantic Croaker	Atlantic Silverside	Bay Anchovy	Bay Anchovy	Naked Goby	Blue Crab
	juvenile	larvae/juvenile/ adult	egg	larvae/juvenile/ adult	larvae/ juvenile	megalopae
06/23/05	0.0	1.5	341.7	2.9	16.8	0.0
06/29/05	0.0	0.2	150.2	3.8	29.0	0.0
07/13/05	0.0	0.0	0.4	1.1	12.0	0.0
07/28/05	0.0	0.0	0.0	2.4	10.3	0.0
08/10/05	0.0	0.0	3.2	5.0	7.1	0.5
08/24/05	0.0	0.0	3.8	5.9	0.9	1.4
09/14/05	0.0	0.0	0.9	0.8	0.0	3.5
09/28/05	1.4	0.0	0.1	2.8	0.0	0.0
10/12/05	0.5	0.0	1.2	1.3	0.0	0.1
10/26/05	1.2	0.2	0.0	0.1	0.0	0.1
11/29/05	8.5	0.0	0.0	0.5	0.0	0.0
12/12/05	2.3	0.0	0.0	0.5	0.0	0.0
12/27/05	0.6	0.0	0.0	10.3	0.0	0.0
01/11/06	0.3	0.0	0.0	9.1	0.0	0.0
01/25/06	7.8	0.0	0.0	1.0	0.0	0.0
02/13/06	0.7	0.4	0.0	2.3	0.0	0.0
02/27/06	0.0	0.0	0.0	0.5	0.0	0.0
03/08/06	0.0	0.0	0.0	0.5	0.0	0.0
03/22/06	0.0	0.1	0.0	0.9	0.0	0.0
04/12/06	0.0	3.8	0.0	2.9	0.0	0.0
04/26/06	0.0	4.0	0.5	3.6	0.0	0.0
05/10/06	0.0	7.1	1.3	0.5	0.0	0.0
05/24/06	0.0	1.9	64.6	0.3	5.8	0.0

Source: Table 11 of EA 2007

Table 3-4. Density (No./m^3) of Ichthyoplankton and Blue Crab Larvae Entrained at Surry Power Station, June 2005 – May 2006

Sample Date	Atlantic Croaker	Atlantic Silverside	Bay Anchovy	Bay Anchovy	Naked Goby	Blue Crab
	juvenile	larvae/juvenile/ adult	egg	larvae/juvenile/ adult	larvae/ juvenile	megalopae
06/23/05	0.0	1.9	167.9	16.0	36.3	0.0
06/29/05	0.0	0.0	10.5	10.3	69.0	0.0
07/13/05	0.0	0.0	7.1	10.7	45.7	0.0
07/28/05	0.0	0.0	7.3	10.8	131.4	0.0
08/10/05	0.0	0.0	2.3	11.0	22.5	1.1
08/24/05	0.0	0.0	12.7	17.5	2.2	3.4
09/14/05	0.3	0.0	0.0	14.1	0.0	28.3
09/28/05	0.4	0.0	0.8	4.1	0.0	0.0
10/12/05	1.4	0.0	1.4	2.3	0.0	0.2
10/26/05	0.7	0.0	1.4	0.8	0.0	0.0
11/29/05	3.4	0.0	0.0	0.4	0.0	0.0
12/12/05	7.4	0.0	0.0	2.1	0.0	0.0
12/27/05	2.0	0.0	0.0	0.7	0.0	0.0
01/11/06	2.0	0.0	0.0	0.6	0.0	0.0
01/25/06	40.6	0.0	0.0	21.0	0.0	0.0
02/13/06	1.6	0.0	0.0	2.5	0.0	0.0
02/27/06	1.4	0.0	0.0	4.6	0.0	0.0
03/08/06	0.4	0.0	0.0	2.5	0.0	0.0
03/22/06	0.2	0.0	0.0	6.1	0.0	0.0
04/12/06	0.2	4.9	0.0	5.0	0.0	0.0
04/26/06	0.0	25.9	0.0	0.0	0.0	0.0
05/10/06	0.0	8.5	4.7	0.5	0.0	0.0
05/24/06	0.0	2.6	50.6	0.6	0.0	0.0

Source: Table 10 of EA 2007

4 Threatened and Endangered Species

The EPA consulted with the US Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) (or collectively, Services) under the Endangered Species Act (ESA) during development of the existing facilities §316(b) Rule. The Services concluded that the Rule is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat. Among other requirements, §122.21(r)(4) requires that facilities submit, to the extent such data is available, "*a list of species (or relevant taxa) for all life stages and their relative abundance in the vicinity of the cooling water intake structure*" and identify "*all threatened, endangered, and other protected species that might be susceptible to impingement and entrainment at your cooling water intake structure.*" In addition, §122.21(r)(9) requires facilities to develop an Entrainment Characterization Study "that includes a minimum of two years of entrainment data collection." The text below provides a review of listed species associated with SPS to support compliance with these provisions and development of this Entrainment Characterization Study Plan.

The Virginia Fish and Wildlife Information Service (VAFWIS) database, managed by the Virginia Department of Game and Inland Fisheries (VDGIF) and the USFWS Information, Planning, and Conservation System were consulted on August 20, 2014 to develop a list of Federal and state of Virginia endangered and threatened species known or likely to occur within a 2-mile radius of SPS (See Table 4-1)[3]. Additionally, the complete list of threatened and endangered species that occur in the state of Virginia (USFWS 2014) was reviewed and compared against the list of threatened and endangered species under NMFS jurisdiction (NMFS 2014) to confirm that NMFS species were not omitted from the list. A review of scientific literature and other documents was also conducted, including a NMFS Biological Opinion and Letter of Concurrence for projects proposed to occur near the vicinity of the CWIS; those documents were used to confirm that marine species under the jurisdiction of NMFS were appropriately considered. Additionally, for each species with the potential to occur in the vicinity of the CWIS, the USFWS or NMFS species profile was reviewed to confirm that no critical habitat was designated. A review of the following resources was used to develop the species list in Table 4-1.

- VAFWIS (http://vafwis.org/fwis/)
- IPAC (http://ecos.fws.gov/ipac/)
- USFWS Listings and Occurrence for Virginia (http://ecos.fws.gov/tess_public/pub/stateListingAndOccurrenceIndividual.jsp?state=VA&s8fid=112761032792&s8fid=112762573902)
- Endangered and Threatened Species Under NMFS' Jurisdiction (http://www.nmfs.noaa.gov/pr/species/esa/listed.htm)

[3] Using the VAFWIS, the minimum radius that can be screened for is a 2-mile radius from the center of the power station. There is no determination that species found within a 2-mile radius of SPS are susceptible to entrainment. Similarly, the occurrence of a species on the Service's Information, Planning, and Conservation System, which provides a search area encompassing both terrestrial and aquatic habitats, does not necessarily indicate that the species is likely to be present in the source water body.

Table 4-1. Federal and State Threatened, Endangered, and Proposed Species with the Potential to Occur within 2 miles of the Cooling Water Intake of Surry Power Station

Common Name	Scientific Name	Status*	Tier**	Potential to Occur within 2 miles of the Intake	Potential for Entrainment of Early Life Stages
FISH					
Atlantic Sturgeon[a]	*Acipenser oxyrinchus*	FE, SE	II	Improbable	Highly improbable
Blackbanded Sunfish[a]	*Enneacanthus chaetodon*	SE	I	No - Freshwater species only known to exist in the Chowan River drainage[c]	No
REPTILES					
Kemp's Ridley Sea Turtle[a]	*Lepidochelys kempii*	FE, SE	–	Improbable - may be present near the confluence of the James River[d]	No
Leatherback Sea Turtle[a]	*Dermochelys coriacea*	FE, SE	–	Improbable - may be present near the confluence of the James River[d]	No
Loggerhead Sea Turtle[a]	*Caretta caretta*	FT, ST	I	Improbable - may be present near the confluence of the James River[d]	No
Eastern Chicken Turtle[a]	*Deirochelys reticularia reticularia*	SE	I	No - interdunal ponds and sinkhole complexes that experience seasonal water fluctuations[e]	No
Canebrake Rattlesnake[a]	*Crotalus horridus*	SE	II	No – terrestrial	No
AMPHIBIANS					
Eastern Tiger Salamander[a]	*Ambystoma tigrinum*	SE	II	No - aquatic habitats include ditches, vernal ponds, and rarely, sluggish streams[f]	No
Mabee's Salamander[a]	*Ambystoma mabeei*	ST	II	No - fish-free vernal ponds or ephemeral coastal plain sinkholes up to 1.5 meters deep, with surrounding forests[g]	No
Barking Treefrog[a]	*Hyla gratiosa*	ST	II	No - breeds in cypress ponds and bays, and in pine barren ponds; open canopied ponds; all Virginia breeding sites were found in graminoid dominated temporary ponds[h].	No

Common Name	Scientific Name	Status*	Tier**	Potential to Occur within 2 miles of the Intake	Potential for Entrainment of Early Life Stages
BIRDS					
Red Cockaded Woodpecker[a]	*Picoides borealis*	FE, SE	I	No – terrestrial	No
Piping Plover[a]	*Charadrius melodus*	FT, ST	I	No – terrestrial	No
Red Knot[a]	*Calidris canutus rufa*	FP	IV	No – terrestrial	No
Black Rail[a]	*Laterallus jamaicensis*	SE	I	No – terrestrial	No
Peregrine Falcon[a]	*Falco peregrinus*	ST	I	No – terrestrial	No
Upland Sandpiper[a]	*Bartramia longicauda*	ST	I	No – terrestrial	No
Loggerhead Shrike[a]	*Lanius ludovicianus*	ST	I	No – terrestrial	No
Henslow's Sparrow[a]	*Ammodramus henslowii*	ST	I	No – terrestrial	No
Migrant Loggerhead Shrike[a]	*Lanius ludovicianus migrans*	ST	–	No – terrestrial	No
MAMMALS					
Northern Long-Eared Bat[a]	*Myotis septentrionalis*	FP	–	No – terrestrial	No
Rafinesque's Eastern Big-eared Bat[a]	*Corynorhinus rafinesquii macrotis*	SE	I	No – terrestrial	No
Southeastern Dismal Swamp Shrew[a]	*Sorex longirostris fisheri*	ST	IV	No - associated with a heavy ground cover; can be found in all successional stages from grassy openings to closed forests, generally in moist to wet areas in or bordering swamps, marshes, or rivers.[j]	No

Common Name	Scientific Name	Status*	Tier**	Potential to Occur within 2 miles of the Intake	Potential for Entrainment of Early Life Stages
PLANTS					
Sensitive Joint-Vetch[b]	*Aeschynomene virginica*	FT	–	No - typically grows in the intertidal zone of coastal marshes[i]	No
Status*		**Tier** for State-listed Species**			
FE= Federally Endangered FT= Federally Threatened SE= State Endangered ST= State Threatened FP= Federally Proposed		I=VA Wildlife Action Plan - Tier I – Critical Conservation Need; II=VA Wildlife Action Plan - Tier II - Very High Conservation Need; III=VA Wildlife Action Plan - Tier III - High Conservation Need; IV=VA Wildlife Action Plan - Tier IV - Moderate Conservation Need			
Source:					
[a]Virginia Department of Game and Inland Fisheries; Fish and Wildlife Information Service [b]U.S. Fish and Wildlife Service; Information, Planning, and Conservation System [c]Kercher 2006, [d]VDGIF 2014a, [e]VDGIF 2014b, [f]VDGIF 2014c, [g]VDGIF 2014d, [h]VDGIF 2014e, and [i]USFWS 2012					

- Biological Opinion of James River Federal Navigation Project: Tribell Shoal Channel to Richmond Harbor in Surry, James City, Prince George, Charles City, Henrico, and Chesterfield Counties and the Cities of Richmond and Hopewell, Virginia (FINER/2012/01183).
- Letter of concurrence, from Mr. D.M. Morris, NMFS, to Ms. Amy Hull, Nuclear Regulatory Commission that continued operation Surry Nuclear Power Station, Units 1 and 2 is not likely to adversely affect species listed by NMFS.
- USFWS or NMFS Species Profile (http://www.fws.gov/endangered/, or http://www.nmfs.noaa.gov/pr/species/esa/listed.htm)

Note that only Federal and State threatened and endangered species were included in Table 4-1. Federal species of concern and candidate species were omitted from the list (unless they were also State Threatened or Endangered), because there are no requirements to address those species under Section 7 of the ESA.

The majority of the species in Table 4-1 are terrestrial species or occur in habitats that are not in the vicinity of the SPS CWIS and thus would not be subject to entrainment or impingement at the facility. Additional literature was reviewed to identify aquatic species that do not occur near the CWIS and thus should be eliminated from further consideration; these documents are cited in Table 4-1.

Kemp’s Ridley (endangered), Leatherback (endangered), and Loggerhead (threatened) Sea Turtles occur seasonally in Chesapeake Bay and may be present and forage near the confluence of the James River near Hampton Roads and Portsmouth, Virginia. However, the facility is approximately 25 miles upstream of where sea turtles are expected to occur (NMFS 2012a, NMFS 2012a). At the vicinity of the facility, the James River is classified as oligohaline with salinities ranging from 0.5-5.0 ppt, considered representative. This salinity range does not support sea turtle habitat or their forage base, which includes estuarine and marine species such as whelks, crabs, and other shellfish and benthic invertebrates for Loggerheads and Kemp's Ridleys; sea grasses and marine algae for Green Sea Turtles, and cnidarians, salps, jellyfish and tunicates for Leatherback Sea Turtles (NMFS 2012a). Therefore, high quality forage habitat is not located near the facility. As such, listed sea turtles are not expected to swim, forage, or rest in the vicinity of the CWIS and thus generally not be subject to direct impacts by the cooling water intake system.

Atlantic Sturgeon (listed as both endangered and threatened)[4] spawn in the James River, however, the spawning grounds are located at least 50 miles upstream of the SPS intake with a second area of potentially suitable habitat located approximately 25 miles upstream (refer to Appendix A for more detail). Atlantic Sturgeon eggs are adhesive and demersal and occur only on the spawning grounds (Hildebrand and Schroeder 1927). Spawning is expected to occur

[4] Atlantic Sturgeon originating from the New York Bight, Chesapeake Bay, South Atlantic and Carolina Distinct Population Segments (DPSs) are listed as endangered. Those originating from the Gulf of Maine DPS are listed as threatened. Atlantic Sturgeon from these five DPSs have the potential to occur in the James River and the vicinity of the SPS cooling water intake; however, the majority of the spawning adults are likely to originate from the James River and thus, the Chesapeake Bay DPS (NMFS 2012b).

during April through June (temperatures for spawning can range from 13 – 26°C); and recent studies suggest that spawning might occur in the fall as well, with high adult usage in the river from August through November (Balazik et al. 2012, Secor et al. 2012). Eggs typically hatch in 4-7 days depending on temperature (Gilbert 1989; Hildebrand and Schroeder 1927). At hatching, Atlantic Sturgeon larvae are large bodied and are assumed to undertake a demersal existence in the same areas where they were spawned (ASMFC 2012, Bath et al. 1981). Based on the preceding, entrainment of Atlantic Sturgeon is highly improbable to occur at SPS.

This is confirmed through the 2012 Nuclear Regulatory Commission initiated ESA Section 7 consultation with NMFS that followed the listing of the Chesapeake Bay DPS of Atlantic Sturgeon as endangered. NMFS (2012b) reviewed a variety of materials as part of the consultation, and concluded "…based on information from NRC, Dominion, and other sources, all effects to listed species will be insignificant or discountable. Therefore, the continued operation of Surry 1 and 2 is not likely to adversely affect any listed species under NMFS jurisdiction."

Nonetheless, because of its protected status this study plan includes explicit methods that are focused on maximizing the potential of identifying early life stage Atlantic Sturgeon in the improbable event that they are collected in entrainment samples (refer to Methods for Identifying Atlantic Sturgeon section for additional details).

5 Basis for Sampling Design

HDR performed a site visit at SPS on August 19, 2014 to evaluate potential entrainment sampling options for the Low-level CWIS, the point of §316(b) compliance at the facility, and determined that collection locations are greatly limited for the following reasons:

- There is no access to the water between the Ristroph screens and the circulating water pumps for the collection of pumped or streamed net entrainment samples;
- There is very limited access to the water between the bar racks and Ristroph screens from the deck level such that collection of pumped or streamed net entrainment samples is not feasible;
- Streamed net sampling from the intake channel in front of the bar racks requires the use of a boat anchored in the channel which introduces weather related safety concerns and potential for missed sampling events and limited control over volume sampled (subject to intake velocity rather than pump capacity).

Based on these findings, it was determined that pumped samples taken from the river side of the bar racks is the preferred location for entrainment sample collections. Specifically, entrainment samples are to be collected by using a gas-powered 4-inch trash pump to pump water through a 335-µm mesh plankton net suspended in a water buffering tank. Entrainment samples will be collected concurrently from three depth intervals (near surface, mid-depth, and near bottom).

Entrainment sampling surveys will be conducted twice per month over a 24-month interval from August 1, 2015 – July 31, 2017. Each sample collection event will be conducted over a 24-hour period with sample sets collected every 6 hours. The sample frequency selected for this entrainment study will provide finfish and invertebrate (shellfish) taxa, density distribution and seasonal/diel variation data over a two year period. Shellfish, for the purposes of this study, will be inclusive of shrimp, crabs (including horseshoe), lobsters, crayfish, and motile stages of bivalves and gastropods.

This methodology includes the following significant changes relative to the June 2005 - May 2006 entrainment study (refer to Section 3.1 for details):

1) Use of a pump to collect samples directly in front of the bar racks rather than a streamed net approximately 100 feet in front of the bar racks.
2) Use of 335-µm mesh targeted for the current study rather than 505-µm mesh;
3) Collection of detailed morphometric data is included to support alternative technology evaluations;
4) Inclusion of methods and evaluations to maximize resolution of the taxonomic identifications with regard to Atlantic Sturgeon and other species; and
5) Collection of 24 months of entrainment data rather than 12 months.

The approach for development of the specific entrainment characterizations required in §122.21(r)(9) based on the collected data is summarized in Table 5-1.

Table 5-1. Summary of Approach for Development of §122.21(r)(9) Required Entrainment Characterizations

122.21(r)(9) Requirement	Basis for Meeting the Requirement
Two years of data and annual variation	Evaluation of species and life stage composition and densities based on August 2015 – July 2016 (Year 1) and August 2016 – July 2017 (Year 2) entrainment studies
Seasonal variation	Evaluation of monthly species and life stage compositions based on the Year 1 and Year 2 studies
Diel variation	Evaluation of densities in 6-hour sample collections in the Year 1 and Year 2 studies
Variation related to climate and weather	Evaluation of Year 1 and Year 2 data relative to water temperature and weather events (e.g., rain events)
Variation related to spawning, feeding and water column migrations	Evaluation of Year 1 and Year 2 data to determine species and life stage period of occurrence for spawning and feeding variation; Evaluation of differences among near surface, mid-depth and near bottom collections for water column migrations
Identification of lowest taxon possible	The resolution of taxonomic and life stage designations will be monitored through regular evaluations of catch data with the goal of reducing percent of unidentified organisms and increasing resolution of genera and higher taxonomic designations
Data must be representative of each intake	Sampling in front of Unit 1 would be representative of “average” intake water because eight screens and eight cooling water pumps are identical
How the location of the intake in the water body are accounted for	Sampling of near surface, mid-depth and near bottom at the bar racks assumed to be best method for accounting for intake location
Document flow associated with the data collections	Facility will monitor flows for period of sampling for use in the final report produced after sampling
Methods in which latent mortality will be identified	Assume 100% mortality
Data must be appropriate for a quantitative survey	Data will be expressed as taxon and life stage specific densities which can be multiplied by flow to support quantification of entrainment

6 Entrainment Characterization Study Plan

6.1 Introduction

This section of the Study Plan provides methods, materials, and procedures for entrainment sample collection and processing. Any failures at the sampling or laboratory analysis stage are often uncorrectable because design-specified sampling times cannot be repeated once they have passed. Therefore, Standard Operating Procedures (SOPs) and a Quality Assurance (QA) Plan will be developed by the contractor performing the field studies for the entrainment sample collection and processing based on this Study Plan and the contractors preferred methods, datasheets and equipment to eliminate, reduce, and/or quantify those errors.

Adherence to sample collection and lab analysis SOPs will be observed and documented through regular technical assessments/audits. These technical assessments/audits will be conducted by a QA officer, who is independent of those individuals collecting and generating the data during the study and has experience in performing QA/QC programs for aquatic monitoring surveys, and will be scheduled to occur at least quarterly throughout the course of the study. The specific requirements are to be developed by the contractor performing the work, will incorporate a checklist of items to be inspected based on the SOPs, and will include observations relevant to performance of sampling that may not be covered by the SOP. Careful attention will be paid to the initiation of the study when staff may be less familiar with the SOPs.

Entrainment sampling will be carried out at SPS twice per month from August 1, 2015 – July 31, 2017. The sampling will start in August 2015. This month was selected to expedite the start date for sampling to the extent possible as required within the larger §316(b) compliance timeframe and with a goal of minimizing the potential for disjoining year classes of anadromous fishes where the period of occurrence for entrainment of these species if generally over by July. Entrainment samples will be collected directly from in front of the bar racks at the Low-level CWIS. During each 24-hr sampling event, concurrent samples will be collected from near surface, mid-water and near bottom depths four times, centered around 0400, 1000, 1600, and 2200 hours. Samples will be collected by pumping water through a 0.5-m diameter mouth plankton net constructed of 335-µm netting suspended in a buffering tank. A total of four, 6-hour samples will be collected from each depth over a 24-hr period sampling event twice per month. Table 6-1 provides the details of entrainment sampling.

Table 6-1. Entrainment Sampling Details

Entrainment	Details
Units to be Sampled	Unit 1 (Primary Location) and Unit 2 (Secondary Location)
August 1, 2015 – July 31, 2017 Sampling Events	Twice per month sampling events (within the first and third week of each month) for 24 months (2/month x 24 months = 48 sampling events)
Daily Collection Schedule	Samples collected every 6 hours in a 24-hr period (4 collections / 24-hr period)
Targeted Organisms	Fish eggs, larvae, and juveniles; shellfish life stages
Depths	Near surface, mid-depth, near bottom for a total of 3 depths
Number of Samples Collected per Depth	1 sample per depth by pumping water through a 335-µm net suspended in a buffering tank (Three sub-samples for each depth will be combined)
Sample Duration	~100 minutes per depth per 6-hour sample (or time required to get 100 m^3 per depth per 6-hour sample)
Number of Samples per Sampling Event	4 collections/survey x 3 depths/collection x 1 sample/depth = 12 samples/survey
Total Number of Samples	12 samples/survey x 2 surveys/month x 24 months = 576 samples

6.2 Safety Policy

All work performed under the direction of Dominion Environmental Services (DES) and/or Dominion Business Units (BU) on Dominion properties and/or on properties owned or operated by third parties (i.e., not owned or operated by the contractor or Dominion) is to be performed using safe work practices that are at least equivalent to those required for Dominion personnel and of any third party owner or operator. At a minimum, all contractors are expected to be aware of, and adhere to, Dominion's Corporate Safety Policy, DES Safety Work Practices and any BU or other location-specific safety policies and procedures.

6.3 Field Collection Procedures

6.3.1 Location

Entrainment samples will be collected in front of bar racks at the Low-level CWIS from near surface, mid-water and near bottom depths. The primary sample location will be at Unit 1 in front of the bar rack 1B (See Figure 6-1). If Unit 1 is not operating the secondary location will be at Unit 2 in front of the bar rack 2C. Changes or variations in the sampling location over the duration of the 24-month study will require Dominion notification and approval.

Near surface, mid-water and near bottom pumped samples will be collected from intake piping installed along the front of the bar racks with the face of bar racks used to stabilize the temporary intake piping. The near bottom sample will be collected approximately 3 feet above the bottom, the mid depth sample will be collected at the mid-depth of the water column at Mean Sea Level (MSL), and the surface sample intake will be positioned 3 feet below the surface at

Mean Low Water (MLW) in order to make sure that the intake piping of the surface sample is low enough to stay below the water surface and the system keeps its prime. Figure 6-2 presents the conceptual design of intake piping for the entrainment sampling at three depths.

6.3.2 Equipment

Sampling equipment will be acquired and/or constructed according to specifications in this Study Plan. Adequate backup equipment will be provided to ensure the study design can be followed in the event of equipment failure or loss. Prior to initiation of sampling, equipment will be tested or otherwise confirmed to meet specifications. A calibration program will be instituted for equipment requiring calibration that must be consistent with Dominion's instrumentation calibration and maintenance practice document (See Appendix B).

Cooling water at the Low-Level CWIS will be pumped using temporary gas-powered four-inch centrifugal pumps (trash pump) and four-inch diameter intake piping installed at the face of bar racks. The pumped intake water will be filtered through a 335-micron mesh conical plankton net suspended in a 200-gallon polyethylene sample buffering tank (See Figure 6-3).

The following list includes the minimum items expected to be required for entrainment sample collection:

- 94 x 102-cm, 335-µm mesh hoop plankton nets (9) with 335-µm mesh PVC cod-end buckets (9)
- 94 x 102-cm, 505-µm mesh hoop plankton nets (9) with 505-µm mesh PVC cod-end buckets (9)[5]
- 4-Inch trash pumps with open head design/gas cans (4 pumps)
- 200-gallon buffering tanks (3)
- Intake hoses (surface, mid, and bottom)
- 4-inch Schedule 40 PVC pipe of various lengths and configurations
- 4-inch PVC flex hose of various lengths and configurations
- In-line flowmeter (3)
- 120 VAC submersible wash down pump with 25 feet of ¾-inch diameter hose and waterproof switch
- 1-L wide-mouth sample jars with labels
- 10% Formalin/Rose Bengal stain solution
- PPE: hard hats, safety glasses, steel toe boots, ear muffs/plugs, PFD's
- First-aid kit
- Flashlights
- Disposable Nitrile gloves
- Plastic buckets (assorted capacities)
- 335-µm sieves (3), squirt bottles, spoons
- Field Binder w/pens, pencils, SOP, data sheets, calibration sheets, QC sheets, etc.

[5] It is anticipated that during certain periods, 335-µm mesh may result in clogging of the net with a potential to compromise sample collections; 505-µm mesh may be used during these periods. Dominion is to be notified prior to, or immediately after, a net mesh large than 335-um is required to be used.

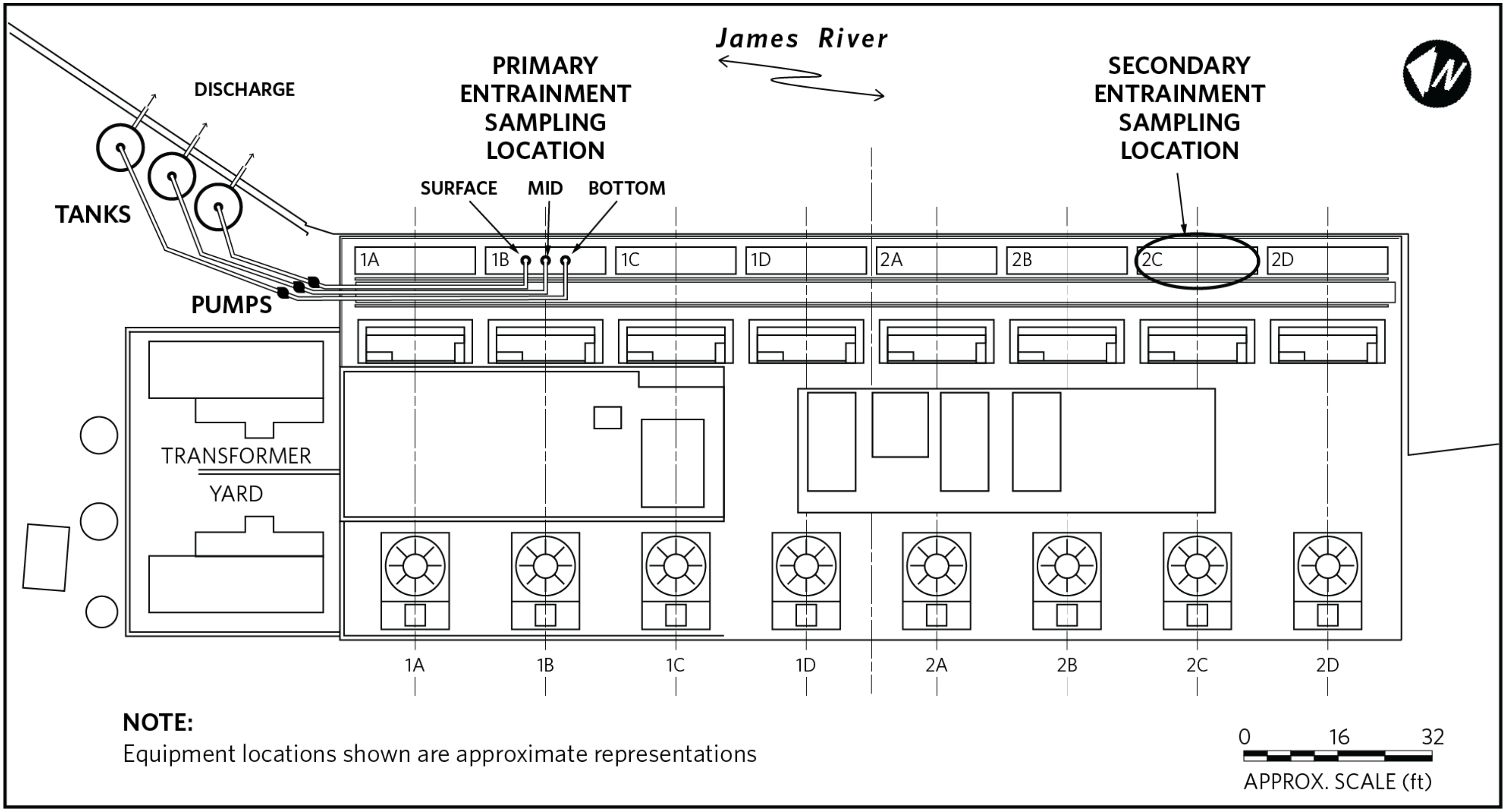


Figure 6-1. Proposed Location of Surry Power Station Entrainment Sampling, 2015 – 2017

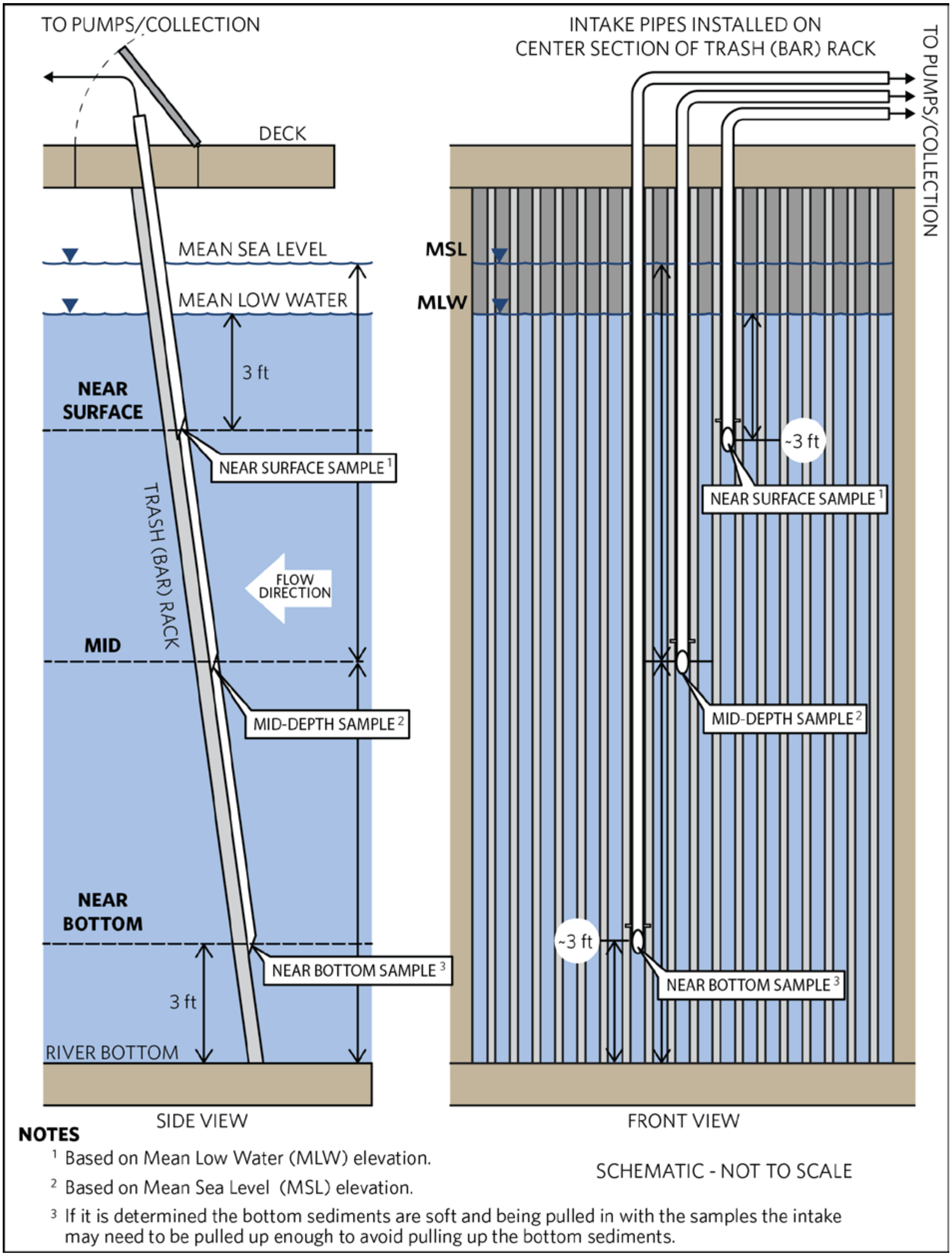


Figure 6-2. Conceptual Design of Intake Piping for Entrainment Sampling

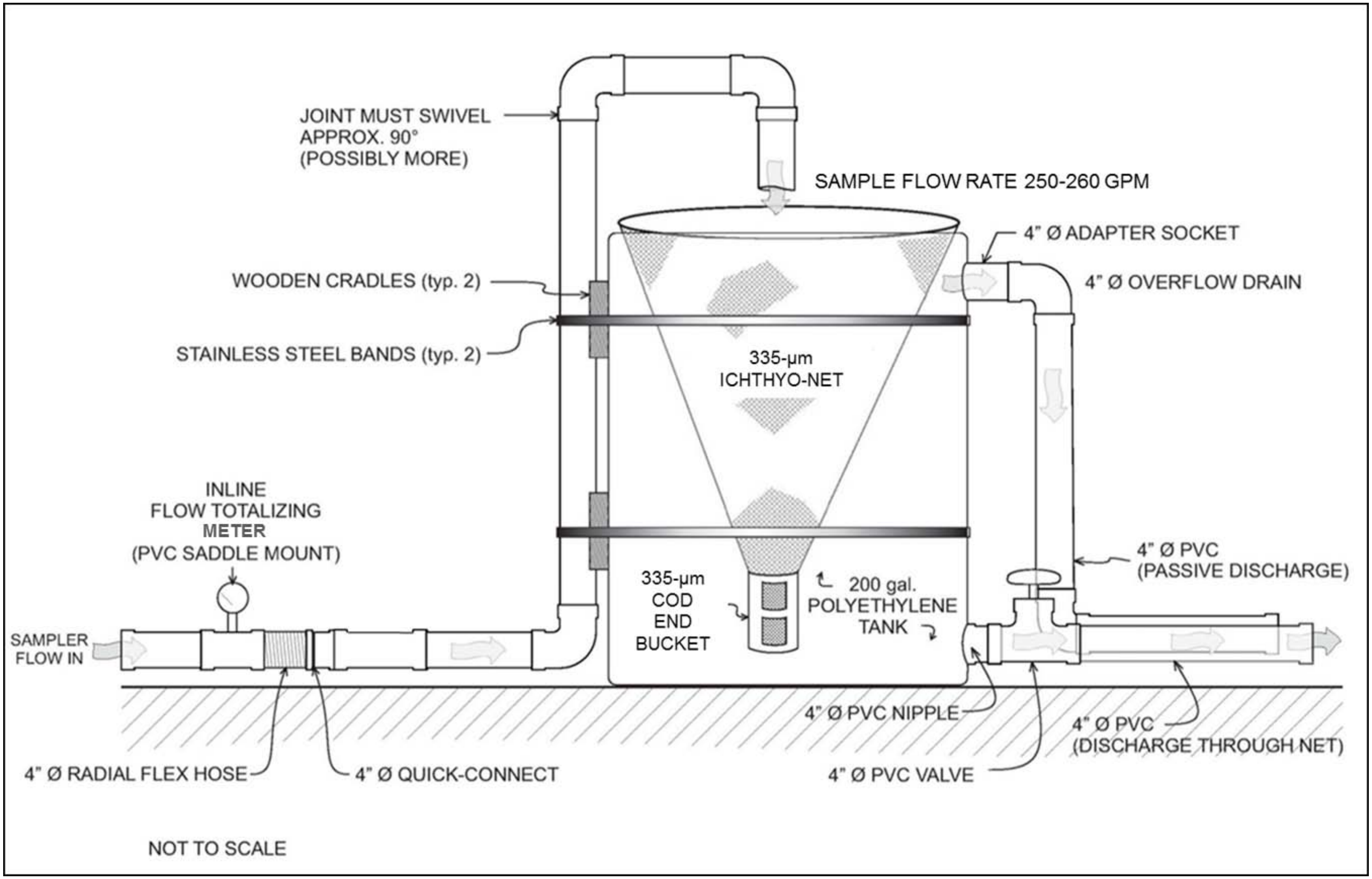


Figure 6-3. Entrainment Pump Sampling System Configuration

- Clipboard
- Stopwatch
- Niskin water sampler
- Extra 5-gal buckets or similar for sample transportation
- Portable water quality meters (2) as described below[6]
    - Handheld Salinity, Conductivity & Temperature meters (2) with autoranging scales (e.g., YSI Model 30 or equivalent) with the following minimum specifications:
        - Conductivity ranges of 0 to 500 µS/cm and 0-200 mS/cm with an accuracy of +/- 0.5 % full scale
        - Salinity range of 0 to 80 ppt with an accuracy of +/- 2 % or +/- 0.1 ppt
        - Temperature range of -5 to 45 ˚C with an accuracy of +/- 0.2 ˚C
    - Handheld Dissolved Oxygen & Temperature meters (2) with autoranging scales (e.g., YSI Model 55 or equivalent) with the following minimum specifications:
        - Dissolved Oxygen % Saturation ranging from 0 to 200 % with an accuracy of +/- 2 %
        - Dissolved Oxygen mg/L ranging from 0 to 2 mg/L with an accuracy of +/- 0.3 mg/L
        - Temperature range of -5 to 45 ˚C with an accuracy of +/- 0.2 ˚C
    - Portable pH meters (2) with the following minimum specifications:
        - pH range of 0 to 14 units with an accuracy of +/- 0.2 units
- Calibration solutions as required for the water quality instrumentation

6.3.3 Sampling Schedule

The program anticipates sampling for 24 consecutive months with 48 sampling events (twice per month) conducted over the August 1, 2015 – July 31, 2017 period. Sampling events will be distributed within the first and third week of each month for the 24-month period. Each sampling event will encompass a 24-hour period divided into four, 6-hour subsampling periods centered around 0400, 1000, 1600, and 2200 hours. If a sampling event is missed due to weather or other unforeseen events, the scheduled sampling event will be conducted within 96-hours of resolution of the complicating event.

6.3.4 Entrainment Sample Collection Procedures

The first shift crew will check in with the facility operations engineer or designee and security personnel to notify them of the initiation of the survey and the crew's arrival on site. Prior to initiating entrainment sampling, the crew will install the intake piping at the three depths along the bar rack (refer to Section 6.3.1 for details). Stabilizers will be used to keep the pipes in place and orient them to the intake flow. Once the intake pipes are secured in place, the intake piping will be connected to trash pumps with 4-inch flexible hoses and then the hoses will be connected to the buffering tanks. All connections will be checked. All sampling pumps will be

[6] A multiple parameter water quality meter may be used provided it meets the minimum specifications outlined for the individual meters.

placed in secondary containments with oil/fuel sorbent pads in the event there is a fuel or oil spill[7]. The discharge hoses from the tanks will be directed over the bulkhead back into the river.

The gas-powered pump head will be primed (filled with water) before starting the pump. Once the pump has begun to discharge water and a stable flow has been established the engine throttle will be adjusted and/or the throttling valve located at the terminal end of the flow metering pipe will be adjusted slowly to achieve a flow rate of approximately 250-275 gallons per minute (gpm). A pump flow rate check is to be conducted for each pump prior to commencing the 24-hour sampling event (refer to Section 6.3.5 for details). To commence sampling, the buffering tank discharge valve should be closed to fill to the level of the tank to the upper overflow drain. The discharge valve is then partially opened to balance the level in the buffering tank to the point where water is just spilling into the upper overflow drain (and not overflowing the top).

Once the flow in the system is balanced, the sample net is inserted into the buffering tank and the start time, pump flow and flow totalizer readings are recorded on the appropriate data sheet. The crew should observe the sampler to ensure that the water level is maintained at the correct level throughout the collection period. This is particularly important as the river is tidally influenced and a rising river level will result in higher pump flows while a dropping river level will result in lower pump flows.

Flow rates will be monitored and adjusted as necessary; a maximum flow rate of 250-275 gpm has been selected to minimize potential damage to the organisms from abrasion in the net during the sample collection interval. An inline flowmeter will be used to monitor and maintain the flow rate for each sample. The target water volume for each entrainment sample is 100 m^3. Contractor's SOP must include methods for tracking sample volumes in the field with potential to adjust sample times as may be required to achieve 100 m^3 sample volume per depth. In the event that ctenophores are present in entrainment samples and are clogging the net mesh (generally occurring in July – September at SPS), target total sample volume may be reduced to as low as 50 m^3. Systematic deviation from this target sample volume will require Dominion's prior approval.

In addition, three sub-samples of approximately 35 m^3 each (~35 minutes) will be collected from each depth interval. After approximately 35 minutes (or a volume of ~35 m^3; ~9,246 gallons), the net will be removed from the buffer tank and switched with a second net (this is to be performed without shutting down the pump). The removed net containing the first sub-sample will then be washed down from the outside of the net into the cod-end bucket and the sample will be transferred to a 1-liter wide-mouth polyethylene sample jar labeled with the pertinent sample information. Label information shall include: sample number/ID, date, time (start and end), sample location, sample depth, and crew member initials. The second and third sub-

[7] All pumps will be shut down and allowed to cool prior to refueling. Gasoline storage cans will be Type I UL-approved containers outfitted with flame arrestors; the gas cans will be stored in secondary containments. A dry chemical (ABC) fire extinguisher will be available in the area of the pumps.

samples will be washed down and transferred to the same 1-liter sample jar which contains the first sub-sample for each depth interval. The near surface, mid-depth, and near bottom samples will be collected concurrently using three pairs of pumps and buffering tanks.

The sample jar(s) will be preserved to a 5% Formalin solution with a “vital stain”, such as rose bengal and labeled appropriately. Each sample jar will be filled no more than halfway (50%) with the sample so that at least 500 ml of a 10% Formalin solution can be mixed with the sample to properly preserve it. All preserved samples will be packaged and transported to the laboratory for processing.

All pertinent information for each sample will be recorded on the appropriate data sheet to document the samples collected and ensure they are correctly identified and labeled for sampling processing. This information shall include but is not limited to: sample number/ID, year, date, time (start and end), sample location, sample depth, pumping duration (min), total volume filtered (m^3), water quality measurements, cooling water pump status, crew member initials.

At the completion of the 24-hr sampling period and final pump flow calibrations, the entrainment sampling apparatus will be broken down. The intake piping will be removed from the bar racks and all equipment (pumps. hoses, and buffering tanks) will be removed from the intake structure and stored in the designated location. The second shift crew will check in with the facility operations engineer or designee and security personnel to notify them of the surveys completion and the crew’s departure from the site. The number and rated capacity of circulating water pumps in operation during the sampling interval will be verified and recorded.

Measures must be made to ensure the sampling event does not interfere with plant operation nor result in risk to health and safety of field personnel. The contractor must contact the facility to provide them a weeks’ notice prior to each sampling event. The contractor should coordinate with the facility personnel to ensure sampling activities will not interfere with any scheduled maintenance activities at the intake structure of the station. If there are required activities that could conflict with plant maintenance operations the sampling event will be postponed as necessary so it does not interfere with plant operations. Prior to the sampling events, the contractor shall request that the facility personnel observe the bar racks and clean them of debris prior to the installation of the sampling equipment to minimize the possibility that the bar racks will need to be cleaned during the sampling event. In the event the station is required to access the bar racks during the sampling event due to unscheduled maintenance activities the sampling equipment can be removed if necessary. All open grates will be protected with barricades during the sampling events.

6.3.5 Pump Flow Rate Check Procedures

Prior to commencing with the first sampling period and again at the beginning of the second crew shift, a pump flow rate check will be conducted for each pump according to the flow rate check procedure outlined as follows:

- With the sample net removed from the tank, the crew will lower the water level of the buffering tank to the 50-gal mark on the side of the tank by opening the discharge regulating valve on the lower discharge line from the tank.
- When the water level is at the 50-gal line in the tank, the valve will be quickly closed.
- The totalized “start” flow from the flowmeter will be recorded immediately following valve closure.
- The crew will time, and record, how long it takes the rising water level in the tank to reach the 150-gal level line (100 gal pumped).
- The totalized “end” flow from the flowmeter will be recorded immediately after the 150-gal level line is reached.

The flow rate check will be calculated by the following equation:

$$100 \text{ gal}/t = X \text{ gal}/60 \text{ sec} \quad \text{or} \quad X = 6000/t$$

Where: t is the time in seconds to fill 100 gal, and X is the calculated gpm.

This procedure will be run three times, and the average compared to the observed flow rate from the flowmeter. If there is a discrepancy of more than 20%, the pipe connections will be checked and the flow rate check procedure will be conducted again until the results are within 20% of the flowmeter results. All flow rate check data will be recorded on the appropriate data sheet.

6.3.6 Water Quality Measurements

During each 6-hour sample period, water quality data will be collected twice (approximately every 3 hours), targeted for the start and end of each period at near-surface, mid-depth, and near-bottom depths at a convenient location along the bulkhead using a calibrated water quality meter (see instrument specifications above). Parameters that will be collected are: temperature (˚C), dissolved oxygen (DO) (mg/L), specific conductance (µS/cm), salinity (ppt) and pH. In addition ambient DO will be measured at mid-water depth at a pre-determined location near the entrainment samplers (where DO reading is unaffected by the discharge from the buffering tank) before the trash pumps are turned on for each entrainment sampling period. Water quality measurements will be recorded on the Entrainment Sampling Field Data Sheet.

Quality control for water quality data collection will be performed twice per sampling event (once per 12-hour shift) using either a second calibrated water quality meter or by collecting water samples for wet chemistry analysis. Calibration of water quality equipment will be consistent with the *Field Instrumentation: Calibration and Standardizations* requirements in Appendix B.

6.4 Laboratory Procedures

The entrainment samples collected during this study will be transported to the laboratory for sorting and analysis using the equipment and procedures identified below.

6.4.1 Equipment

The following list includes the expected minimum items required for laboratory analysis:

- Light boxes
- Pyrex trays
- 335µm sieves
- Plastic buckets (2 qt)
- Folsom Plankton Splitter (or equivalent)
- Binocular dissecting microscope with ocular micrometer
- Computer with ImageTool™ Software (or equivalent)
- Measuring board (accurate to the nearest millimeter)
- Featherweight forceps, dissecting forceps, eyedroppers, probes, spoons
- Petri dishes and covers
- Pencils, data sheets
- Vials (assorted capacities: 8 to 120 ml), vial holders
- Multiple and single mechanical hand counters
- Labels, Scotch tape
- 5% Formalin solution
- Safety glasses
- Squirt bottles (assorted sizes), plastic beakers (2 L)
- Nitrile gloves, paper towels
- SOP
- Taxonomic keys.

6.4.2 Laboratory Analysis

After collected samples are transported to the laboratory for processing, following major activities will be accomplished:

1) For very abundant samples, the total sample may be carefully mixed and split as needed to obtain a reliable and representative estimate of the total sample collection (refer to Sort Sub-sampling Procedure section for more information).
2) Identify each fish and shellfish to the lowest practicable taxon including life stage designation.
3) Determine the number and size of fish and shellfish collected (refer to Morphometrics section for more information).
4) Enter field sheet information and laboratory analysis data into Dominion approved database format.

Chronological sample processing will be performed for the duration of the study. Samples will be stored for a minimum of five years after the completion of the data collection effort. Protocols for managing and storing samples from multiple facilities, should a contractor be working at multiple facilities, will be required.

Sample Sorting

The following sample sorting protocol is to be followed:

- After a sample number has been assigned, the sample will be gently rinsed through a mesh of 335 µm or smaller to remove excess formalin.
- The rinsed sample will be placed in a sorting tray with adequate water to cover the sample. If the sample is thick with detritus, it may be split into several trays using a Motodo™ Plankton Splitter to improve visibility and sorting effectiveness.
- The organisms will be removed with forceps or eyedroppers and sorted into their respective groups of fish larvae, eggs, or shellfish larvae and enumerated. Each group will be placed in a separate glass vial with 5% buffered formalin and labeled externally with the sample number for identification. Tops of vials will be taped to reduce loss of fluid. Samples that are estimated to contain more than 400 fish eggs or 400 larvae will be sub-sampled.
- All samples (sorted organisms and not detritus) will be stored as appropriate to protect from freezing, breakage, or other sample damage.

Sort Sub-sampling Procedure

The preservative-free washed sample will be transferred to the Motodo™ Plankton Splitter. A sufficient quantity of water will be added to the box to ensure thorough mixing and dispersal of the sample. The box will be tilted until the sample has moved into the two separate chambers. Then, half of the sample will be carefully drained from the box. Samples will be split in half, and then the halves will be split in quarters, and so on, until the approximate number of organisms that were the target of the split is ≥200 in the final split portion.

The final split portion will be analyzed for whichever group was the target of the subsampling procedure. If a minimum of 200 eggs or larvae is reached, sorting for that group ends with that split portion. The whole sample, including the final split, will be analyzed for the other group of ichthyoplankton. The split fraction will be recorded on the data sheet for each taxon and life stage to which the split applies.

Sample Identification

After sorting, the fish and shellfish will be identified to the lowest practical taxon and enumerated. All fish will be assigned a life stage: viable egg, non-viable egg, yolk sac larvae, post yolk sac larvae, juvenile, or unidentified larval stage. Only whole larvae, parts of larvae with a head and a majority portion of the body present (more than half), or pieces of larvae with an extensive portion of the body present (more than three quarters) will be counted. All fish and shellfish will be preserved in 5% formalin and stored in properly labeled vials. All shellfish will be identified to the lowest practical taxon, enumerated and assigned to a life stage.

Morphometrics

For each 24-hr sampling event, the following morphometric data will be collected and recorded for each life stage of fish and shellfish (i.e., larval fish, fish egg, and blue crab) on the corresponding Morphometric Data Sheet:

- Up to 5 individuals from each fish taxon and life stage will be measured for total length and notochord length, greatest body depth and width, and head capsule depth and width, all to the nearest 0.1 mm;
- Up to 5 eggs of each taxon will be measured for minimum and maximum diameter;
- Up to 5 Blue Crab (*Callinectes sapidus*) individuals from each life stage will be measured for greatest body length, width, and depth to the nearest 0.1 mm; megalopa and later life stage measurement maximum widths and depths will be based on carapace.

Only whole organisms will be subject to morphometric evaluations. Organisms subject to the morphometric evaluation should be selected at random from within each taxonomic category (i.e., each taxon and life stage). Length measurements will be performed with a calibrated ocular micrometer or other calibrated tool (e.g., ImageTool™ Software).

Taxonomic Resolution Monitoring

The resolution of taxonomic and life stage designations will be monitored through regular evaluations of catch data with the goal of reducing percent of unidentified organisms and increasing resolution of genera and higher taxonomic designations. These evaluations will occur on a quarterly basis. Density data will be reported to Dominion within one month of the close of each three month period, as number of organisms per 100 m^3 by month, for each taxon and life stage.

Methods for Identifying Atlantic Sturgeon

Atlantic Sturgeon are not expected to be susceptible to entrainment at SPS. However, in the improbable event of identification of Atlantic Sturgeon in entrainment samples, the NRC will be notified by SPS within four hours of any state agency notification of an event pursuant to 10 CFR 50.72(b)(2)(xi), and the VDGIF will be contacted by Dominion (i.e., DES) within 24-hours of the event as per the requirements of the Scientific Collection Permit. The following method will be used to maximize the potential identification of this species in entrainment samples in the improbable event that they are collected:

1. Because of their large size and distinctive morphology, it is unlikely that sturgeon eggs and larvae would remain unidentified. Regardless, unidentified eggs and larvae and split fraction samples collected from March through November will be subject to an additional visual scan for eggs ranging in size from 2-3 mm and for larvae 6 mm or greater. This range of months is meant to be inclusive because of the uncertainty associated with spawning period of the James River Atlantic Sturgeon. The range of sizes is also meant to be inclusive to allow for slight variation from the descriptions.

2. This subset of eggs will be scanned for an apparent germinal disc and pigmentation. All pigmented eggs will be examined for consistency with the description of eggs provided in Appendix A.

3. The subset of yolk-sac larvae will be viewed for consistency with the description of yolk-sac larvae provided in Appendix A, distinguishing characteristics will include size, color

and a continuous finfold extending from behind the head dorsally around the notochord and ventrally to the posterior end of the yolk sac.

4. Larvae will be examined for consistency with size and developmental stage (see Snyder 1988). Bath et al. (1988) provides an extensive description of Atlantic and Shortnose Sturgeon (*Acipenser brevirostrum*), that can be used as an aid in identifying Atlantic Sturgeon.

For Quality Control purposes, any eggs and larvae identified as potential sturgeon specimens will be preserved separately and provided to an appropriate third party for taxonomic identification. The third party will provide a “blind” taxonomic identification wherein they will not be provided the results from the original taxonomic designation.

See Appendix C for a list of data to be collected and recorded during field collection and processing.

6.4.3 Laboratory Quality Control (QC) Procedures

Quality control methods for split, sort and identification of ichthyoplankton will be checked using a continuous sampling plan (CSP) to assure an Average Outgoing Quality Limit (AOQL) of 0.1 (≥90% accuracy). Specific methods for quality control will be provided in the SOP developed by the contractor performing the work. Quality control checks will be recorded on appropriate datasheets and these records will be maintained for review.

7 References

Atlantic States Marine Fisheries Commission (ASMFC). 2012. Habitat Addendum IV to Amendment 1 to the Interstate Fishery Management Plan for Atlantic Sturgeon.

Bain, M.B. 1997. Atlantic and shortnose sturgeons of the Hudson River: Common and divergent life history attributes. Environmental Biology of Fishes 48: 347-358.

Bain, M.B., N. Haley, D. Peterson, J.R. Waldman, and K. Arend. 2000. Harvest and habitats of Atlantic sturgeon *Acipenser oxyrinchus Mitchill*, 1815, in the Hudson River estuary: Lessons for sturgeon conservation. Boletin-Instituto Español de Oceanografía 16: 43-53.

Balazik, G., C. Garman, and J.P. Van Eenennaam. 2012. Empirical Evidence of Fall Spawning by Atlantic Sturgeon in the James River, Virginia. Transactions of the American Fisheries Society 141: 1465-1471.

Bath, D.W., J.M. O'Conner, J.B. Alber, and L.G. Arvidson. 1981. Development and identification of larval Atlantic sturgeon (*Acipenser oxyrhynchus*) and shortnose sturgeon (*A. brevirostrum*) from the Hudson River estuary, New York. Copeia 1981: 711–717.

CH2MHILL. 2006. Draft Comprehensive Demonstration Study for Surry Power Station. 2006.

Connelly, W.J. 2001. Growth patterns of three species of catfish (Ictaluridae) from three Virginia tributaries of the Chesapeake Bay. Master's Thesis. College of William and Mary, Williamsburg, VA. 153p.

Dominion 2005. Proposal for Information Collection - SURRY POWER STATION.

EA Engineering and Technology (EA). 2007. Entrainment Characterization Report; Surry Power Station.

Gilbert, C.R. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic Bight)--Atlantic and shortnose sturgeons. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.122). U.S. Army Corps of Engineers TR EL82-4. 28 pp.

Hager, C. 2011. Atlantic sturgeon review: Gather data on reproducing subpopulation of Atlantic sturgeon in the James River. Contract EA133FlOCN0317.

Hildebrand, S.F. and W.C. Schroeder. 1928. Fishes of Chesapeake Bay. Department of Commerce, Bulletin of the United States Bureau of Fisheries, Volume XLIII.

Jenkins, R.E., and N.M. Burkhead. 1993. Freshwater fishes of Virginia. American Fisheries Society, Bethesda, Maryland.

Johnson, R.I. 1970. The Systematics and Zoogeography of the Unionidae (Mollusca: Bivalvia) of the Southern Atlantic Slope Region. Bulletin of Museum of Comparative Zoology 140(6):263-449.

Kercher, D.M. 2006. Genetic Assessment of Rare Blackbanded Sunfish (*Enneacanthus Chaetodon*) Populations in Virginia. M.S. Thesis. Virginia Commonwealth University.

Kynard, B., D. Pugh, and T. Parker. 2005. Experimental studies to develop a bypass for shortnose sturgeon at Holyoke Dam. Final report to Holyoke Gas and Electric, Holyoke, MA.

Kynard, B. and M. Horgan. 2002. Ontogenetic behavior and migration of Atlantic Sturgeon, *Acipenser oxyrinchus oxyrinchus*, and Shortnose Sturgeon, *A. brevirostrum*, with notes on social behavior. Environmental Behavior of Fishes 63: 137-150.

Moser, M. L., and S. W. Ross. 1995. Habitat use and movements of shortnose and Atlantic sturgeons in the lower Cape Fear River, North Carolina. Transactions of the American Fisheries Society 124: 225-234.

National Marine Fisheries Service (NMFS). 2012a. Biological Opinion of James River Federal Navigation Project: Tribell Shoal Channel to Richmond Harbor in Surry, James City, Prince George, Charles City, Henrico, and Chesterfield Counties and the Cities of Richmond and Hopewell, Virginia (FINER/2012/01183).

NMFS. 2012b. Letter of concurrence, from Mr. D.M. Morris, NMFS, to Ms. Amy Hull, Nuclear Regulatory Commission, that continued operation Surry Nuclear Power Station, Units 1 and 2 is not likely to adversely affect species listed by NMFS.

Smith, T.I.J., E. K. Dingley, and D. E. Marchette. 1980. Induced spawning and culture of the Atlantic sturgeon, *Acipenser oxyrinchus* (Mitchill). Progressive Fish-Culturist 42: 147-151.

Snyder, D.E. 1988. Description and Identification of Shortnose and Atlantic Sturgeon Larvae. American Fisheries Society Symposium 5: 7-30.

U.S. Fish and Wildlife Service (FWS), Raleigh Ecological Serices Field Office. 2012. Sensitive Joint-vetch (*Aeschynomene virginica*). Retrieved September 7, 2014. http://www.fws.gov/raleigh/species/es_sensitive_joint-vetch.html

Virginia Department of Game and Inland Fisheries (VDGIF). 2014a. Eastern chicken turtle (*Deirochelys reticularia reticularia*). Available online. Retrieved September 7, 2014. http://www.dgif.virginia.gov/wildlife/information/?s=030064

VDGIF. 2014b. Eastern tiger salamander (*Ambystoma tigrinum tigrinum*). Available online. Retrieved September 7, 2014. http://www.dgif.virginia.gov/wildlife/information/?s=020052

VDGIF. 2014c. Mabee's salamander (*Amybstoma mabeei*). Available online. Retrieved September 7, 2014. http://www.dgif.virginia.gov/wildlife/information/?s=020044

VDGIF. 2014d. Barking treefrog (*Hyla gratiosa*). Available online. Retrieved September 7, 2014. http://www.dgif.virginia.gov/wildlife/information/?s=020002

VDGIF. 2014e. Dismal Swamp southeastern shrew (*Sorex longisrostris fisheri*). Available online. Retrieved September 7, 2014. http://www.dgif.virginia.gov/wildlife/information/?s=050008

VEPCO. 1977. Section 316(a) Demonstration (Type 1). Surry Power Station - Units 1 and 2. Virginia Electric and Power Company. Richmond, VA.

VEPCO. 1980. Surry Power Station-Units 1 and 2 Cooling Water Intake Studies.

Watson, J. 2012. James River Mainstem Freshwater Mussel Surveys. Virginia Department of Game & Inland Fisheries, Bureau of Wildlife Resources. Accessed on November 13, Available online: http://www.google.com/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=4&ved=0CC8QFjAD&url=http%3A%2F%2Fncmollusks.wikispaces.com%2Ffile%2Fview%2FJamesRiverSurveys.pdf&ei=1QVmVIfDH_TesASBvICgBg&usg=AFQjCNHoLbYHINRMh89V_2H6BPNyEZT8cA&sig2=NR_T2jFldgg2ucIZqnJn_w&bvm=bv.79142246,d.cWc.

Appendix A

Atlantic Sturgeon Life History Information

Atlantic Sturgeon Life History Information

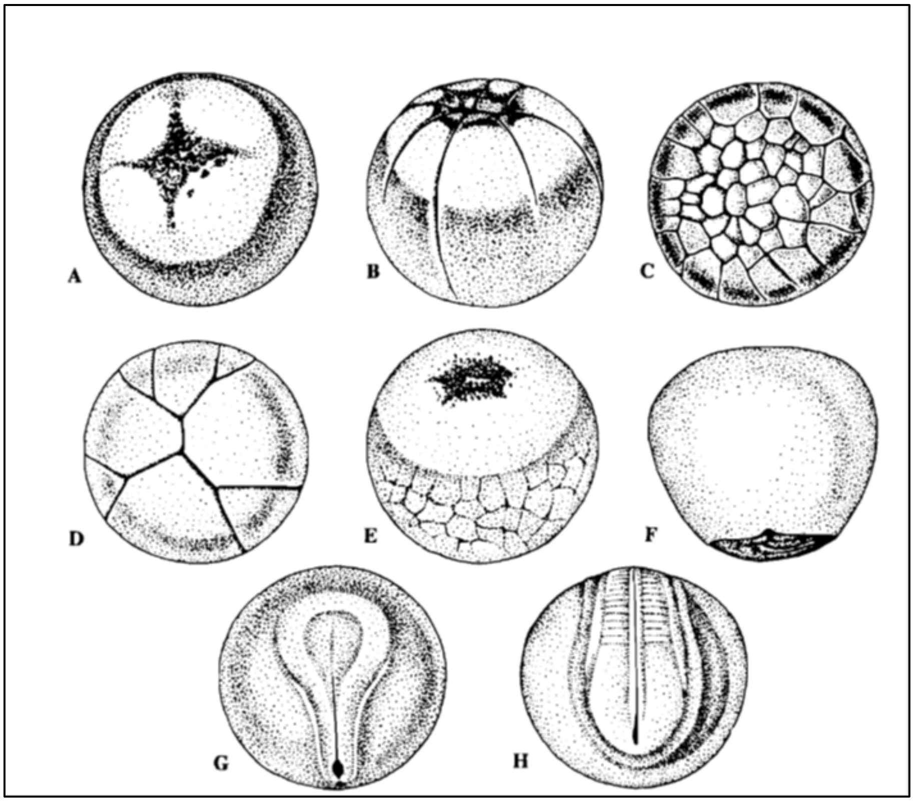
Atlantic Sturgeon (*Acipenser oxyrinchus*) originating from the New York Bight, Chesapeake Bay, South Atlantic and Carolina Distinct Population Segments (DPSs) are listed as endangered. Those originating from the Gulf of Maine DPS are listed as threatened. Atlantic Sturgeon from these five DPSs have the potential to occur in the James River and the vicinity of the cooling water intake of Surry Power Station (SPS). The marine range of all five DPSs extends along the Atlantic coast from Canada to Cape Canaveral, Florida (NMFS 2012a).

The James River has historically provided the largest stock of Atlantic Sturgeon in the Chesapeake and the majority of the adults in the river are likely to originate from the James River and thus, the Chesapeake Bay DPS (Hildebrand and Shroeder 1928; ASSRT 2007; Hager 2011; NMFS 2012a). Because early life stages (eggs and larvae), yearlings, and juveniles do not leave their natal river or estuary, any Atlantic Sturgeon from these life stages in the James River would have originated from the Chesapeake Bay DPS. Subadult Atlantic Sturgeon (greater than 50 cm but not yet sexually mature), move outside their natal rivers. Therefore, subadult Atlantic Sturgeon present in the James River and in the vicinity of the intake could be from any of the five DPSs.

Atlantic Sturgeon spawn in the James River. However, the spawning grounds are located at least 50 miles upstream of the SPS intake with a second area of seemingly suitable habitat also located approximately 25 miles upstream (NMFS 2012a). Spawning is expected to occur from the April through June; evidence exists that spawning might occur in the fall as well, with high adult usage in the river from August through November (Balazik et al. 2012, Secor et al. 2000). Virginia Marine Resources Commission restricts dredging in the James River from March 15 through June 30 to accommodate spring-spawning anadromous fish (Balazik et al. 2012) and NMFS (2012b) recently restricted dredging in the lower James River from February 15 to June 15th and in the rest of the river from February 15 to June 30 to protect anadromous fish during migration and spawning periods.

Eggs can hatch in 4 - 7 days depending on temperature (Gilbert 1989; Hildebrand and Schroeder 1928). Eggs are strongly adhesive and demersal, and occur only on the spawning grounds attaching to the substrate in 20 minutes (Jones et al. 1978). Atlantic Sturgeon eggs are approximately 2.6 mm in diameter (Hildebrand and Schroeder 1928) and hatch approximately 94, 140, and 168 hours after egg deposition at temperatures of 20°C, 18°C, and 17.8 °C, respectively (Gilbert 1989; Hildebrand and Schroeder 1928).

Ripe (unfertilized) Atlantic Sturgeon eggs are reported to be 2.5 - 2.6 mm in diameter, globular in shape, and of a light to dark brown color. Fertilized eggs are up to 2.9 mm in diameter, slate gray or light to dark brown, and become oval as development proceeds (Jones et al. 1978) (see Figure A-1). The germinal disc is evident in the unfertilized egg. A cross- or star-shaped pigment patch is apparent in the animal pole of the fertilized egg. The eggs are distinctly two-layered with the outer layer being a viscous substance.



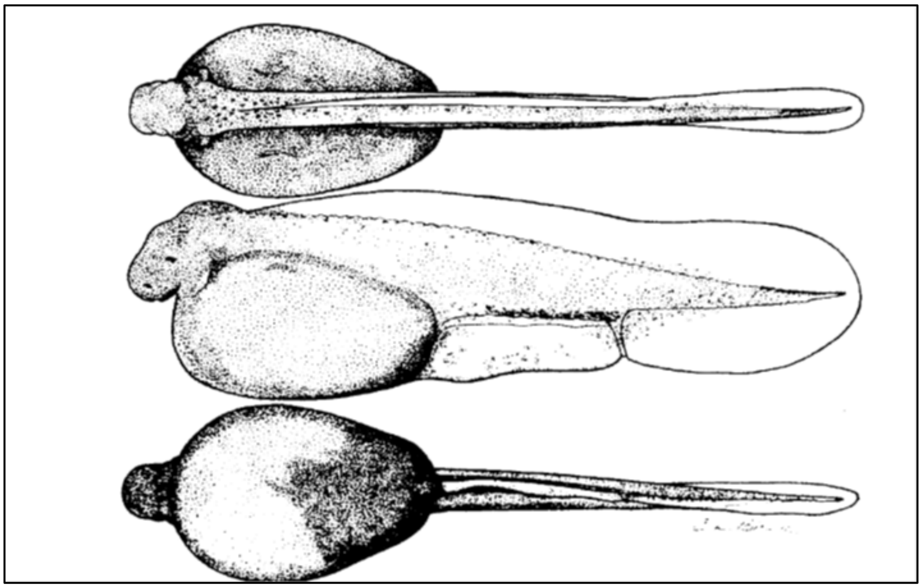
Source: Jones et al. 1978 as presented in Gilbert 1989

Figure A-1. Atlantic Sturgeon Egg Development from Unfertilized Egg to 48-hour Stage

Yolk-sac larvae are expected to inhabit the same areas where they were spawned (Bain et al. 2000; ASMFC 2012). Smith et al. (1980 in Gilbert 1989) also reported that the yolk-sac larvae were darkly pigmented and active swimmers. Hard substrate is important to larval Atlantic Sturgeon as it provides refuge from predators (Kieffer and Kynard 1996 and Fox et al. 2000 as cited in ASMFC 2012). Bath et al. (1981) only collected sturgeon larvae in bottom samples. Larvae are also active swimmers and leave the bottom when 8 to 10 days old to swim in the water column (Kynard and Horgan 2002).

The yolk-sac larval stage is completed in about 8 to12 days (Jones et al. [1978] reports 6 days), at which time the larvae move downstream to the rearing grounds (Kynard and Horgan 2002). During the first half of this migration, larvae move only at night and use benthic structure (e.g., gravel matrix) as refuge during the day (Kynard and Horgan 2002). During the latter half of migration to the rearing grounds, when larvae are more fully developed, movement occurs during both day and night. Larvae transition into the juvenile phase at approximately 30 mm total length (TL) and move further downstream into brackish waters, developing a tolerance to salinity as they go., Eventually they become residents in estuarine waters for months to years before emigrating to open ocean (ASSRT 2007, ASMFC 2012).

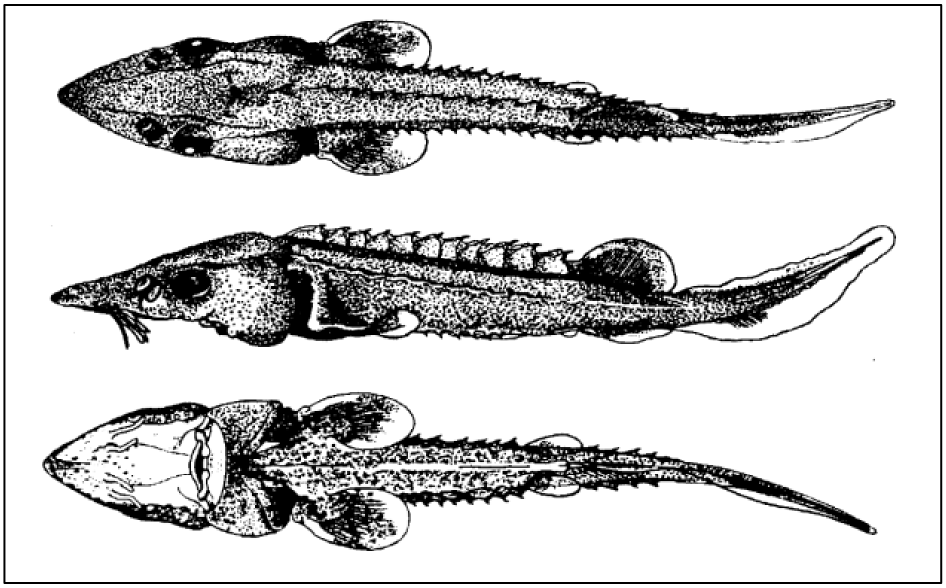
Atlantic Sturgeon larvae are expected to be approximately 7 - 9 mm TL at hatching (Bath et al. 1981, Smith 1980 as cited in Bain et al. 2000, Gilbert 1989, Snyder 1988), although Jones et al. (1978) describe a newly hatched Atlantic Sturgeon larvae at 11.5 mm TL. The head width is 8% of standard length (SL) with a depth of 11 % of SL (behind the posterior margin of the eye). The yolk-sac maxima is 23 % of SL and the yolk-sac depth is 20% of SL (Snyder 1988). Jones et al. (1978) describes the newly hatched Atlantic Sturgeon larvae with a head and the tail that is darkly pigmented and a yolk that is a large “dirty yellow,” vascular oval. The head is not deflected over the yolk (bent around the yolk). The mouth is formed. The eye is relatively small and is about the same size as the round auditory vesicles. The branchial arches are concealed by the opercular folds, the barbels are lacking, pectoral buds are present, and the origin of the dorsal finfold is in the occipital region. Bath et al. (1981) reports that a continuous finfold extends from behind the head dorsally around the notochord and ventrally to the posterior end of the yolk sac, a dorsal wedge-shaped cavity at the fourth ventricle in the posterior of the blunt head, and a vent extended through the finfold at 0.6 to 0.7 of the TL from the snout. The spiral valve was distinguishable, even in small specimens.



Source: Snyder 1988

Figure A-2. Atlantic Sturgeon Yolk Sac Larvae Just Hatched

Snyder (1988) reports that Atlantic Sturgeon complete yolk absorption by 13 - 14 mm SL in 6 - 7 days, acquire their first scutes between 17 and 20 mm SL at 13 - 29 days, acquire their first fin rays at 21 mm SL (13 - 29 days), and acquire a full complement of fin rays, except the caudal fin, between 47 and 58 mm SL at 29 - 100 days. A 29-day hatchery-reared larva is presented in Figure A-3. Mean myomere counts for shortnose and Atlantic Sturgeon are 38 preanal and 22 or 23 postanal. Snyder (1988) presents a detailed comparison of shortnose and Atlantic Sturgeon and provides details on the age and length of the onset of certain developmental events.



Source: Snyder 1988

Figure A-3. Atlantic Sturgeon, 28.9 mm SL, 29.3 MM TL, 29 Days After Hatching

Juvenile Atlantic Sturgeon demonstrate a lot of variation with regard to salinity tolerance (ASMFC 2012). Atlantic Sturgeon spawn in their natal river and remain in the river until approximately age two and at lengths of approximately 76 - 92 cm (30 - 36 inches; ASSRT 2007). Yearlings are known to occupy freshwater portions of their natal river (Secor et al. 2000) and their distribution in the James River is expected to follow this pattern. Juveniles in the river are also restricted to low salinity areas, with overwintering known to occur in deep water areas near river mile 25 (NMFS 2012).

Hager (2011) used telemetry to establish movement patterns of adult and subadult Atlantic Sturgeon in the James River. Thirty-two adults and thirty-three subadults were outfitted with telemetry tags and telemetry receivers were placed throughout the river to record the presence of tagged fish when they are within approximately one kilometer of the receivers.

Results of Hager (2011) indicate that adult Atlantic Sturgeon enter the James River in spring when water temperatures are around 17°C, and occur from river mile 29 to river mile 67 before departing from the river in June when water temperatures are around 24° C. Data collected in 2010 demonstrated a congregation of sturgeon in freshwater areas near river mile 48, suggesting the possibility of spawning in this area (Hager 2011). Adult sturgeon appear to be absent from the James River for most of the summer until late August when tagged fish are once again detected in the river (Hager 2011). During the late summer-early fall residency (August-October), fish ascend the river rapidly and congregate in upriver sites between river mile 48 and the fall line near Richmond, VA; possibly in response to physiologically stressful conditions (e.g., low dissolved oxygen and elevated water temperature) in the lower James River and Chesapeake Bay (Hager 2011). As temperature declines in late September or early October, adults disperse through downriver sites and begin to move out of the river (Hager 2011). By November, adults occupy only lower river sites (Hager 2011). By December, adults are undetected on the tracking array and, thus, are presumed to be out of the river (Hager 2011).

The highest number of subadults are present in the river in the spring and fall with the lowest numbers present in August when ambient water temperatures in the river are the highest. At this time of year, most subadults leave the river and any Atlantic Sturgeon remaining in the river are holding in cool water refugia (Hager 2011). The number of subadults in the river peaks in October. Many subadults leave the river for overwintering with some known to overwinter off the coast of North Carolina. Subadults overwintering within the river are located downstream of Hog Island.

Literature Cited

Atlantic States Marine Fisheries Commission (ASMFC). 2012. Habitat Addendum IV to Amendment 1 to the Interstate Fishery Management Plan for Atlantic Sturgeon.

Atlantic Sturgeon Status Review Team (ASSRT). 2007. Status Review of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). Report to National Marine Fisheries Service, Northeast Regional Office. February 23, 2007. 174 pp.

Balazik, G., C. Garman, and J.P. Van Eenennaam. 2012. Empirical Evidence of Fall Spawning by Atlantic Sturgeon in the James River, Virginia. Transactions of the American Fisheries Society 141: 1465-1471.

Bain, M.B., N. Haley, D. Peterson, J.R. Waldman, and K. Arend. 2000. Harvest and habitats of Atlantic sturgeon *Acipenser oxyrinchus* Mitchill, 1815, in the Hudson River estuary: Lessons for sturgeon conservation. Boletin-Instituto Español de Oceanografía 16: 43-53.

Bath, D.W., J.M. O'Conner, J.B. Alber, and L.G. Arvidson. 1981. Development and identification of larval Atlantic sturgeon (*Acipenser oxyrhynchus*) and shortnose sturgeon (*A. brevirostrum*) from the Hudson River estuary, New York. Copeia 1981: 711–717.

Fox, D. 2006. History of Atlantic Sturgeon Fishery. Power Point presentation presented to Delaware Department of Natural Resources, courtesy of Greg Murphy (DEDNR) April 13, 2006.

Gilbert, C.R. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic Bight)--Atlantic and shortnose sturgeons. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.122). U.S. Army Corps of Engineers TR EL82-4. 28 pp.

Hager, C. 2011. Atlantic sturgeon review: Gather data on reproducing subpopulation of Atlantic sturgeon in the James River. Contract EA133FlOCN0317.

Hildebrand, S.F. and W.C. Schroeder. 1928. Fishes of Chesapeake Bay. Department of Commerce, Bulletin of the United States Bureau of Fisheries, Volume XLIII.

Jones, P. W., Martin, F. D. and Hardy, J. D. Jr. 1978: Development of fishes of the Mid-Atlantic Bight. An atlas of egg, larval and juvenile stages. Volume I Acipenseridae through Ictaluridae. U. S. Dep. Interior, Fish Wildl. Serv., Biol. Serv. Prog. FWS/OBS-78/12. 366 pp.

Kercher, D.M. 2006. Genetic Assessment of Rare Blackbanded Sunfish (*Enneacanthus chaetodon*) Populations in Virginia. M.S. Thesis. Virginia Commonwealth University.

Kieffer, M. C. and B. Kynard. 1993. Annual movements of shortnose and Atlantic sturgeons in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society 122: 1088-1103.

Kynard, B. and M. Horgan. 2002. Ontogenetic behavior and migration of Atlantic sturgeon, *Acipenser oxyrinchus oxyrinchus*, and shortnose sturgeon, *A. brevirostrum*, with notes on social behavior. Environmental Behavior of Fishes 63: 137-150.

Kynard, B., D. Pugh, and T. Parker. 2005. Experimental studies to develop a bypass for shortnose sturgeon at Holyoke Dam. Final report to Holyoke Gas and Electric, Holyoke, MA.

NMFS. 2012. Biological Opinion of James River Federal Navigation Project: Tribell Shoal Channel to Richmond Harbor in Surry, James City, Prince George, Charles City, Henrico, and Chesterfield Counties and the Cities of Richmond and Hopewell, Virginia (FINER/2012/01183).

Smith, T.I.J., E. K. Dingley, and D. E. Marchette. 1980. Induced spawning and culture of the Atlantic sturgeon, *Acipenser oxyrinchus* (Mitchill). Progressive Fish-Culturist 42: 147-151.

Secor, D.H.,E., J. Niklitschek, J.T. Stevenson, T.E. Gunderson, S.P. Minkkinen, B. Richardson, B. Florence, M. Mangold, J. Skjeveland, and A. Henderson-Arzapalo. 2000. Dispersal and growth of yearling Atlantic sturgeon, *Acipenser oxyrinchus*, released into Chesapeake Bay. Fishery Bulletin 98: 800-810.

Snyder, D.E. 1988. Description and Identification of Shortnose and Atlantic Sturgeon Larvae. American Fisheries Society Symposium 5: 7-30.

Appendix B

Field Instrumentation:
Calibrations and Standardizations

WORK PRACTICE DOCUMENT

Field Instrumentation:

Calibrations and Standardizations

Dominion Environmental Services

Table of Contents

WORK PRACTICE DOCUMENT

Calibrations and Standardizations

Electric Environmental Biology

Written Date: 8/16/2011

Revision Date:

Document Owner: Casey Seelig

1.0 Introduction

Dominion is required to monitor a variety of physicochemical parameters in the environment. These parameters are monitored with various types and models of scientific instrumentation. Instruments must be either calibrated or standardized and properly maintained to ensure the accuracy and precision of the data being collected. **Calibration** is a process of physically adjusting an instrument to accurately read a known standard or series of standards. **Standardization** is a process of checking an instrument against a known standard or series of standards to document its accuracy. Standardization, without a physical adjustment to the instrument, checks that the instrument is functioning to its design specifications and, if not the instrument can either be calibrated, serviced by the operator, or sent back to the manufacturer for repair. The manufacturer's recommended calibration and maintenance procedures for a particular instrument are designed to keep the equipment performing to the manufacturer's specifications. Every instrument's accuracy should be verified and documented to ensure it meets the acceptability criteria established for the work.

2.0 Scope

The purpose of this work practice document is to provide the protocols necessary to ensure all field instrumentation and test methods, which are used to measure environmental parameters, are providing data of acceptable accuracy. This work practice document defines the proper methods, frequencies, and acceptance criteria for documenting field instrument and test kit accuracy using calibrations and standardizations. The procedures in this document are general in nature. Due to the number and variety of field instrumentation used, specific calibration procedures for each instrument are beyond the scope of this document. The user's manual should be consulted for specific calibration and standardization procedures.

3.0 Dominion Employees Covered

This work practice applies to all Dominion Environmental Services (DES) employees using field instrumentation to monitor environmental parameters as well as any contractors employed by DES that conduct environmental analyses for monitoring studies. The guidelines and procedures listed in this work practice document apply to instruments used in the field. This does not cover the calibration or standardization of laboratory equipment.

4.0 Work Practice Description

The field instrumentation calibrations and standardizations work practice provides guidance on how to prepare for and safely conduct calibrations and equipment accuracy checks on field instrumentation. This work practice is intended for experienced field technicians or for those under the direct supervision of employees trained in proper calibration and standardization methods used for equipment and reagents required in the collection of environmental data.

5.0 Safety

Safety is a core Dominion principle and all calibration and standardization work must incorporate safe work practices. It is the responsibility of every employee and contractor to work safely. Safety of each employee, contractor, their co-workers and the general public are the first priority of every job. The conduct of all work should conform to the expectations described in the Dominion Safety Policy, the Safety Work Practice for Dominion Environmental Services, the Safety Work Practice for Biology, and the policies of the business unit where the work is being done. The types of Personal Protective Equipment (PPE) necessary for calibrating and standardizing field instruments must be reviewed prior to starting calibrations or standardizations to identify and mitigate any hazards.

1. Specific hazards associated with the type of instruments to be calibrated or standardized must be known prior to the start of the calibration or standardization. Examples of such hazards might include: health and safety concerns associated with the use of pH standards as identified by the Material Safety Data Sheet (MSDS).

2. Where the mitigation of hazards is not possible, Personal Protective Equipment (PPE) must be worn to safely complete the calibration/standardization. A hazard assessment must be performed to evaluate each calibration or standardization task and the proper PPE needs to be worn as outlined in the MSDS and any governing Laboratory Chemical Hygiene Plan. The need for safety glasses, gloves, and appropriate clothing should be considered in every hazard assessment.

3. All employees are required, at a minimum, to be familiar with the Hazard Communication Program for their business unit. The Hazard Communication Program outlines safety expectations when handling and using chemical products, including employee training, chemical labeling, and access to MSDS.

6.0 Work Practice Requirements

1. Personnel that will be calibrating or standardizing instruments or test kits for readings will, at a minimum:

a) Be cognizant of the safe handling and waste disposal of calibration or standardization chemicals.
b) Have training in the use of instrumentation;
c) Have training for the proper use of required PPE;
d) Have a thorough understanding of the proper methods outlined by the manufacturer to maintain, calibrate or standardize the instrument or test kit.

2. Verify state and federal protocols for accuracy and precision of measurements:
   a) Review acceptance criteria required by the state and agencies (current acceptance criteria are listed in calibration procedures below and in Table1);
   b) Document all calibrations and standardizations of monitoring instruments and test kits.
3. Pre-Calibration/Standardization Preparation
   a) Review the manufacturer's recommendations and procedures;
   b) Locate and fill out the appropriate calibration/standardization log sheet;
   c) Verify the expiration/certification date of all standards to be used in the calibration/standardization process;
   d) Verify the instrument's or test kit's make, model, and serial number or unique identifier and record it on the log sheet;
4. Instrument or Test kit Calibration/Standardization
   a) Document the date, time, and the person(s) conducting the calibration/standardization;
   b) Select a range of standards to be used for calibration or to be checked for the instrument/test kit's accuracy, which will bracket expected field/laboratory survey results;
   c) Document the results (standard verses reading) and verify that they meet the acceptance criteria;
   e) If the equipment fails calibration/standardization, service and clean the equipment and re-calibrate/standardize;
   f) If the equipment continues to fail, label "Inactive Status" and remove the equipment from service (send the equipment back to the manufacturer for servicing) and document this on the log sheet;

Note: If an instrument or test kit does not comply with the established acceptance criteria, it must not be used for collecting data and must be removed from service.

   g) Properly label and dispose of all waste chemicals and materials. Dispose of any hazardous wastes according to the Hazard Waste Management Guidance Document.
5. Verification
   a) DES personnel must record the instrument/test kit identifier (e.g., serial number) on field and boat log sheets to provide a traceable accuracy for every measurement collected;
   b) Annual reviews of calibration/standardization logs should be performed to verify compliance. Calibration/standardization logs should be checked to verify that records are complete, legible, and up to date.

7.0 Calibration and Standardization Protocols

Many instruments and test kits are not able to be calibrated in the field or by the user. These instruments and test kits need to be checked routinely using known standards to establish and document their accuracy. For example it is not possible to adjust a capillary thermometer; therefore accuracy needs to be compared to a reference thermometer of certified accuracy. In many cases checking standards and documenting the instrument's accuracy in the range of conditions it will be used can be more efficient than calibration procedures. In all cases, follow the manufacturer's recommended maintenance and calibration directives.

The following frequencies (Table 1) established for documenting calibrations and standardizations are for instruments and test kits routinely being used for weekly or monthly monitoring studies. If equipment is being used daily for recording large amounts of data, calibration/standardization frequencies must be increased (see Table 1) or standards must be run with samples. For infrequently used equipment (once a quarter or year), calibrations and standardizations should occur prior to use. Data loggers which are being deployed for extended periods of time (>1 month) must be calibrated/standardized immediately prior to and following deployment in the field.

Prior to calibration, all instrument probes must be cleaned according to the manufacturers instructions. Failure to perform this step (proper maintenance) can lead to erratic measurements. When calibrating instruments care must be taken to insure that the volume of the calibration solutions is sufficient to cover both the probe and temperature sensor and be free of air bubbles (see manufacturer's instructions for additional information).

A record of each calibration must be made in the calibration log. The record needs to include at a minimum:

- serial number of the instrument
- parameters which were calibrated
- standards used in calibration
- date and time of calibration
- initials of technician

7.1 Chlorine

Chlorine testing in the field is usually done using a colorimeter. There are two methods of standardization: 1) gel standards (once a week or prior to use) and 2) ampule standards (recommended every 13 weeks). Prior to reading the standards, zero the colorimeter with a blank (deionized water) and record measurements to 0.01 mg/L. Acceptance criterion for the gel standards (0.20, 0.83, and 1.53 mg/L) is ±15% and for the ampule standards (0.12, 0.60, 1.20 mg/L) is ±20%. If expected chlorine levels are higher than the range of these standards, select standards that bracket the expected field results.

7.2 Conductivity and Salinity

Conductivity is used to measure the ability of an aqueous solution to carry an electrical current. Specific conductance is the conductivity value corrected to 25°C. There are a variety of instruments available to measure conductivity, specific conductance, salinity, and temperature. Most instruments are calibrated against a single standard which is near, but below the specific conductance of the environmental samples. A second standard which is above the environmental sample specific conductance is used to check the linearity of the instrument in the range of measurements.

If cleaning electrical connections, changing batteries (recharging), or changing sensors does not correct standardization failures, then the unit should be sent back to the manufacturer for servicing. Freshwater standards (0.05-1.00 mS/cm) or Seawater standards (40-60 mS/cm) are recommended for standardizations checks every 13 weeks. These standardizations should be conducted at a temperature of 25°C±1°C. The acceptance criterion is ±5%. The temperature probes of these meters should be checked for accuracy (acceptance criterion ±0.5°C) at the same time because temperature is factored into the meters program for calculating conductivity, specific conductance and salinity. Standardizations can be done with a specifically designated and labeled "Reference Meter", which must be standardized with standard water samples every 4 weeks. Refractometers (salinity/density) must be standardized (acceptance criterion ±1.0 ppt) every 13 weeks or prior to use with a "Reference Meter." Before using a refractometer for recording salinity data, verify that it meets or exceeds the precision requirements for the data being collected.

Calibration Procedure

1. Allow the calibration standard to equilibrate to the ambient temperature.

2. Remove probe from its storage container, rinse the probe with a small amount of the conductivity/specific conductance standard (discard the rinsate), and place the probe into the conductivity/specific conductance standard.

3. Select monitoring/run mode. Wait until the probe temperature has stabilized.

4. Look up the conductivity value at this temperature from the conductivity versus temperature correction table usually found on the standard bottle or on the standard instruction sheet. You may need to interpolate the conductivity value between temperatures. Select calibration mode, then conductivity. Enter the temperature corrected conductivity value into the instrument.

5. Select monitoring/run mode. The reading should remain within manufacturer's specifications. If it does not, re-calibrate. If readings continue to change after recalibration, consult manufacturer.

6. Read the specific conductance on the instrument and compare the value to the specific conductance value on the standard. The instrument value should agree with the standard within the manufacturer's specifications. If not, re-calibrate. If the re-calibration does not correct the problem, the probe may need to be cleaned or serviced by the instrument manufacturer.

7. Remove probe from the standard, rinse the probe with a small amount of the second conductivity/specific conductance standard (discard the rinsate), and place the probe into the second conductivity/specific conductance standard. The second standard will serve to verify the linearity of the instrument. Read the specific conductance value from the instrument and compare the value to the specific conductance on the standard. The two values should agree within the specifications of the instrument. If they do not agree, recalibrate. If readings do not compare, then the second standard may be outside the linear range of the instrument. Use a standard that is closer, but above the first standard and repeat the verification. If values still do not compare, try cleaning the probe or consult the manufacturer.

8. When monitoring groundwater or surface water, use the specific conductance readings.

7.3 Dissolved Oxygen (D.O.)

Dissolved oxygen (DO) content in water is measured using a membrane electrode. The DO probe's membrane and electrolyte solution should be replaced prior to the sampling period. Failure to perform this step may lead to erratic measurements. There are a variety of instruments available to measure dissolved oxygen (% saturation & mg/L) and temperature.

If cleaning electrical connections, changing batteries (recharging), or changing the permeable membrane on the sensor does not correct standardization failures, then the unit should be sent back to the manufacturer for servicing. If the unit has an air calibration function, air calibrate (100% saturation) the meter prior to use or follow manufacture's directives. Newer instruments utilize a luminescent dissolved oxygen probe (LDO). LDO sensor caps need to be replaced based on the manufacturer's maintenance schedule. LDO sensors are calibrated using air saturated water.

Calibration Procedure

1. Gently dry the temperature sensor according to manufacturer's instructions.

2. Place a wet sponge or a wet paper towel on the bottom of the DO calibration container.

3. Place the DO probe into the container without the probe coming in contact with the wet sponge or paper towel. The probe must fit tightly into the container to prevent the escape of moisture evaporating from the sponge or towel.

4. Allow the confined air to become saturated with water vapor (saturation occurs in approximately 10 to 15 minutes). During this time, turn-on the instrument to allow the DO probe to warm-up. Select monitoring/run mode. Check temperature readings. Temperature readings must stabilize before continuing to the next step.

5. Select calibration mode; then select "DO %".

6. Enter the local barometric pressure (usually in mm of mercury) for the sampling location into the instrument. This measurement must be determined from an on-site barometer. Do not use barometric pressure obtained from the local weather services unless the pressure is corrected for the elevation of the sampling location. [Note: inches of mercury times 25.4 mm/inch equals mm of mercury or consult Oxygen Solubility at Indicated Pressure, Table 2].

7. The instrument should indicate that the calibration is in progress. The instrument will take approximately one minute to calibrate. After calibration, the instrument should display percent saturated DO.

8. Select monitoring/run mode. Compare the DO mg/l reading to the Oxygen Solubility at Indicated Pressure chart (Table 2). The numbers should agree. If they do not agree to the accuracy of the instrument (usually ± 0.2 mg/L), repeat calibration. If this does not work, change the membrane and electrolyte solution. Insure that there are no air bubbles trapped below the membrane.

9. Remove the probe from the container and place it into a 0.0 mg/L DO standard. The standard must be filled to the top of its container and the DO probe must fit tightly into the standard's container (no head space). Check temperature readings. They must stabilize before continuing.

10. Wait until the "mg/l DO" readings have stabilized. The instrument should read 0.0 mg/L or to the accuracy of the instrument (usually ± 0.2 mg/L). If the instrument cannot reach these values, it will be necessary to clean the probe, and change the membrane and electrolyte solution. If this does not work, prepare a new 0.0 mg/L DO standard. If these measures do not work, contact manufacturer.

Note: To prepare a zero mg/L DO standard follow the procedure stated in Standard Methods (4500-O G; 18th edition). The method states to add excess sodium sulfite (until no more dissolves) and a trace amount of cobalt chloride to water. The standard container must be completely filled (no head space). This solution is prepared prior to the sampling event. If some of the solution is lost during instrument calibration, add more water to the container so that the standard is stored with no head space.

7.4 pH Meters

The pH of a sample is determined electrometrically using a glass electrode. There are a variety of instruments available to measure pH and temperature. There are pH test strips, indicator solutions, data loggers (e.g., Hydrolab minisonde) with pH sensors and hand-held DC powered pH meters. A pH meter must be calibrated/standardized daily prior to use (Standard Methods 4500-H^+ B; 18th Edition). If standardizing, select standard buffer solutions that bracket the pH range of the samples to be measured. The acceptance criterion is ±0.1 su. If pH standards 2 and 10 are used, pH 7 should be used as a check. When calibrating (two point calibration), use fresh (unused) buffer standards. The temperature probes of pH meters (if there is a readout displayed) should be checked for accuracy (acceptance criterion (±0.5°C) at the same time as pH calibration/standardization because temperature adjustments are made by the meters program in calculating the pH value. Properly label and dispose of all waste chemicals and materials. Dispose of hazardous wastes according with the Hazard Waste Management Guidance Document.

Calibration Procedure

1. Allow the fresh buffered standards to equilibrate to the ambient temperature.

2. Fill calibration containers with the fresh buffered standards so each standard will cover the pH probe and temperature sensor.

3. Remove probe from its storage container, rinse with distilled water, and blot dry with soft tissue.

4. Select monitoring/run mode. Immerse probe into the initial standard (e.g., pH 7).

5. Stir the standard until the readings stabilize. If the reading does not change within 30 seconds, select calibration mode and then select "pH". Enter the buffered standard value into instrument. Select monitoring/run mode. The readings should remain within manufacturer's specifications; if they change, re-calibrate. If readings continue to change after re-calibration, consult manufacturer.

6. Remove probe from the initial standard, rinse with distilled water, and blot dry.

7. Immerse probe into the second standard (e.g., pH 4). Repeat step 5.

8. Remove probe from the second standard, rinse with distilled water, and blot dry. If instrument only accepts two standards, the calibration is complete. Go to step 11. Otherwise continue.

9. Immerse probe in third buffered standard (e.g., pH 10) and repeat step 5.

10. Remove probe from the third standard, rinse with distilled water, and blot dry.

11. Select monitoring/run mode, if not already selected. To ensure that the initial calibration standard (e.g., pH 7) has not changed; immerse the probe into the initial standard. Wait for the readings to stabilize. The reading should read the initial standard value within the manufacturer's specifications. If not, re-calibrate the instrument. If recalibration does not help, the calibration range may be too great. Reduce calibration range by using standards that are closer together.

12. The calibration is complete. Place pH probe in its storage container.

7.5 Flowmeters

Flowmeters (e.g., General Oceanics, Inc.) are used in the openings of plankton nets to estimate the volume of water passing through the net during sampling. These mechanical meters record the revolutions of the impellers; the revolutions per unit time are used to calculate flow through the net. Flowmeters must be standardized once every 52 weeks. The accuracy of these meters is based on how freely the impeller spins, which is verified using a General Oceanics, Inc. Calibration Frame. The frame imparts a torsionally precise spin to the rotor and a count difference is noted in the flowmeter window. A minimum count is necessary for the flowmeter to be within calibration. The acceptance criterion for a General Oceanics, Inc. flowmeter is 80 revolutions per standard spin.

7.6 Temperature

Temperature data are collected with data loggers, thermometers, and thermistors in a variety of multiparameter meters (e.g., pH, D.O., and Conductivity/Salinity). Each instrument must have the accuracy of its temperature component verified because many of the other parameters change with temperature. "Reference Thermometers" are glass, capillary thermometers that have a read out accuracy 0.1°C and they have their accuracy verified with a certified thermometer once every 52 weeks. The acceptance criterion for Reference Thermometers is ±0.2°C. All other capillary thermometers used in the collection of data are standardized to the Reference Thermometers every 52 weeks (the acceptance criterion is ±0.5°C). Data loggers are standardized every 26 weeks (the acceptance criterion is ±0.5°C). Thermistors in multimeters are standardized every 13 weeks (the acceptance criterion is ±0.5°C).

Verification Procedure

1. Allow a container filled with water to come to room temperature.

2. Place a thermometer that is traceable to the National Institute of Standards and Technology (NIST) and the instrument's temperature sensor into the water and wait for both temperature readings to stabilize.

3. Compare the two measurements. The instrument's temperature sensor must agree with the reference thermometer measurement within the accuracy of the sensor (usually ±0.15°C). If the measurements do not agree, the instrument may not be working properly and the manufacturer needs to be consulted.

7.7 Turbidity

Turbidity meters are standardized with primary standards once every 13 weeks and with secondary standards prior to use. The meters are zeroed with de-ionized water prior to standardization and use. Primary standards are made up from mixing a powder in de-ionized water (4 standards are measured: <1, 20, 100, & 800 NTU) and the acceptance criterion is ±5%. Secondary standards are gels in the range of 5, 50, 500

NTU and the acceptance criterion is ±10%. De-ionized water is measured three times prior to measuring the gel standards.

The turbidity is based upon a comparison of intensity of light scattered by a sample under defined conditions with the intensity of light scattered by a standard reference suspension. A turbidimeter is a nephelometer with a visible light source for illuminating the sample and one or more photo-electric detectors placed ninety degrees to the path of the light source. Some instruments will only accept one standard. For these instruments, the standards will serve as check points.

Calibration Procedures

1. Allow the calibration standards to equilibrate at the ambient temperature. The use of commercially available polymer primary standards (AMCO-AEPA-1) is preferred, however, the standards can be prepared using Formazin according to the EPA analytical Method 180.1.

2. If the standard cuvette is not sealed, rinse a cuvette with deionized water. Shake the cuvette to remove as much water as possible. Do not wipe dry the inside of the cuvette because lint from the wipe may remain in the cuvette. Add the standard to the cuvette.

3. Before performing the calibration procedure, make sure the cuvettes are not scratched and the outside surfaces are dry, free from fingerprints and dust. If the cuvette is scratched or dirty, discard or clean the cuvette respectively.

4. Zero the instrument by using either a zero or 0.02 NTU standard. A zero standard (approximately 0 NTU) can be prepared by passing distilled water through a 0.45 micron pore size membrane filter.

5. Using a standard in the range of 5 - 20 NTUs, calibrate according to manufacturer's instructions or verify calibration if instrument will not accept a second standard. If verifying, the instrument should read standard value to within the specifications of the instrument. If the instrument has range of scales, check each range that will be used during the sampling event with a standard that falls within that range.

7. Using a standard between 20 and 100 NTUs, calibrate according to manufacturer's instructions or verify calibration if instrument does not accept a third standard. If verifying, the instrument should read standard value to within the specifications of the instrument. If the instrument has range of scales, check each range that will be used with the proper standard for that scale.

7.8 Weight

Precision balances with an accuracy of 0.001 to 0.00001 grams are calibrated once every 52 weeks by a vendor. All scales and balances used for collecting environmental data are standardized with a minimum of three standard weights (Class 4 or better) every 4 weeks. Personnel using balances to collect weight data need to check the calibration sticker for the standardization expiration date and the range of the standardization. If weight measurements are being made outside the documented standardization range, a new weight range bracketing the expected measurements needs to be used in standardizing the balance.

7.9 Oxidation/Reduction Potential (ORP)

The oxidation/reduction potential is the electrometric difference measured in a solution between an inert indicator electrode and a suitable reference electrode. The electrometric difference is measured in millivolts (mV) and is temperature dependent. ORP is calibrated using one-point calibration with a Zobell solution. The acceptance criteria for ORP standard potential should be within ±10 mV at a defined temperature.

Calibration Procedure

1. Allow the calibration standard (a Zobell solution) to equilibrate to ambient temperature.

2. Remove the probe from its storage container, and place it into the standard.

3. Select monitoring/run mode.

4. While stirring the standard, wait for the probe temperature to stabilize, and then read the temperature.

5. Look up the millivolt (mv) value at this temperature from the millivolt versus Temperature (Table 3) correction table usually found on the standard bottle or on the standard instruction sheet. You may need to interpolate millivolt value between temperatures. Select "calibration mode", then "ORP". Enter the temperature-corrected ORP value into the instrument.

6. Select monitoring/run mode. The readings should remain unchanged within manufacturer's specifications. If they change, re-calibrate. If readings continue to change after re-calibration, consult manufacturer.

7. If the instrument instruction manual states that the instrument is factory calibrated, then verify the factory calibration against the standard. If they do not agree within the specifications of the instrument, the instrument will need to be re-calibrated by the manufacturer.

8.0 Contacts

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9.0 Tables

Table 1. Calibration and Standardization Protocols

Parameter	Method	Interval	Standard	Acceptance Criterion	Calib./Stand. Method	Comments
Chlorine	Test Kit (gel standard)	Weekly	0.20 mg/L, 0.83 mg/L, 1.53 mg/L	±15%	Standardization	Zero meter to blank prior to measuring gel standards.
	Test Kit (ampule standard)	13 wks	Total Chlorine 0.12 (0.02 to 0.22) mg/L 0.60 (0.40 to 0.80) mg/L 1.20 (0.90 to 1.50) mg/L	±20%	Standardization	Record concentrations to 0.01 mg/L. Zero meter to blank prior to measuring standards.
Conductivity (specific conductance)	Instrument/Meter	13 wks	Freshwater 0.05-1.00 mS/cm	±5%	Standardization	If standard temperature is 25°C±1, standardize to specific conductance or conductivity.
			Seawater 40-60 mS/cm	±5%	Standardization	
	Reference Meter	4 wks	Freshwater 0.05-1.00 mS/cm	±5%	Standardization	
			Seawater 40-60 mS/cm	±5%	Standardization	

Parameter	Method	Interval	Standard	Acceptance Criterion	Calib./Stand. Method	Comments
Dissolved Oxygen	Reference/Instrument/Meter	4 wks	Azide – Winkler method using potassium iodide – iodate solution with an equivalent DO concentration of about 10 mg/L	±0.05 mg/L	Standardization	For dissolved oxygen, air calibrate prior to comparing to standard and record the temperature of standard.
	Optical DO Meter	4 wks	Azide – Winkler method using potassium iodide – iodate solution with an equivalent DO concentration of about 10 mg/L or Reference Meter	±0.05 mg/L	Standardization	
	Test Kit	52 wks	Azide – Winkler method using potassium iodide – iodate solution with an equivalent DO concentration of about 10 mg/L or Reference Meter	±0.05 mg/L	Standardization	
	Test Kit Instrument/Meter	Air calibrate prior to use	Azide – Winkler method using potassium iodide – iodate solution with an equivalent DO concentration of about 10 mg/L or Reference Meter	±0.05 mg/L	Standardization	
ORP	Instrument/Meter	Prior to use	Zobell's Solution	±10mV	Calibration	

Parameter	Method	Interval	Standard	Acceptance Criterion	Calib./Stand. Method	Comments
pH	AC Counter Top Units	Daily/Weekly	4.0, 7.0, and 10.0 Buffers	±0.1 su	Two Point Calibration or Standardization	Daily when meter is first turned on or weekly if meter remains on
	Battery Powered Portable Units	Day-of-Use	4.0, 7.0, and 10.0 Buffers	±0.1 su	Two Point Calibration or Standardization	Day-of-Use = 24 hour period following the last meter calibration or standardization
Flowmeter	Calibration Fame	52 wks	Standard spin	at least 80 revolutions	Standardization	General Oceanics Inc. Method
Salinity (specific conductance)	Visual Inspection	13 wks	Manufacturer's recommendations	Good condition	Equipment Check	Batteries are replaced every 13 weeks
	Reference Meter	4 wks	Freshwater 0.05-1.00 mS/cm	±5%	Standardization	If standard temperature is 25°C±1, standardize to specific conductance or conductivity.
	Instrument/Meter	13 wks	Seawater 40-60 mS/cm	±5%	Standardization	
	Instrument/Meter	13 wks	Freshwater 0.05-1.00 mS/cm	±5%	Standardization	
	Instrument/Meter	13 wks	Seawater 40-60 mS/cm	±5%	Standardization	

Parameter	Method	Interval	Standard	Acceptance Criterion	Calib./Stand. Method	Comments
Temperature	Reference Thermometer	52 wks	Certified Thermometer	±0.2°C	Three Temperatures to 0.1 °C accuracy	If deviation is greater than 0.1 °C, attach a tag with the correction factor to 0.1 °C or replace the thermometer
	Thermistor	13 wks	Reference Thermometer	±0.5°C	One temperature to 0.1 °C accuracy	
	Thermometer	52 wks	Reference Thermometer	±0.5°C	One temperature to 0.1 °C accuracy	For thermometers with 1 °C increments, record temperature to 0.2 °C and for thermometers with 0.1 °C increments to 0.1 °C
	Data Logger	26 wks	Reference Thermometer	±0.5°C	One temperature to 0.1 °C accuracy	
Turbidity	Primary Standard	13 wks	4 Standards (<1, 20, 100, & 800 NTU)	±5%	Standardization	Zero meter to de-ionized water.
	Secondary Standard	Prior to Use	Gel Standards (0-10, 10-100, 100-1000 NTU)	±10%	Standardization	Measure de-ionized water three times prior to measuring gel standards.
Weight	Balance	4 wks	Minimum of three reference weights	±5% Reference Weight	Standardization	Two weights should bracket the expected range for which the balance will be used and the third weight should be at an approximate mid-range.

Table 2. Oxygen Solubility (mg/L) at Indicated Pressure

	Atmospheric Pressure (mm Hg)						
Temp. °C	760	755	750	745	740	735	730
0	14.57	14.47	14.38	14.28	14.18	14.09	13.99
1	14.17	14.08	13.98	13.89	13.79	13.70	13.61
2	13.79	13.70	13.61	13.52	13.42	13.33	13.24
3	13.43	13.34	13.25	13.16	13.07	12.98	12.90
4	13.08	12.99	12.91	12.82	12.73	12.65	12.56
5	12.74	12.66	12.57	12.49	12.40	12.32	12.23
6	12.42	12.34	12.26	12.17	12.09	12.01	11.93
7	12.11	12.03	11.95	11.87	11.79	11.71	11.63
8	11.81	11.73	11.65	11.57	11.50	11.42	11.34
9	11.53	11.45	11.38	11.30	11.22	11.15	11.07
10	11.28	11.19	11.11	11.04	10.96	10.89	10.81
11	10.99	10.92	10.84	10.77	10.70	10.62	10.55
12	10.74	10.67	10.60	10.53	10.45	10.38	10.31
13	10.50	10.43	10.36	10.29	10.22	10.15	10.08
14	10.27	10.20	10.13	10.06	10.00	9.93	9.86
15	10.05	9.98	9.92	9.85	9.78	9.71	9.65
16	9.83	9.76	9.70	9.63	9.57	9.50	9.43
17	9.63	9.57	9.50	9.44	9.37	9.31	9.24
18	9.43	9.37	9.30	9.24	9.18	9.11	9.05
19	9.24	9.18	9.12	9.05	8.99	8.93	8.87
20	9.06	9.00	8.94	8.88	8.82	8.75	8.69
21	8.88	8.82	8.76	8.70	8.64	8.58	8.52
22	8.71	8.65	8.59	8.53	8.47	8.42	8.36
23	8.55	8.49	8.43	8.38	8.32	8.26	8.20
24	8.39	8.33	8.28	8.22	8.16	8.11	8.05
25	8.24	8.18	8.13	8.07	8.02	7.96	7.90
26	8.09	8.03	7.98	7.92	7.87	7.81	7.76
27	7.95	7.90	7.84	7.79	7.73	7.68	7.62
28	7.81	7.76	7.70	7.65	7.60	7.54	7.49
29	7.68	7.63	7.57	7.52	7.47	7.42	7.36
30	7.55	7.50	7.45	7.39	7.34	7.29	7.24
31	7.42	7.37	7.32	7.27	7.22	7.16	7.11
32	7.30	7.25	7.20	7.15	7.10	7.05	7.00
33	7.08	7.13	7.08	7.03	6.98	6.93	6.88

34	7.07	7.02	6.97	6.92	6.87	6.82	6.78
35	6.95	6.90	6.85	6.80	6.76	6.71	6.66
36	6.84	6.79	6.76	6.70	6.65	6.60	6.55
37	6.73	6.68	6.64	6.59	6.54	6.49	6.45
38	6.63	6.58	6.54	6.49	6.44	6.40	6.35
39	6.52	6.47	6.43	6.38	6.35	6.29	6.24
40	6.42	6.37	6.33	6.28	6.24	6.19	6.15
41	6.32	6.27	6.23	6.18	6.14	6.09	6.05
42	6.22	6.18	6.13	6.09	6.04	6.00	5.95
43	6.13	6.09	6.04	6.00	5.95	5.91	5.87
44	6.03	5.99	5.94	5.90	5.86	5.81	5.77
45	5.94	5.90	5.85	5.81	5.77	5.72	5.68

Table 2 (cont'd). Oxygen Solubility (mg/L) at Indicated Pressure

	Atmospheric Pressure (mm Hg)							
Temp. °C	725	720	715	710	705	700	695	690
0	13.89	13.80	13.70	13.61	13.51	13.41	13.32	13.22
1	13.51	13.42	13.33	13.23	13.14	13.04	12.95	12.86
2	13.15	13.06	12.07	12.88	12.79	12.69	12.60	12.51
3	12.81	12.72	12.63	12.54	12.45	12.36	12.27	12.18
4	12.47	12.39	12.30	12.21	12.13	12.04	11.95	11.87
5	12.15	12.06	11.98	11.89	11.81	11.73	11.64	11.56
6	11.84	11.73	11.68	11.60	11.51	11.43	11.35	11.27
7	11.55	11.47	11.39	11.31	11.22	11.14	11.06	10.98
8	11.26	11.18	11.10	11.02	10.95	10.87	10.79	10.71
9	10.99	10.92	10.84	10.76	10.69	10.61	10.53	10.46
10	10.74	10.66	10.59	10.51	10.44	10.36	10.29	10.21
11	10.48	10.40	10.33	10.28	10.18	10.11	10.04	9.96
12	10.24	10.17	10.10	10.02	9.95	9.88	9.81	9.46
13	10.01	9.94	9.87	9.80	9.73	9.66	9.59	9.52
14	9.79	9.72	9.65	9.68	9.51	9.45	9.38	9.31
15	9.58	9.51	9.44	9.58	9.31	9.24	9.18	9.11
16	9.37	9.30	9.24	9.17	9.11	9.04	8.97	8.91
17	9.18	9.11	9.05	8.98	8.92	8.85	8.79	8.73
18	8.99	8.92	8.86	8.80	8.73	8.67	8.61	8.54
19	8.81	8.74	8.68	8.62	8.56	8.49	8.43	8.37

20	8.63	8.57	8.51	8.45	8.39	8.33	8.27	8.21
21	8.46	8.40	8.34	8.28	8.22	8.16	8.10	8.04
22	8.30	8.24	8.18	8.12	8.06	8.00	7.95	7.89
23	8.15	8.09	8.03	7.97	7.91	7.86	7.80	7.74
24	7.99	7.94	7.88	7.82	7.76	7.71	7.65	7.59
25	7.85	7.79	7.74	7.68	7.60	7.57	7.51	7.46
26	7.70	7.65	7.59	7.54	7.48	7.43	7.37	7.32
27	7.57	7.52	7.46	7.41	7.35	7.30	7.25	7.19
28	7.44	7.38	7.33	7.28	7.22	7.17	7.12	7.06
29	7.31	7.26	7.21	7.15	7.10	7.05	7.00	6.94
30	7.19	7.14	7.08	7.03	6.98	6.93	6.88	6.82
31	7.06	7.01	6.96	6.91	6.86	6.81	6.76	6.70
32	6.95	6.90	6.85	6.80	6.70	6.70	6.64	6.59
33	6.83	6.78	6.73	6.68	6.83	6.58	6.53	6.48
34	6.73	6.68	6.63	6.58	6.53	6.48	6.43	6.38
35	6.61	6.56	6.51	6.47	6.42	6.37	6.36	6.27
36	6.51	6.46	6.41	6.36	6.31	6.27	6.22	6.17
37	6.40	6.35	6.31	6.26	6.21	6.16	6.12	6.07
38	6.30	6.26	6.21	6.16	6.12	6.07	6.02	5.98
39	6.26	6.15	6.11	6.06	6.01	5.97	5.92	5.87
40	6.10	6.06	6.01	5.96	5.92	5.86	5.83	5.78
41	6.00	5.96	5.91	5.87	5.82	5.78	5.73	5.69
42	5.91	5.86	5.82	5.77	5.73	5.69	5.64	5.60
43	5.82	5.78	5.73	5.69	5.65	5.60	5.56	5.51
44	5.72	5.68	5.64	5.59	5.55	5.51	5.46	5.42
45	5.64	5.59	5.55	5.51	5.47	5.42	5.38	5.34

Table 3. Temperature Dependency of Zobell's ORP Standard

Temp. °C	mV
10	243.5
15	236.0
20	228.5
25	221.1

11.0

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Appendix C

Lists of Data to be Collected and Recorded for Field Collection and Laboratory Analysis

Minimum Entrainment Sample Collection Data

Category	Parameter	Value			
General Information	Crew Names				
	Date				
	Time (military)				
	Tidal Phase				
Weather Condition	Air Temp. (^{o}C)				
	Wind Direction				
	Wind Speed (MPH)				
	Sky				
	Precipitation (in)				
	Wave Height (ft)				
Facility Operation	Circulating Pump Status				
	Screen Status				
	Screen Wash Status				
Sampling Location	Unit/Bar Rack	Unit #	Bar Rack ID		
	Time (military)	Start	End		
	Duration (min.)	Calculated			
Flow meter Readings	Time (military)	Meter	Start	End	
	Flow (m^3)	Meter	Start	End	
	Total Volume (m^3)	Calculated			
Water Quality	Time (military)				
	Depth (ft)	Reading	Surface	Mid	Bottom
	Temp. (^{o}C)	Meter	Surface	Mid	Bottom
	DO (mg/L)	Meter	Surface	Mid	Bottom
	Specific Cond. (µs)	Meter	Surface	Mid	Bottom
	Specific Cond. @ 25 ^{o}C (µs)	Calculated			
	Salinity (ppt)	Calculated	Surface	Mid	Bottom
	pH	Meter	Surface	Mid	Bottom
Water Quality QC	Temp. (^{o}C)	Bottle			
	DO (mg/L)	Bottle			
	Specific Cond. (µs)	Bottle			
	pH	Bottle			
Gear Used	Mesh size (µm)				
	Dimension				
	Configuration				
Sample Collection	IP Sample Bottle #	Label	Surface	Mid	Bottom
Observations	Vegetation	Note	Light	Moderate	Heavy
	Invertebrates	Note	Light	Moderate	Heavy
	Vertebrates	Note	Light	Moderate	Heavy
Comments					
Crew Signature					

Minimum Entrainment Sample Laboratory Data Sheet

Category	Parameter	Value
Enumeration	Date/Time	
	Sample ID	
	Species Taxon Name	
	Egg	Split Fraction Count Egg
	Larvae	Split Fraction Count UID YS PYS JUV
	Total Larvae	Count
	Total Shellfish	Count
	Comments	
Morphometrics	Date/Time	
	Sample Number	
	Species Taxon Name	
	Lifestage	
	Total Length / Notochord Length (mm)	
	Body Depth / Width (mm)	
	Head Capsule Depth / Width (mm)	
	Greatest Body Depth / Width (mm)	
	Diameter, Max and Min (eggs only; mm)	
	Greatest Body Length, Width & Depth (Blue Crab only for each life stage; mm)	
	Maximum Widths and Depths based on carapace (Megalopa and later life stage only; mm)	
	Comments	

Note: UID = Unidentified; YS = Yolk Sac; PYS = Post Yolk Sac; JUV = Juvenile

DRAFT Impingement Characterization Study Plan

Prepared for:
Dominion Resources Services, Inc.

Prepared by:
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May 29, 2016

Surry Power Station

Surry, VA 23883

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1 Introduction

1.1 Regulatory Background

Clean Water Act §316(b) was enacted under the 1972 Clean Water Act, which also introduced the National Pollutant Discharge Elimination System (NPDES) permit program. Facilities with NPDES permits are subject to §316(b), which requires that the location, design, construction and capacity of cooling water intake structures (CWIS) reflect best technology available (BTA) for minimizing adverse environmental impacts. Cooling water intakes can cause adverse environmental impacts by drawing early life-stage fish and shellfish into and through cooling water systems (entrainment), or trapping juvenile or adult fish against the screens at the opening of an intake structure (impingement).

On August 15, 2014, the final §316(b) Rule for existing facilities was published in the Federal Register. The Rule applies to existing facilities that withdraw more than 2 million gallons per day (MGD) from Waters of the United States, use at least 25 percent of that water exclusively for cooling purposes, and have or require an NPDES permit. The Rule supersedes the Phase II Rule, which regulated large electrical generating facilities until it was remanded in 2007, and the remanded existing-facility portion of the previously promulgated Phase III Rule.

Facilities subject to the new Rule are required to develop and submit technical material, identified at §122.21(r)(2)-(13), that will be used by the NPDES Director (Director) to make a BTA determination for the facility (Table 1-1). The specific material required to be submitted and compliance schedule are dependent on actual intake flow rates at the facility and NPDES permit renewal date, respectively. Facilities are to submit their §316(b) application material to their Director along with their next permit renewal, unless that permit renewal takes place prior to July 14, 2018, in which case an alternate schedule may be negotiated.

Dominion's Surry Power Station (SPS) is subject to the existing facility Rule and based on its current configuration and operation is anticipated to be required to develop and submit each of the §122.21(r)(2)-(13) submittal requirements with its next permit renewal in accordance with the Rule's technical and schedule requirements. Within the §122.21(r)(2)-(13) requirements, (r)(4) and (6) have specific requirements related to impingement data and evaluations (refer to Table 1-1 for details). While these requirements do not specify that an Impingement Characterization Study must be conducted, Dominion has determined that one is warranted based on the following anticipated benefits:

- Ability to document current impingement at SPS where recent impingement data is not available to supplement data to be provided pursuant to§122.21(r)(4) and potentially inform the chosen method of compliance pursuant to (r)(6); and
- Understanding the nature of current impingement at SPS to evaluate potential effectiveness of alternative technologies and determination of fragile species composition.

Table 1-1. §316(b) Rule for Existing Facilities Submittal Requirements Summary

Submittal Requirements at §122.21(r)		Submittal Descriptions
(2)	Source Water Physical Data	Characterization of the source water body including intake area of influence
(3)	Cooling Water Intake Structure Data	Characterization of cooling water system; includes drawings and narrative; description of operation; water balance
(4)	Source Water Baseline Biological Characterization data	Characterization of biological community in the vicinity of the intake; life history summaries; susceptibility to impingement and entrainment; must include existing data; identification of missing data; threatened and endangered species and designated critical habitat summary for action area; identifies fragile fish and shellfish species list (<30 percent impingement survival)
(5)	Cooling Water System Data	Narrative description of cooling water system and intake structure; proportion of design flow used; water reuse summary; proportion of source water body withdrawn (monthly); seasonal operation summary; existing impingement mortality and entrainment reduction measures; flow/MW efficiency
(6)	Chosen Method of Compliance with Impingement Mortality Standard	Provides facility's proposed approach to meet the impingement mortality requirement (chosen from seven available options); provides detailed study plan for monitoring compliance, if required by selected compliance option; addresses entrapment where required
(7)	Entrainment Performance studies	Provides summary of relevant entrainment studies (latent mortality, technology efficacy); can be from the facility or elsewhere with justification; studies should not be more than 10 years old without justification; new studies are not required.
(8)	Operational Status	Provides operational status for each unit; age and capacity utilizations for the past five years; upgrades within last 15 years; uprates and Nuclear Regulatory Committee relicensing status for nuclear facilities; decommissioning and replacement plans; current and future operation as it relates to actual and design intake flow
(9)	Entrainment Characterization Study	Requires at least two years of data to sufficiently characterize annual, seasonal, and diel variations in entrainment, including variations related to climate, weather, spawning, feeding, and water column migration; facilities may use historical data that are representative of current operation of the facility and conditions at the site with documentation regarding the continued relevance of the data to document total entrainment and entrainment mortality; includes identifications to the lowest taxon possible; data must be representative of each intake; must document how the location of the intake in the water body and water column are accounted for; must document intake flows associated with the data collection; documentation in the study must include the method in which latent mortality would be identified (including QAQC); sampling and data must be appropriate for a quantitative survey
(10)	Comprehensive Technical Feasibility & Cost Evaluation Study	Provides an evaluation of technical feasibility and incremental costs of entrainment technologies; Net Present Value of facility compliance costs and social costs to be provided; requires peer review
(11)	Benefits Valuation Study	Provides a discussion of monetized and non-monetized water quality benefits of candidate entrainment technologies from (r)(10) using data in (r)(9); benefits to be quantified physical or biological units and monetized using appropriate economic valuation methods; includes changes in fish stock and harvest levels and description of monetization; must evaluate thermal discharges, facility capacity, operations, and reliability; discussion of previous mitigation efforts and affects; benefits to environment and community; social benefits analysis based on principle of willingness-to-pay; requires peer review
(12)	Non-Water Quality Environmental and Other Impacts Assessment	Provides a discussion of non-water quality factors (air emissions and their health and environmental impacts, energy penalty, thermal discharge, noise, safety, grid reliability, consumptive water use, etc.) attributable to the entrainment technologies; requires peer review
(13)	Peer Review	Documentation of external peer review, by qualified experts, of submittals (r) (10), (11), and (12). Peer Reviews must be approved by the NPDES Director and present their credentials. The applicant must explain why it disregarded any significant peer reviewer recommendations.

1.2 Study Plan Objectives and Document Organization

The Impingement Characterization Study Plan provided in this report was developed to support the SPS §316(b) compliance project through development of a site-specific impingement study plan that meets and exceeds the requirements of the §316(b) Rule with the following key objectives in mind:

1. Collect data to supplement the submission of data required under §122.21(r)(4), including a list of species and life stages most susceptible to impingement at the facility including documentation of fragile fish and shellfish species (those with < 30% impingement survival)[1];

2. Collect data to support Dominion's objective of having data sufficient to evaluate biological efficacy of potential alternative intake technologies.

To meet these objectives, this document provides summaries of the station's configuration and operations (Section 2), historical biological sampling efforts conducted at the facility that are relevant to cooling water intake evaluations (Section 3), a summary of Threatened and Endangered Species identified in the vicinity of the facility (Section 4), a sampling program design justification based on this information (Section 5), and the recommended study methods including key parameters of gear, schedule, frequency, and quality control procedures (Section 6).

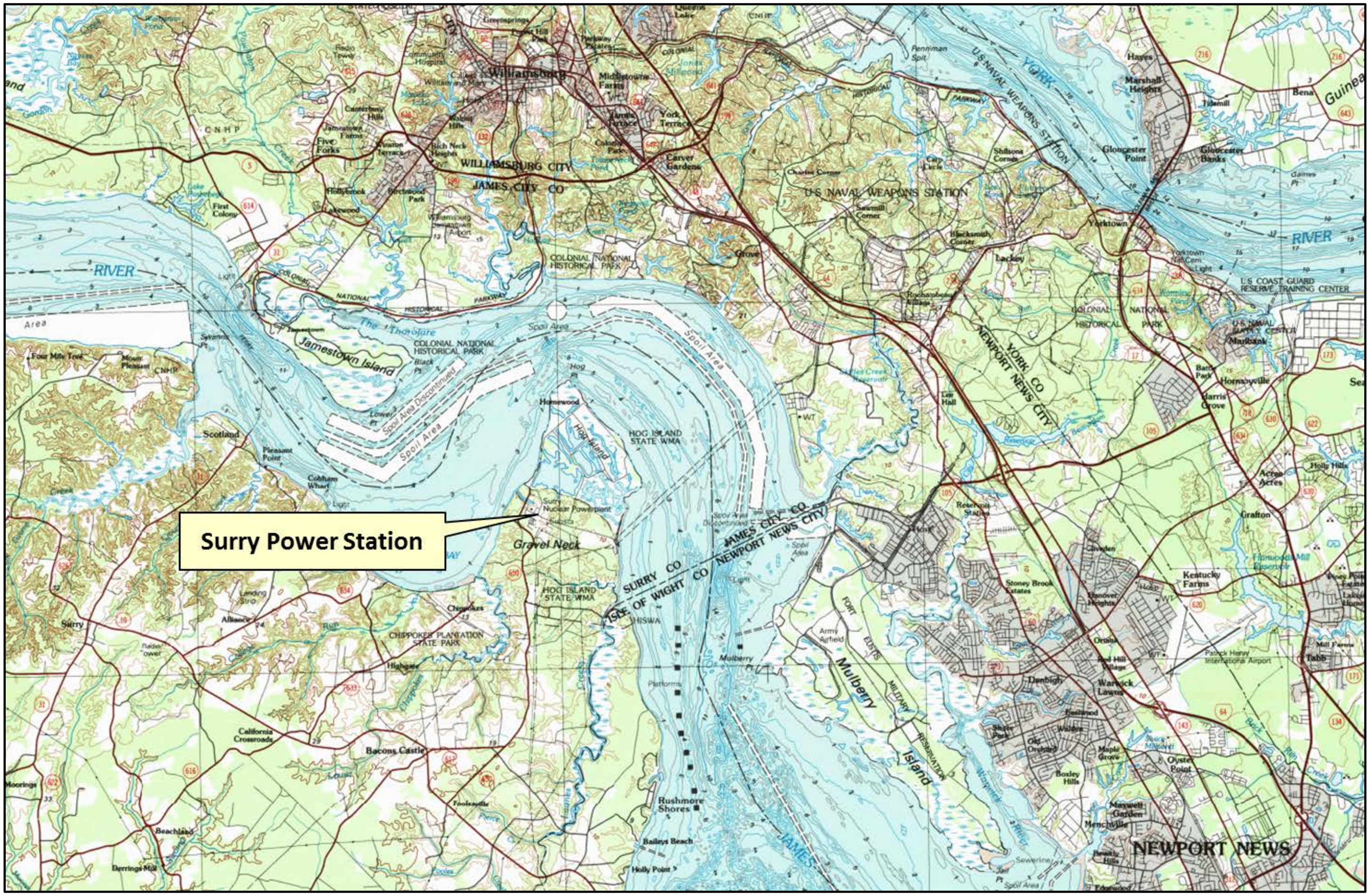
2 Generating Station Description

2.1 Site and Environmental Description

The two nuclear power-generating units at SPS use a once-through cooling water system. Cooling water for both units is withdrawn from the James River through a common Low-level Cooling Water Intake Structure (CWIS) oriented parallel to, and flush with, the western shore of the James River. SPS is located on the estuarine portion of the James River on the Hog Island peninsula in Surry County Virginia, approximately 25 miles upstream of the river's confluence with the Chesapeake Bay (Figure 2-1). SPS is located approximately 44 miles southeast of Richmond and 9 miles south of Williamsburg. The SPS Low-level CWIS for the two units is located on the east side of the peninsula (Figure 2-2).

The James River watershed encompasses approximately 10,000 square miles, which makes up almost 25 percent of the state. The James River watershed covers about one-third of the Chesapeake Bay drainage area in Virginia. The river flows approximately 340 miles from the Alleghany Mountains of western Virginia to the Chesapeake Bay.

[1] 40 C.F.R. § 122.21(r)(4) requires applicant to submit available Source Water Baseline Biological Characterization data.



Map Source: USGS Topographic Map of Williamsburg, VA; Map ID #37076-A1-TB-100 (1984)

Figure 2-1. Surry Power Station Regional Location Map

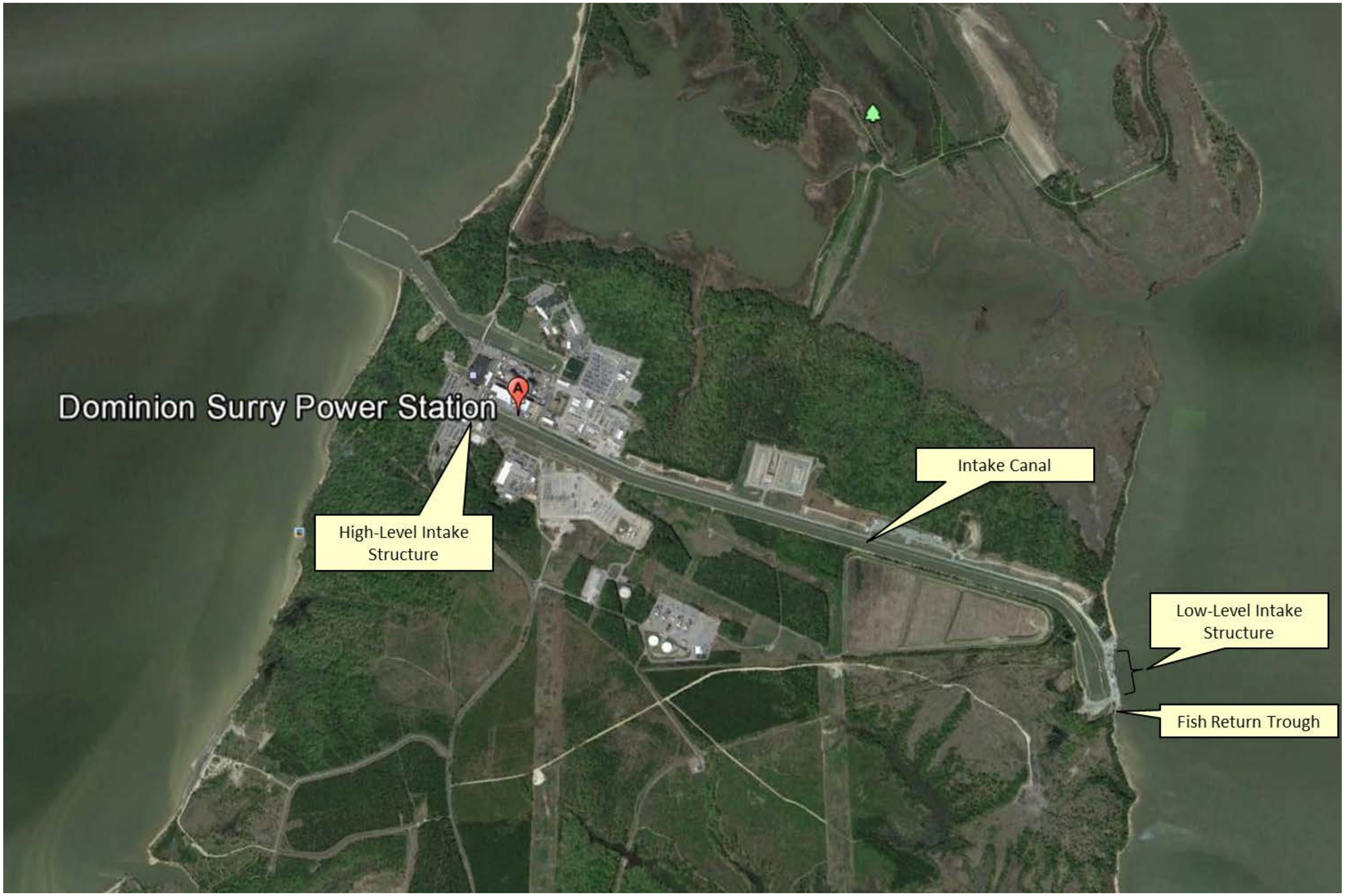
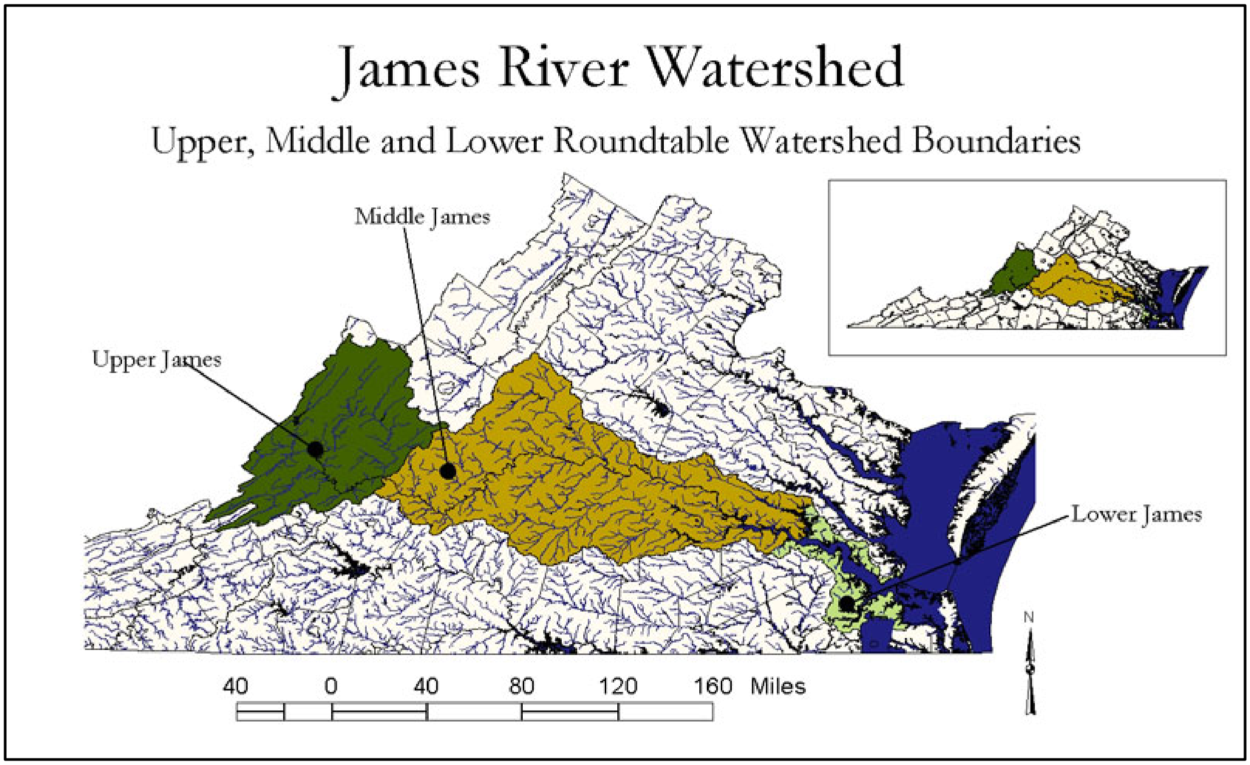


Image Source: Google Earth Retrieved September 8, 2014

Figure 2-2. Aerial View of Surry Power Station

The watershed is comprised of three sections: the Upper James watershed begins in Allegheny County and travels through the Allegheny and Blue Ridge Mountains until Lynchburg, the Middle James watershed runs from Lynchburg to Richmond, while the Lower James watershed stretches from Richmond to the Chesapeake Bay (Figure 2-3).

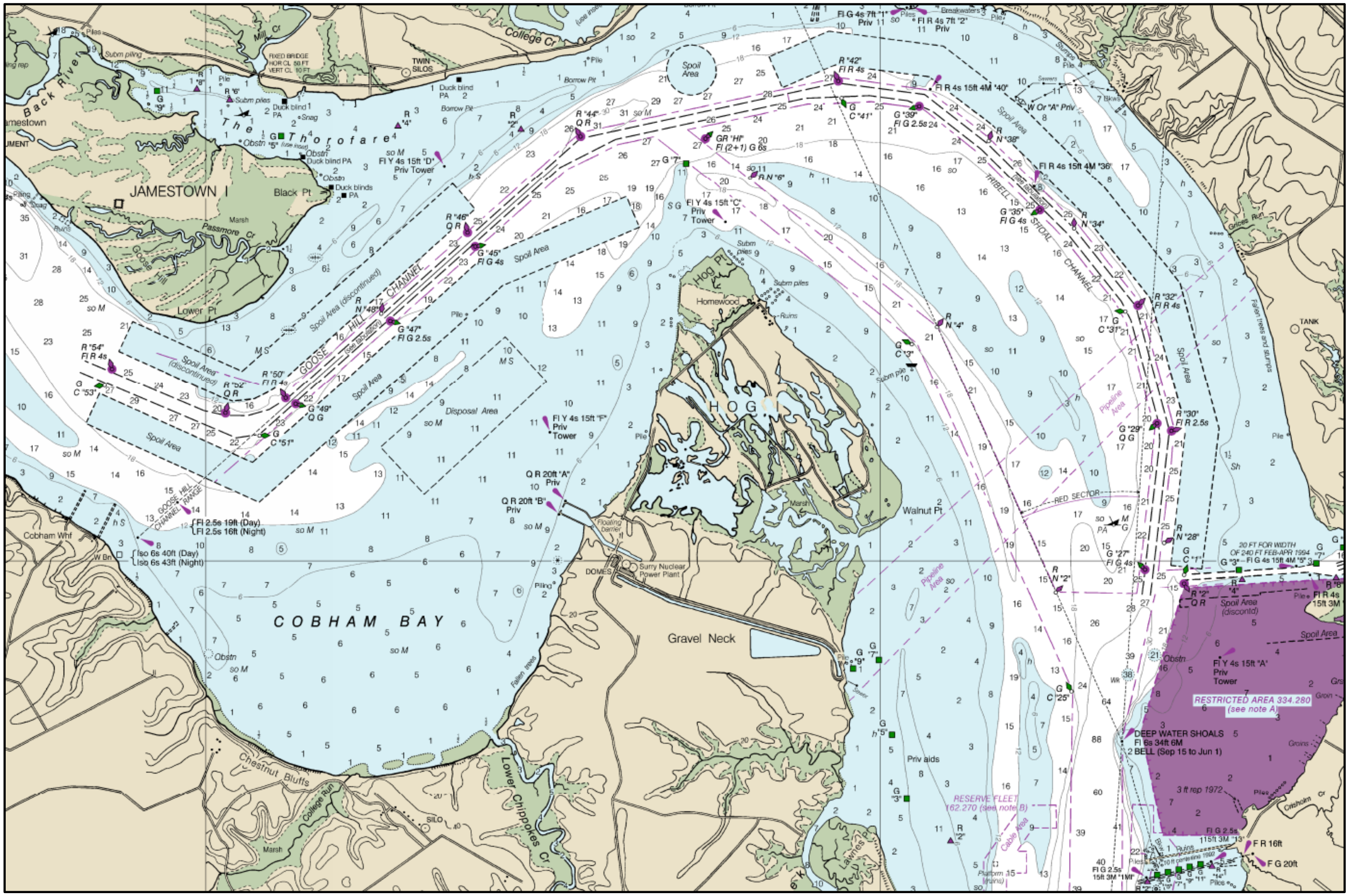


Source: Middle James Roundtable

Figure 2-3. The James River Watershed

SPS is located on the Lower James River section in the Coastal Uplands Physiographic Province. The James River is approximately 3 miles wide at the SPS location. The land surface is generally flat with steep banks sloping down to the river. Land surface elevations at SPS range from sea level to approximately elevation (EL.) +39 feet. Water elevations at SPS are affected by tides with a mean low tide water level of EL. -1.0 foot and a high tide level of EL. 1.1 feet, resulting in a mean tidal range of 2.1 feet and a mean spring tidal range of 2.5 feet. The average water depth in front of the SPS intakes is 26 feet deep. The average maximum ebb and flood tidal currents at SPS are 2.23 ft/s (0.68 m/s) and 1.90 ft/s (0.58 m/s), respectively. The maximum James River flow at the site is approximately 420,000 cubic feet per second (cfs), with a monthly mean range of 857 cfs to 39,778 cfs.

A navigation channel is maintained at 24.9 feet and generally courses through the middle of the river. In the vicinity of the SPS CWIS, the river has an abbreviated littoral or shoreline zone as a result of steep bank elevations and the channelized river bottom. The river bed in the vicinity of SPS is composed of soft mud, clay, sand, and pebbles with no single bottom type predominating. General river depths in the region of SPS are provided in the navigational chart provided in Figure 2-4.



Source: NOAA Office of Coast Survey Chart 12248 (noaa.gov) Retrieved September 7, 2014

Figure 2-4. General River Depths in the Vicinity of Surry Power Station (Soundings in Feet at Mean Lower Low Water)

Salinity concentrations in the James River in the vicinity of SPS characterize the area as the transition region between salt and freshwater. Depending primarily on river discharge, salinity concentrations in the vicinity of SPS can range from 0 ppt to approximately 21 ppt. Despite the large range in salinity covering several salinity zone classifications, for the purposes of this report an oligohaline zone classification (salinity range 0.5-5.0 ppt) is considered representative. River temperatures in the vicinity of the station ranged from 1.8 ˚C to 33.8 ˚C, during 1975-1976 (VEPCO 1977).

2.2 Station Description

2.2.1 Station Operational History

SPS is a base-load facility which means the facility serves as one of Dominion's primary means of generating the minimum amount of power necessary to meet customer demands. Accordingly, the facility generally operates twenty-four hours per day, seven days per week, although there is seasonal variation in its operations and maintenance. In the summer months, all pumps are in operation to meet thermal transfer requirements. Generally, in the winter not all eight circulating water pumps operate. Maintenance outages on the generating units are scheduled at regular intervals. The duration of the maintenance outages depends on the type of outage and the scheduled work that needs to be done on the units.

2.2.2 Intake Structure

The two nuclear power-generating units at SPS use a once-through cooling water system. When the facility is generating power, the circulating cooling water system is in operation. Cooling water for both units is withdrawn from the James River through a common Low-level CWIS oriented parallel to, and flush with, the western shore of the James River (Figure 2-5). The total design flow at SPS with all pumps working to capacity is approximately 2,535 million gallons per day (MGD) [i.e., 3,922 cfs] to meet the water requirements of the power station. Approximately 95 percent of the flow withdrawn from the James River is used for cooling water purposes. The remaining water withdrawn is used in the sluice, seals, and screen wash.

At the intake structures, the James River is approximately 3 miles wide and 26 feet deep and flows in a generally southerly direction. The Low-level CWIS consists of eight screen bays and is equipped with eight Ristroph traveling water screens. Eight circulating water pumps, located downstream of each low-level screen, convey screened water flow to a common high-level intake canal for both units. Water flows down the high-level intake canal to a secondary (high-level intake) screen house at the facility with conventional traveling water screens.

Trash racks extend across each of the eight intake bays to prevent debris from entering the Low-level intakes. Each trash rack has 1/2-inch-wide fiberglass reinforced plastic bars with 4.0-inch spacing, providing a 3.5-inch clear opening. The trash racks have a 1H:12V slope and are 18 feet wide. A curtain wall extends down to El. -8.5 feet, approximately 3.8 feet below the minimum water level, approximately 6 feet downstream of each trash rack.

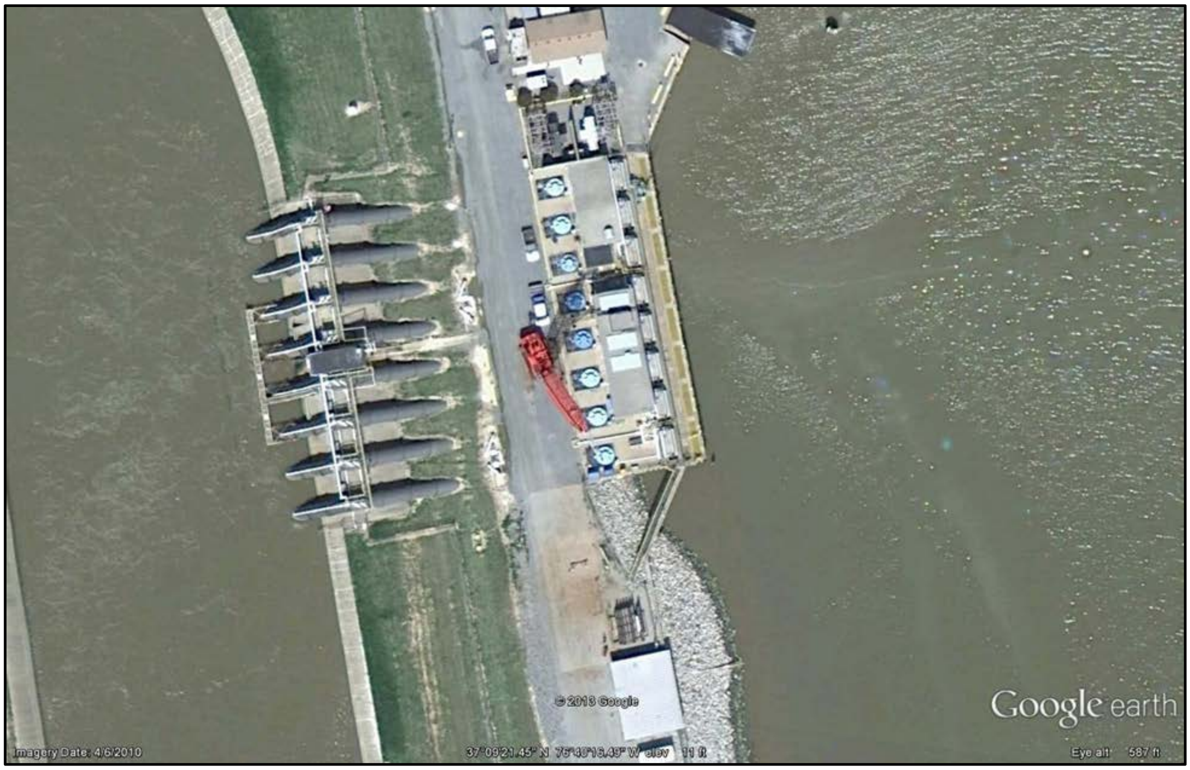
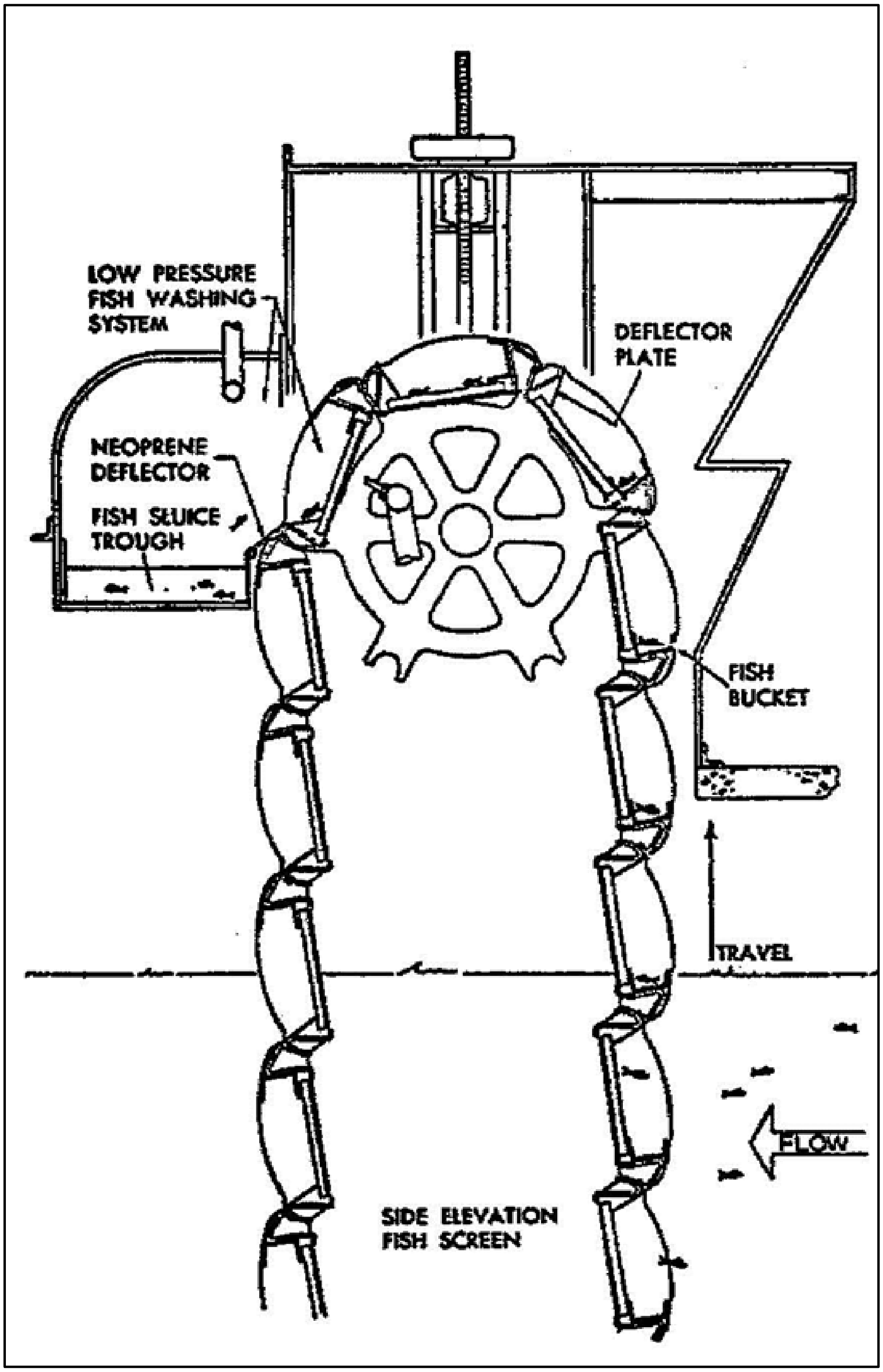


Figure 2-5. Low-level Intake Structure Location (37˚09'22" N, 76˚40'16" W)

The intake contains eight screen bays (15.3 feet wide), equipped with Ristroph traveling water screens (See Figure 2-6) located approximately 17 feet downstream from the bottom of each trash rack. The Low-level intake is the §316(b) compliance point at SPS. Plan and section views of the Low-level CWIS are provided on Figures 2-7 and 2-8, respectively.The screens at SPS have been modified substantially from their original design. Prior to 1974, SPS had conventional traveling screens at the high-level intake structure and no screens at the Low-level intake structure. Starting in 1974, the Low-level intake was fitted with modified Ristroph traveling water screens to maximize fish survival potential. These Ristroph traveling water screens contained 2 foot-high and 14 foot-wide baskets with 3/8-inch [0.146 square inch (in^2)] square mesh openings.

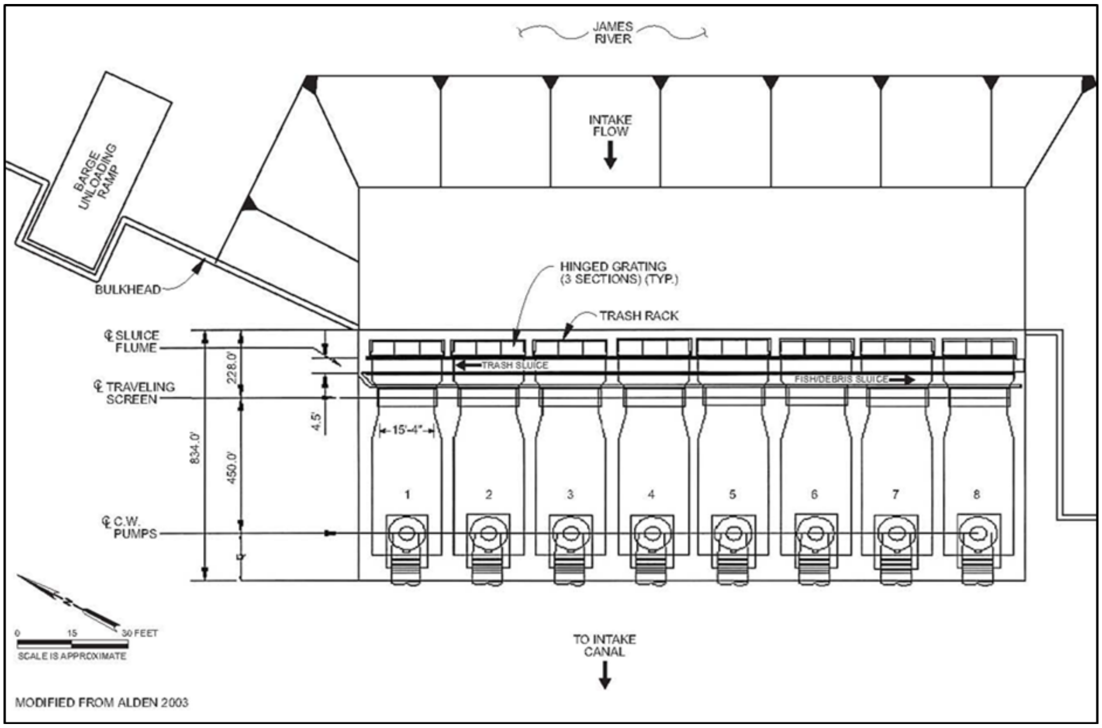
In the early 1990s, the original Ristroph traveling water screens were modified to include 1/8-inch by 1/2-inch rectangular mesh openings. Each screen basket has a 2 inch-deep by 5.5 inch-wide steel fish bucket. The screens are designed for continuous operation and can rotate at a slow speed (approximately 5 feet per minute (ft/min)) or a fast speed (approximately 10 ft/min) in a manual mode. At times of high fish abundance or low river levels, the screens can be rotated at fast speed, reducing impingement time to approximately 1.5 minutes or less.

The outside spray wash has 12 spray nozzles. A single return trough is located upstream of the screens that transports organisms and debris back to the river approximately 1,000 feet south (downstream) of the intake structure and approximately 300 feet from the shore. Transported organisms are therefore discharged away from the hydrodynamic zone of influence of the Low-level CWIS.



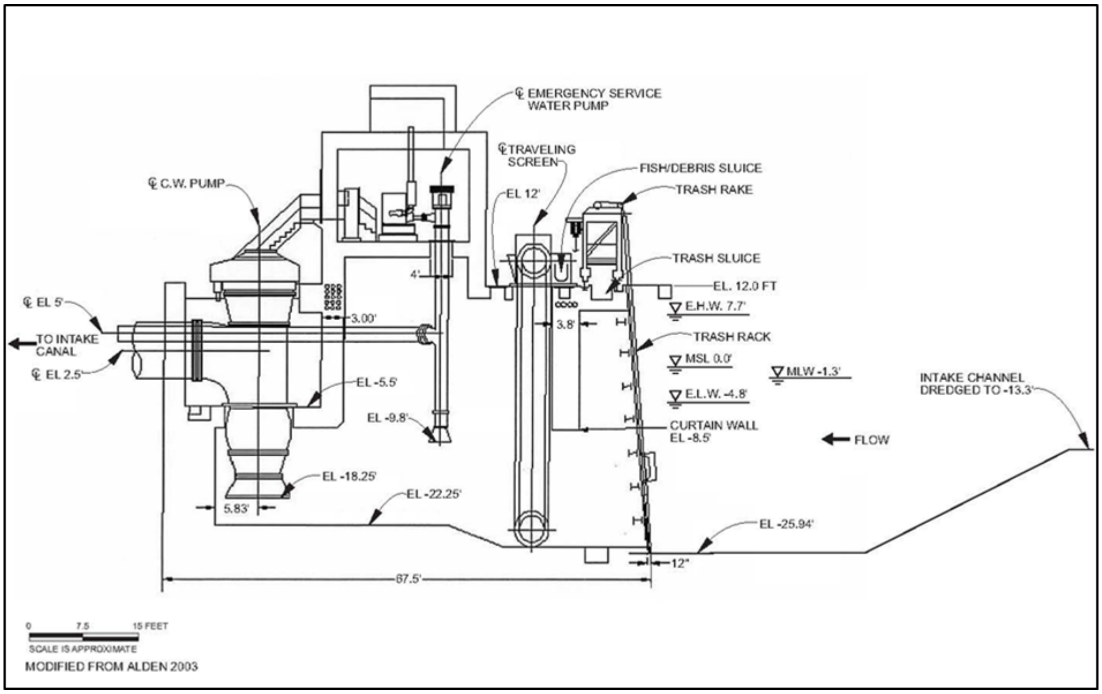
Source: VEPCO (1980)

Figure 2-6. Details of Surry Power Station Ristroph Traveling Water Screen at Low-level Cooling Water Intake Structure



Source: CH2M HILL (2006)

Figure 2-7. Plan View of Surry Power Station Low-level Cooling Water Intake Structure



Source: CH2M HILL (2006)

Figure 2-8. Typical Section View of Surry Power Station Low-level Cooling Water Intake Structure

3 Historical Studies

Past fisheries studies conducted at SPS which are pertinent to §316(b) include the following:

- June 2005 – May 2006 Entrainment Study (EA 2006)
- May 1974 to May 1983 Impingement Studies (CH2M HILL 2006)
- September 2005 – June 2006 Adult and Juvenile Finfish Sampled by Beach Seine and Otter Trawl (EA 2006)
- June 2005 – May 2006 Ambient Ichthyoplankton Study (EA 2006)
- 1970 – 1978 Adult and Juvenile Finfish Sampled by Haul Seine and Otter Trawl (VEPCO 1980)

For the purposes of development of this study plan, historical Impingement Studies from 1974 to 1983 (CH2M HILL 2006) and Ambient Adult and Juvenile Finfish Sampling (EA 2006 and VEPCO 1980) are summarized in the sub-sections below.

3.1 Impingement Studies

Virginia Electric Power Company (VEPCO) collected impingement monitoring data from May 1974 to May 1983. The impingement monitoring data consist of discrete fish samples (identified to species and size groups) that were extrapolated to daily, weekly, and annual estimates of impingement and fish survival. Details of the VEPCO impingement sampling program are presented in Table 3-1.

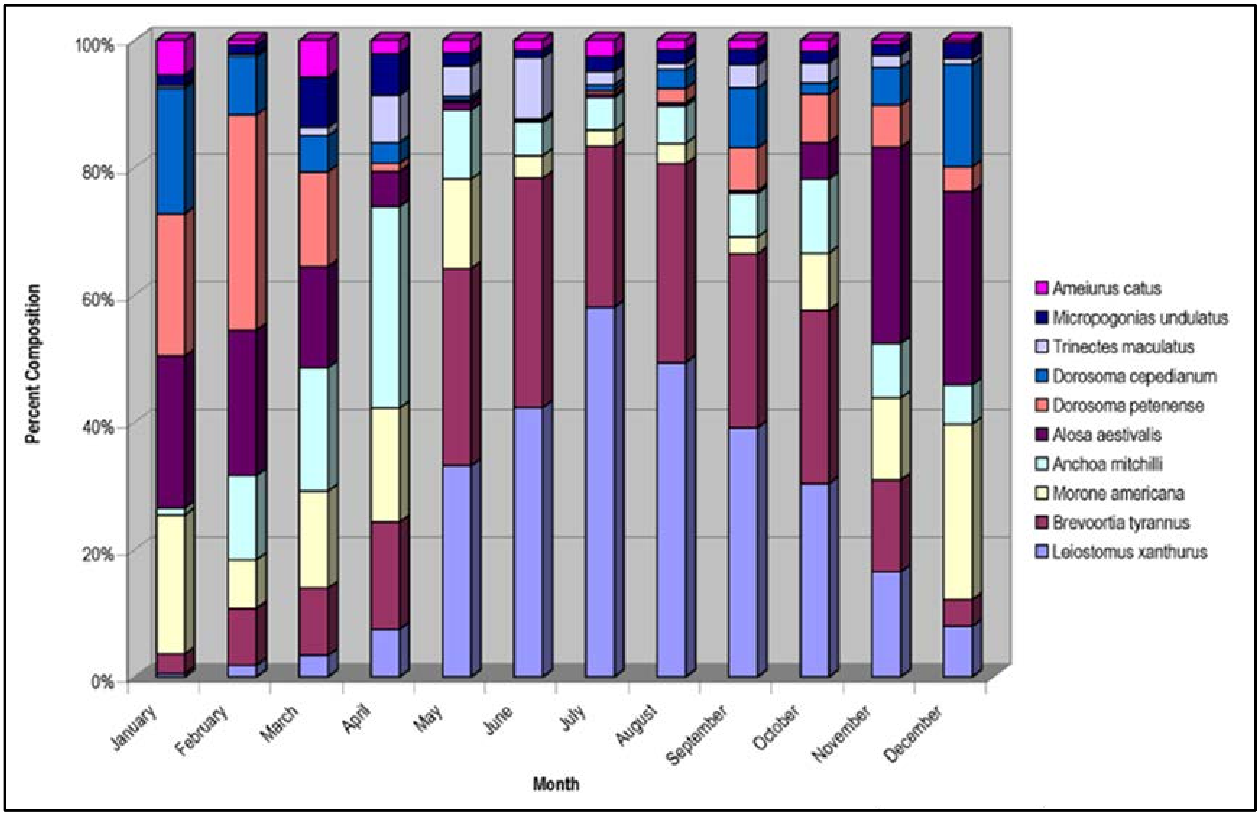
Table 3-1. VEPCO Impingement Sampling Details

Impingement	Details
Units Sampled	Units 1 and 2
Sampling Location	Low level cooling water intake structure
Surveys from May 1974 to May 1983	Almost daily (Monday through Friday)
Sampling Frequency	Two consecutive 5-minute impingement samples taken daily
Sampling Method	Screen wash water trough was fitted with a Y-shaped section with a flop gate that allowed wash water to be diverted into an in-ground holding pool.
Sample Duration	A single unit of effort was obtained by diverting the entire flow of screen wash water from the trough into the holding pool for a 5-minute period.
Sampling Gear	Fishes were collected in a D-frame dip net after the water in the holding pool was drained.
Water Quality Measurements	Temperature, conductivity and salinity measured with Beckman RS5-3 portable salinometer during each sampling

Seasonal trends in impingement exist for many of the fish species. Seasonal impingement rates varied among the 10 top species, with Spot and Menhaden occurring in the samples primarily in summer and early fall (Figure 3-1). In contrast, White Perch, Blueback Herring, and Threadfin

Shad were infrequently impinged during these months, primarily being found in the samples in the late fall and winter months. Bay Anchovy were dominant only in the spring.

Two of the top six dominant impinged species, Spot and White Perch, represented game fish species. Other game fish species impinged, in order of numerical dominance, included Atlantic Croaker, White Catfish, Brown Bullhead, and Channel Catfish. Of these species, the catfishes were impinged at a relatively constant level throughout the year. Atlantic Croaker showed highest impingement rates between March and May.



Source: CH2M HILL (2006)

Figure 3-1. Surry Power Station Seasonal Impingement Variation for Top 10 Species Using 1974 to 1983 Impingement Data

3.2 James River Studies

3.2.1 Trawl and Seine Sampling, 2005-2006

Ambient juvenile and adult fish sampling collections were conducted quarterly along with entrainment studies during June 2005 – May 2006 and sampled at three stations by otter trawl and beach haul seines - one upstream, one downstream, and one near the station intakes. At each station, 30.5 meters of shoreline were seined and one otter trawl was conducted for a 10-minute period. Larger fish were identified, measured, and weighed in the field, and smaller fish were preserved and subsequently processed in the laboratory.

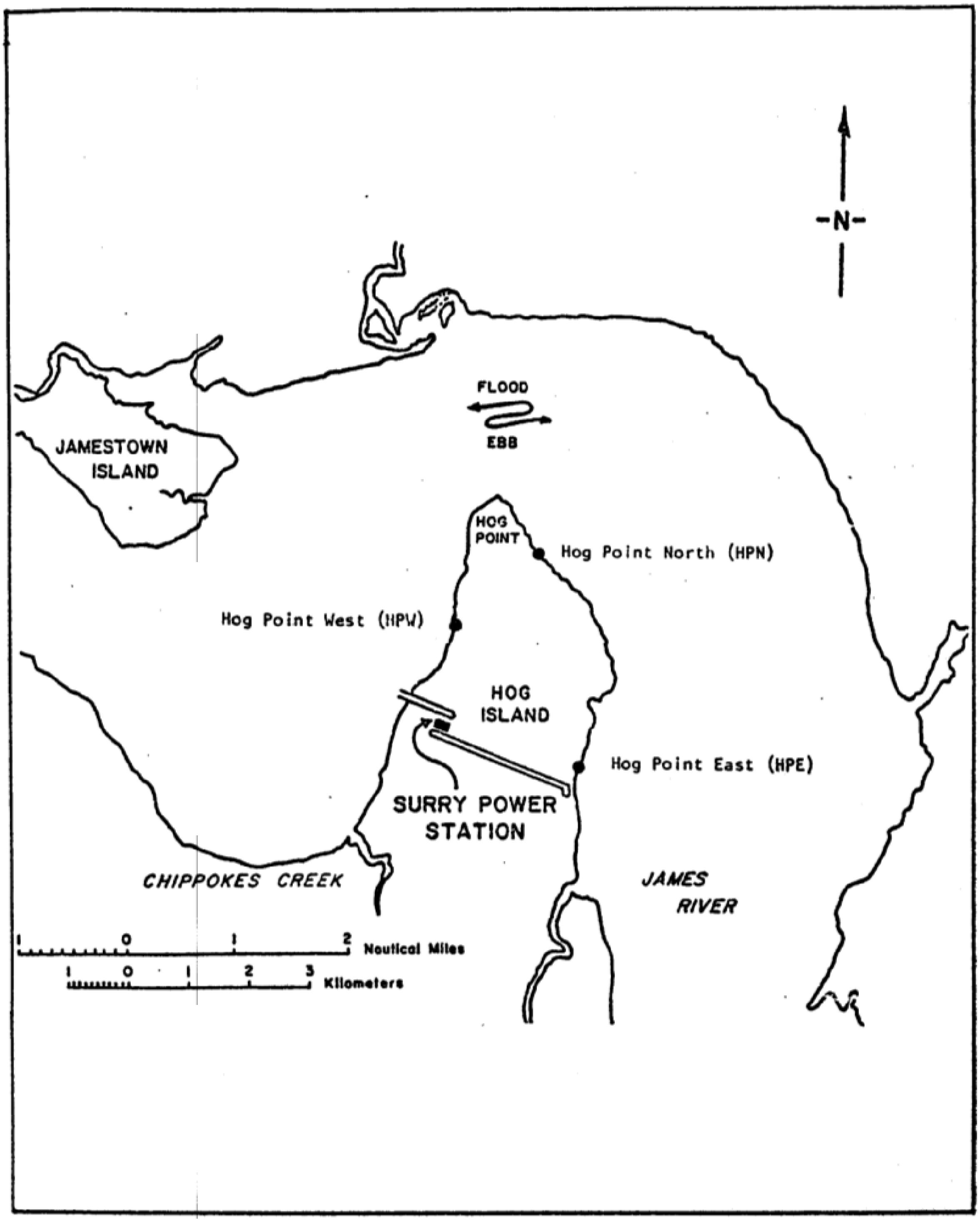
The fish and shellfish collected in 2005 – 2006 were considered representative for that year. Twenty-four species of finfish and one shellfish (Blue Crab) were collected. Blue Catfish, Bay Anchovy, Atlantic Silverside, Spot, Hogchoker, Inland Silverside and White Perch were the most abundant species collected, and accounted for 90 percent of the total catch (Table 3-2). With regards to the catfish, results are consistent with studies that have documented the increasing abundance of Blue Catfish following their successful introduction as a sport fish in the James, Rappahannock, and Mattaponi rivers from 1974 through 1989, and decreasing abundance of White and Channel Catfish (Connelly 2001; NOAA 2014).

3.2.2 Trawl and Seine Sampling, 1970-1978

VEPCO (1980) conducted monthly haul seine and monthly otter trawls in the vicinity of SPS as part of a §316(b) demonstration from 1970 through 1978 (Figure 3-2; 3-3). A total of 63 native and introduced species was collected by haul seines. During the study period, 5 species comprised over three-fourths or 75.5 percent of the total number of fishes collected in the monthly haul seine program (Table 3-3). These species were Atlantic Menhaden, Blueback Herring, Bay Anchovy, Tidewater Silverside and Spottail Shiner. The otter trawl samples reflected a different fish capture selectivity and Hogchoker, Spot, Channel Catfish, Bay Anchovy and Atlantic Croaker were the most commonly collected taxa (Table 3-4).

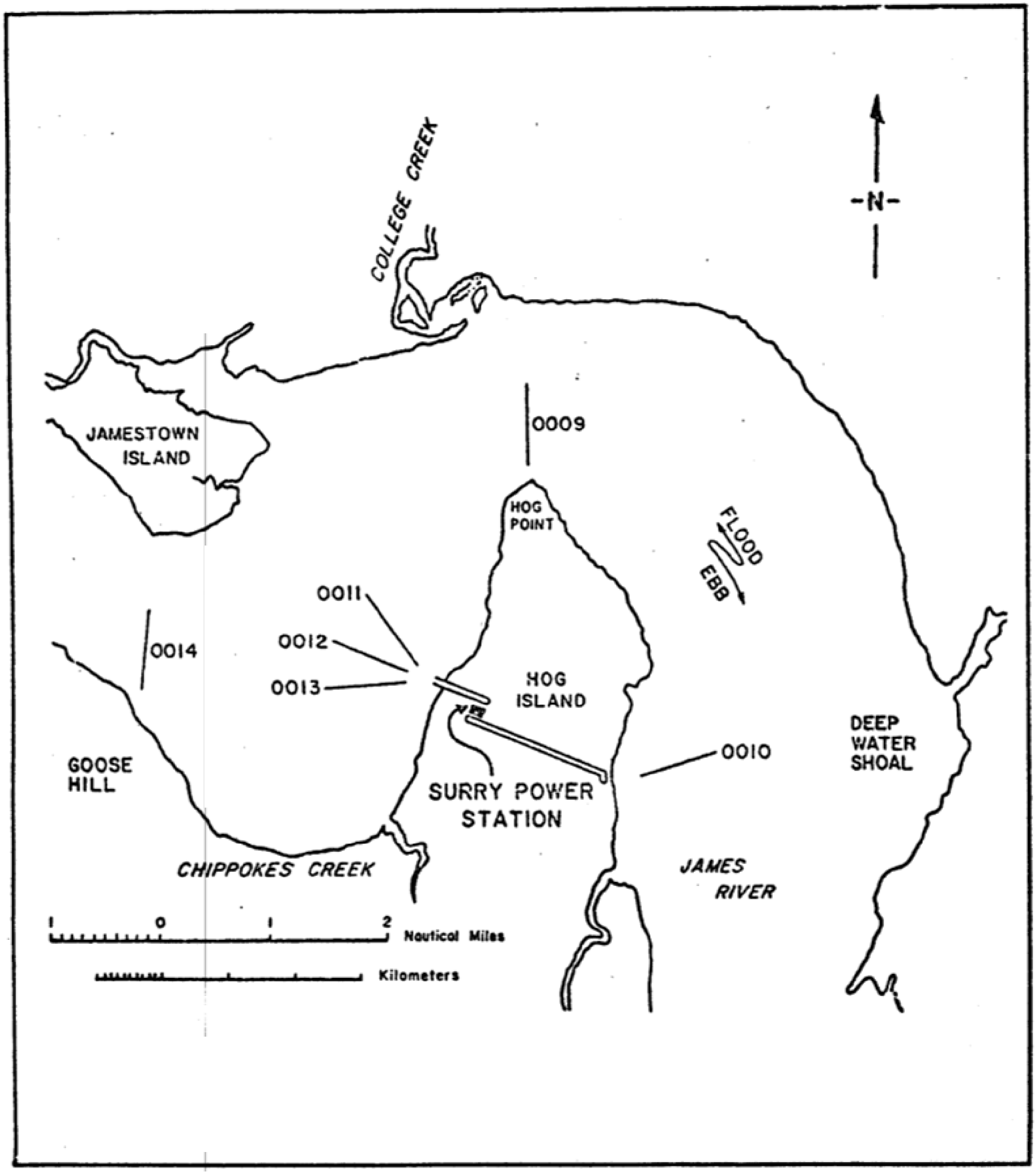
Table 3-2. Number of Fish and Shellfish Collected during Quarterly Otter Trawl and Haul Seine Sampling near Surry Power Station, 2005 – 2006

Species	September (1 Survey)	November (1 Survey)	January (1 Survey)	June (1 Survey)
American Eel		1		
Bay Anchovy	127	46	69	47
Alewife			6	
Blueback Herring			3	2
Hickory Shad		1		
Gizzard Shad			7	2
Atlantic Menhaden	2	13	3	
Common Carp	3	4	2	1
Blue Catfish	160	110	30	140
Channel Catfish				1
White Catfish	8	1	1	
White Mullet	2			
Atlantic Silverside	211	5	31	
Inland Silverside				135
Atlantic Needlefish				2
White Perch	24	31	69	10
Striped Bass	3	3	5	2
Sand Perch		5		
Bluefish	1			1
Atlantic Croaker	2	1	14	49
Silver Perch	17			
Spot	75	109		15
Weakfish	1	3		
Harvestfish	3			
Hogchoker	30	14	126	9
Blue Crab		4		2
Total	669	351	366	418
Source: Table 12 of EA 2006				



Source: VEPCO (1980)

Figure 3-2. Location of Surry Power Station Monthly Haul Seine, 1970 – 1978



Source: VEPCO (1980)

Figure 3-3. Location of Surry Power Station Monthly Otter Trawl Sampling, 1970 – 1978

Table 3-3. Top 10 Fish Collected During Monthly Haul Seine Sampling, 1970 – 1978

Rank	Scientific Name	Common Name	Percent Composition (%)
1	*BREVOORTIA TYRANNUS*	Atlantic Menhaden	26.6
2	*ALOSA AESTIVALIS*	Blueback Herring	14.1
3	*ANCHOA MITCHILLI*	Bay Anchovy	13.2
4	*MENIDIA BERYLLINA*	Tidewater Silverside	13.2
5	*NOTROPIS HUDSONIUS*	Spottail Shiner	8.4
6	*MENIDIA MENIDIA*	Atlantic Silverside	5.9
7	*LEIOSTOMUS XANTHURUS*	Spot	5.6
8	*ALOSA PSEUDOHARENGUS*	Alewife	2.6
9	*ALOSA SAPIDISSIMA*	American Shad	1.8
10	*MORONE AMERICANA*	White Perch	1.8
		Total	93.2
Source: Modified from Table 4 of VEPCO 1980			

Table 3-4. Top 10 Fish Collected During Monthly Otter Trawl Sampling, 1970 – 1978

Rank	Scientific Name	Common Name	Percent Composition (%)
1	*TRINECTES MACULATUS*	Hogchoker	27.6
2	*LEIOSTOMUS XANTHURUS*	Spot	22.1
3	*ICTALURUS PUNCTATUS*	Channel Catfish	13.0
4	*ANCHOA MITCHILLI*	Bay Anchovy	9.5
5	*MICROPOGON UNDULATUS*	Atlantic Croaker	9.4
6	*MORONE AMERICANA*	White Perch	5.1
7	*ICTALURUS CATUS*	White Catfish	4.0
8	*NOTROPIS HUDSONIUS*	Spottail Shiner	2.5
9	*DOROSOMA PETENENSE*	Threadfin Shad	2.2
10	*ANGUILLA ROSTRATA*	American Eel	0.7
		Total	96.1
Source: Modified from Table 11 of VEPCO 1980			

4 Threatened and Endangered Species

EPA consulted with the US Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) (or collectively, Services) under the Endangered Species Act (ESA) during development of the existing facilities §316(b) Rule. The Services concluded that the Rule is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat. Among other requirements, §122.21(r)(4) requires that facilities submit, to the extent such data is available, "*a list of species (or relevant taxa) for all life stages and their relative abundance in the vicinity of the cooling water intake structure*," and identify "*all threatened, endangered, and other protected species that might be susceptible to impingement and entrainment at your cooling water intake structure*." The text below provides a review of listed species associated with SPS to support development of this Impingement Characterization Study Plan.

The Virginia Fish and Wildlife Information Service (VAFWIS) database, managed by the Virginia Department of Game and Inland Fisheries (VDGIF) and the USFWS Information, Planning, and Conservation System were consulted on August 20, 2014 to develop a list of Federal and state of Virginia endangered and threatened species known or likely to occur within a 2-mile radius of SPS (See Table 4-1)[2]. Additionally, the complete list of threatened and endangered species that occur in the state of Virginia (USFWS 2014) was reviewed and compared against the list of threatened and endangered species under NMFS jurisdiction (NMFS 2014) to confirm that NMFS species were not omitted from the list. A review of scientific literature and other documents was also conducted, including a NMFS Biological Opinion and Letter of Concurrence for projects proposed to occur near the vicinity of the CWIS; those documents were used to confirm that marine species under the jurisdiction of NMFS were appropriately considered. Additionally, for each species with the potential to occur in the vicinity of the CWIS, the USFWS or NMFS species profile was reviewed to confirm that no critical habitat was designated. A review of the following resources was used to develop the species list in Table 4-1.

- VAFWIS (http://vafwis.org/fwis/)
- IPAC (http://ecos.fws.gov/ipac/)
- USFWS Listings and Occurrence for Virginia (http://ecos.fws.gov/tess_public/pub/stateListingAndOccurrenceIndividual.jsp?state=VA&s8fid=112761032792&s8fid=112762573902)
  Endangered and Threatened Species Under NMFS' Jurisdiction (http://www.nmfs.noaa.gov/pr/species/esa/listed.htm)

[2] Using the VAFWIS, the minimum radius that can be screened for is a 2-mile radius from the center of the power station. There is no determination that species found within a 2-mile radius of SPS are susceptible to impingement. Similarly, the occurrence of a species on the Service's Information, Planning, and Conservation System, which provides a search area encompassing both terrestrial and aquatic habitats, does not necessarily indicate that the species is likely to be present in the source water body.

Table 4-1. Federal and State Threatened, Endangered, and Proposed Species with the Potential to Occur within 2 miles of the Cooling Water Intake of Surry Power Station

Common Name	Scientific Name	Status*	Tier**	Potential to Occur within 2 miles of the Intake	Potential for Impingement of Adults and Juveniles
FISH					
Atlantic Sturgeon[a]	*Acipenser oxyrinchus*	FE, SE	II	Likely[c]	Highly improbable
Blackbanded Sunfish[a]	*Enneacanthus chaetodon*	SE	I	No - Freshwater species only known to exist in the Chowan River drainage[d]	No
REPTILES					
Kemp's Ridley Sea Turtle[a]	*Lepidochelys kempii*	FE, SE		Improbable - may be present near the confluence of the James River[e]	Highly improbable
Leatherback Sea Turtle[a]	*Dermochelys coriacea*	FE, SE		Improbable - may be present near the confluence of the James River[e]	Highly improbable
Loggerhead Sea Turtle[a]	*Caretta caretta*	FT, ST	I	Improbable - may be present near the confluence of the James River[e]	Highly improbable
Eastern Chicken Turtle[a]	*Deirochelys reticularia reticularia*	SE	I	No - interdunal ponds and sinkhole complexes that experience seasonal water fluctuations[f]	No
Canebrake Rattlesnake[a]	*Crotalus horridus*	SE	II	No – terrestrial	No
AMPHIBIANS					
Eastern Tiger Salamander[a]	*Ambystoma tigrinum*	SE	II	No - aquatic habitats include ditches, vernal ponds, and rarely, sluggish streams[g]	No
Mabee's Salamander[a]	*Ambystoma mabeei*	ST	II	No - fish-free vernal ponds or ephemeral coastal plain sinkholes up to 1.5 meters deep, with surrounding forests[h]	No

Common Name	Scientific Name	Status*	Tier**	Potential to Occur within 2 miles of the Intake	Potential for Impingement of Adults and Juveniles
Barking Treefrog[a]	*Hyla gratiosa*	ST	II	No - breeds in cypress ponds and bays, and in pine barren ponds; open canopied ponds; all Virginia breeding sites were found in graminoid dominated temporary ponds.[i]	No
BIRDS					
Red Cockaded Woodpecker[a]	*Picoides borealis*	FE, SE	I	No – terrestrial	No
Piping Plover[a]	*Charadrius melodus*	FT, ST	I	No – terrestrial	No
Red Knot[a]	*Calidris canutus rufa*	FP	IV	No – terrestrial	No
Black Rail[a]	*Laterallus jamaicensis*	SE	I	No – terrestrial	No
Peregrine Falcon[a]	*Falco peregrinus*	ST	I	No – terrestrial	No
Upland Sandpiper[a]	*Bartramia longicauda*	ST	I	No – terrestrial	No
Loggerhead Shrike[a]	*Lanius ludovicianus*	ST	I	No – terrestrial	No
Henslow's Sparrow[a]	*Ammodramus henslowii*	ST	I	No – terrestrial	No
Migrant Loggerhead Shrike[a]	*Lanius ludovicianus migrans*	ST		No – terrestrial	No
MAMMALS					
Northern Long-Eared Bat[a]	*Myotis septentrionalis*	FP		No – terrestrial	No

Common Name	Scientific Name	Status*	Tier**	Potential to Occur within 2 miles of the Intake	Potential for Impingement of Adults and Juveniles
Rafinesque's Eastern Big-eared Bat[a]	*Corynorhinus rafinesquii macrotis*	SE	I	No – terrestrial	No
Southeastern Dismal Swamp Shrew[a]	*Sorex longirostris fisheri*	ST	IV	No - associated with a heavy ground cover; can be found in all successional stages from grassy openings to closed forests, generally in moist to wet areas in or bordering swamps, marshes, or rivers.[j]	No
PLANTS					
Sensitive Joint-Vetch[b]	*Aeschynomene virginica*	FT		No - typically grows in the intertidal zone of coastal marshes[i]	No
Status*		**Tier** for State-listed Species**			
FE= Federally Endangered FT= Federally Threatened SE= State Endangered ST= State Threatened FP= Federally Proposed		I=VA Wildlife Action Plan - Tier I – Critical Conservation Need; II=VA Wildlife Action Plan - Tier II - Very High Conservation Need; III=VA Wildlife Action Plan - Tier III - High Conservation Need; IV=VA Wildlife Action Plan - Tier IV - Moderate Conservation Need			
Source: [a]Virginia Department of Game and Inland Fisheries; Fish and Wildlife Information Service [b]U.S. Fish and Wildlife Service; Information, Planning, and Conservation System [c]NMFS 2012a, [d]Kercher 2006, [e]VDGIF 2014a, [f]VDGIF 2014b, [g]VDGIF 2014c, [h]VDGIF 2014d, [i]VDGIF 2014e, and [j]USFWS 2012					

- Biological Opinion of James River Federal Navigation Project: Tribell Shoal Channel to Richmond Harbor in Surry, James City, Prince George, Charles City, Henrico, and Chesterfield Counties and the Cities of Richmond and Hopewell, Virginia (FINER/2012/01183).
- Letter of concurrence, from Mr. D.M. Morris, NMFS, to Ms. Amy Hull, Nuclear Regulatory Commission that continued operation Surry Nuclear Power Station, Units 1 and 2 is not likely to adversely affect species listed by NMFS.
- USFWS or NMFS Species Profile (http://www.fws.gov/endangered/, or http://www.nmfs.noaa.gov/pr/species/esa/listed.htm)

Note that only Federal and State threatened and endangered species were included in Table 4-1. Federal species of concern and candidate species were omitted from the list (unless they were also State Threatened or Endangered), because there are no requirements to address those species under Section 7 of the ESA.

The majority of the species in Table 4-1 are terrestrial species or occur in habitats that are not in the vicinity of the SPS cooling water intake structure (CWIS) and thus would not be subject to entrainment or impingement at the facility. Additional literature was reviewed to identify aquatic species that do not occur near the CWIS and thus should be eliminated from further consideration; these documents are cited in Table 4-1.

Kemp’s Ridley (endangered), Leatherback (endangered), and Loggerhead (threatened) Sea Turtles occur seasonally in Chesapeake Bay and may be present and forage near the confluence of the James River near Hampton Roads and Portsmouth, Virginia. However, the facility is approximately 25 miles upstream of where sea turtles are expected to occur (NMFS 2012a, NMFS 2012b). At the vicinity of the facility, the James River is classified as oligohaline with salinities ranging from 0.5-5.0 ppt, considered representative. This salinity range does not support sea turtle habitat or their forage base, which includes estuarine and marine species such as whelks, crabs, and other shellfish and benthic invertebrates for Loggerheads and Kemp's Ridleys; sea grasses and marine algae for Green Sea Turtles, and cnidarians, salps, jellyfish and tunicates for Leatherback Sea Turtles (NMFS 2012b). Therefore, high quality forage habitat is not located near the facility. As such, listed sea turtles are not expected to swim, forage, or rest in the vicinity of the cooling water intake and thus generally not be subject to direct impacts by the cooling water intake system.

Atlantic Sturgeon (listed as both endangered and threatened)[3] spawn in the James River with a primary spawning area at least 50 miles upstream of the SPS intake and a second area of potentially suitable habitat located approximately 25 miles upstream (refer to Appendix A for more detail).

[3] Atlantic Sturgeon originating from the New York Bight, Chesapeake Bay, South Atlantic and Carolina Distinct Population Segments (DPSs) are listed as endangered. Those originating from the Gulf of Maine DPS are listed as threatened. Atlantic Sturgeon from these five DPSs have the potential to occur in the James River and the vicinity of the SPS cooling water intake; however, the majority of the spawning adults are likely to originate from the James River and thus, the Chesapeake Bay DPS (NMFS 2012a).

Atlantic Sturgeon eggs are adhesive and demersal and occur only on the spawning grounds (Hildebrand and Schroeder 1927). Spawning is expected to April through June (temperatures for spawning can range from 13-26°C); some evidence exists that spawning might occur in the fall as well, with high adult usage in the river from August through November (Balazik et al. 2012, Secor et al. 2012). Eggs can hatch in 4-7 days depending on temperature (Gilbert 1989; Hildebrand and Schroeder 1927). At hatching, Atlantic Sturgeon larvae are large bodied and are assumed to undertake a demersal existence in the same areas where they were spawned (ASMFC 2012, Bath et al. 1981). A more detailed account of Atlantic Sturgeon life history, including habitat distribution and size at age and other characteristics is presented in Appendix A.

Impingement occurs when a fish cannot swim fast enough to escape the intake (e.g., the fish's swimming ability is overtaken by the velocity of water being drawn into the intake). The approach velocity at SPS's trash racks is 0.98 feet per second (fps), with a through-rack velocity of 1.12 fps. In order for impingement to happen, a fish must be overcome by the intake or approach velocity. As provided in Appendix A, young of the year (yearling), juvenile and adult Atlantic Sturgeon may occur in the vicinity of the facility's intake[4]. Shortnose Sturgeon, while not expected to occur in the vicinity of the SPS intake, are well studied and have swimming capabilities expected to be representative of Atlantic Sturgeon. Juvenile and adult Shortnose Sturgeon (body lengths greater than 58.1 cm) can avoid impingement at intakes with velocities as high as 3.0 fps (Kynard et al. 2005 as cited in NMFS 2012a). Shortnose Sturgeon with body lengths greater than 28 cm have been demonstrated to avoid impingement at intakes with velocities of 1.0 fps (Kynard et al. 2005 as cited in NMFS 2012a). Assuming that Atlantic Sturgeon have swimming capabilities at least equal to shortnose sturgeon, Atlantic Sturgeon in the vicinity of the intake should also be able to avoid becoming impinged on the trash racks and intake screens. This is a reasonable assumption given that the Atlantic Sturgeon that would be present in the vicinity of the intake are at least of a similar size to the juvenile and adult shortnose sturgeon tested by Kynard et al. (2005) and because these species have similar body forms. As a result, impingement of Atlantic Sturgeon is highly improbable to occur at SPS.

This is confirmed through the 2012 Nuclear Regulatory Commission initiated ESA Section 7 consultation with NMFS that followed the listing of the Chesapeake Bay DPS of Atlantic Sturgeon as endangered. NMFS (2012a) reviewed a variety of materials as part of the consultation, and concluded "…based on information from NRC, Dominion, and other sources, all effects to listed species will be insignificant or discountable. Therefore, the continued operation of Surry 1 and 2 is not likely to adversely affect any listed species under NMFS jurisdiction."

For the purposes of this study plan, it is assumed that the only listed fin-fish species with the potential to occur in the source water of the SPS is Atlantic Sturgeon. Because of it's well

[4] While no federal threatened or endangered species were collected during the impingement studies from 1974 to 1983, entrainment studies from 1970 to 1978 or 2005 – 2006, 2005 – 2006 ambient ichthyoplankton study, or 2005-2006 trawl or seine study, four sturgeon were collected in the trawl sampling from 1970 to 1978, indicating that juvenile or adult sturgeon have the potential to occur in the vicinity of the facility.

developed swimming capabilities, impingement of healthy Atlantic Sturgeon is considered highly improbable. Although no Atlantic Sturgeon are expected to be encountered as part of this study, because of its protected status, this study plan includes handling methods focused on reducing stress and quickly releasing Atlantic Sturgeon, in the improbable event that they are collected in impingement samples.

5 Basis for Sampling Design

HDR preformed a site visit at SPS on August 19, 2014 to evaluate potential impingement sampling options for the Low-level CWIS, the point of §316(b) compliance at the facility. The eight screen wash housings at the Low-level CWIS are arranged in a row and discharge into a common fish return trough which exits to the south of the intake. The fish return trough extends approximately 1,000 feet downstream and approximately 300 feet offshore where it discharges into the James River below the surface of the water. Sampling of screenwash from individual screens was determined to be impracticable due to the limited space available to install an impingement sampling net or basket in the trough sections prior to their joining the common fish discharge trough and because the force of the water entering such a sampling device would result in increased mortality to the organisms collected in the device and thus compromise the planned initial impingement survival assessments that are an important component of the sampling objectives.

Based on these findings, it was determined that the preferred impingement sampling location would be from the common fish return trough south of the Low-level CWIS. Specifically, impingement sample collections will be conducted by diverting the screen wash water into the fish holding pen located in the existing housing designated for impingement study (i.e., impingement building hereafter). Impingement sample collection events will be conducted twice per month over a 12-month study period from August 1, 2015 to July 31, 2016. Impingement sampling will be conducted every 4 hours over a 24-hour period. The targeted sample duration will be approximately 30 minutes within each 4-hour period, or 15 minutes if more than 400 fish and shellfish have been collected in the same sampling time slot of the prior sampling event. This frequency is selected in order to capture efficiencies available from having field staff already on site for the Entrainment Characterization Study. The sub-sample durations of 4 hours and 6 hours for impingement and entrainment characterization studies, respectively are expected to allow a single field crew sufficient time to conduct both studies within a single 24-hour period. The sample duration and frequency selected for the current impingement study will provide finfish and invertebrate (shellfish) taxonomic identifications, seasonal impingement density distributions, diel variation, and initial impingement survival. One year of study is anticipated to be sufficient to achieve the project objects.

The approach for development of the specific impingement characterizations required in §122.21(r) is summarized in Table 5-1.

Table 5-1. Summary of Approach for Development of §122.21(r) Impingement Characterizations

Data	Use of Data
122.21(r)(4) requirement to provide available data regarding species most susceptible to impingement	Evaluation of species and life stage composition and densities based on 2015-2016 Impingement Study
122.21(r)(4) requirement to provide available data regarding identification of fragile fish and shellfish species (<30% impingement survival)	Evaluation of literature values and initial impingement survival values from 2015-2016 Impingement Study
Diel variation	Evaluation of densities in 6-hour sample collections in the 2015-2016 Impingement Study
Variation related to climate and weather	Evaluation of the 2015-2016 Impingement Study data relative to water temperature and weather events (e.g., rain events)
Period of occurrence	Evaluation of the 2015-2016 Impingement Study monthly densities
Impingement data to support alternative technology evaluations	Evaluation of the 2015-2016 Impingement Study densities, length and weight data, and initial impingement survival

6 Impingement Characterization Study Plan

6.1 Introduction

This section of the Study Plan provides methods, materials, and procedures for impingement sample collection and processing. Any failures at the sampling or laboratory analysis stage are often uncorrectable because design-specified sampling times cannot be repeated once they have passed. Therefore, Standard Operating Procedures (SOPs) and a Quality Assurance (QA) Plan will be developed by the contractor performing the field studies for the impingement sample collection and processing based on this Study Plan and the contractors preferred methods, datasheets and equipment to eliminate, reduce, and/or quantify those errors.

Adherence to sample collection SOPs will be observed and documented through regular technical assessments. These technical assessments will be conducted by a QA officer, who is independent of those individuals collecting and generating the data during the study and has experience in performing QA/QC programs for aquatic monitoring surveys, and will be scheduled to occur at least quarterly throughout the course of the study. The specific requirements are to be developed by the contractor performing the work, will incorporate a checklist of items to be inspected based on the SOPs, and will include observations relevant to performance of sampling that may not be covered by the SOP. Careful attention will be paid to the initiation of the study when staff may be less familiar with the SOPs.

6.2 Safety Policy

All work performed under the direction of Dominion Environmental Services (DES) and/or Dominion Business Units (BU) on Dominion properties and/or on properties owned or operated by third parties (i.e., not owned or operated by the contractor or Dominion) is to be performed using safe work practices that are at least equivalent to those required for Dominion personnel and of any third party owner or operator. At a minimum, all contractors are expected to be aware of, and adhere to, Dominion's Corporate Safety Policy, DES Safety Work Practices and any BU or other location-specific safety policies and procedures.

6.3 Field Collection Procedures

An overview of the Impingement Characterization Study Plan methods is provided in Table 6-1. Upon arrival at the plant, the crew will check in with facility security and operations personnel prior to commencing any on-site activities. Prior to the start of each 24-hour impingement sampling event, the crew with the assistance of an operations engineer or designee will document the screens are operating under normal operating conditions. The number of operating cooling water pumps will be documented.

Table 6-1. Impingement Sampling Details

Impingement	Details
Units to be Sampled	Units 1 and 2
August 1, 2015 – July 31, 2016 Sampling Events	Twice per month sampling events (within the first and third week of each month) for 12 months [2/month x 12 months = 24 sampling events]
Daily Collection Schedule	Samples collected every 4 hours in a 24-hr period (6 collections / 24-hr period)
Targeted Organisms	Adult and juvenile fish and shellfish
Sampling Location	Sample common fish return trough screenwash after diversion to a fish holding pen
Sampling Gear	1⁄8-inch x 1⁄2-inch mesh basket on the exit to the fish holding pen
Sample Duration	30 minutes as the target interval (every 4 hours); minimum of 15 minutes allowed if heavy debris loads and/or fish collections
Number of Samples per Survey	6 sample collections/survey
Total Number of Samples	6 samples/survey x 2 surveys/month x 12 months = 144 samples

Consideration must be made to ensure the sampling event does not interfere with plant operation nor result in risk to health and safety of field personnel. Specific sampling details associated with each 4-hour sampling period are as follows:

- Circulating water pump status, traveling screen and rake status will be documented for each Unit, pump and intake bay.

- If no circulating water pumps are operating, sampling will be rescheduled; periods of one unit operation are anticipated and should not affect the schedule, and screens should not be rotated for a unit that is not operating during impingement sampling.
- At the start of impingement sampling, the screen wash water from the fish return discharge trough will be diverted into the fish holding pen by opening the flop gate in the Y-shaped diversion section.
- A minimum water level of 1 foot will be maintained in the fish holding pen during the diversion of fish return discharge water to protect fish entering the holding pen.
- At the end of the sample collection period the flop gate will be pushed back to stop the diversion of the screen wash water into the holding pen.
- After the 30-minute sample time (or 15 minutes depending on debris loading and fish volume) has passed the flop gate in the fish return trough will be returned to its normal position and the holding pen will be slowly drained to allow access into the pen for collection of the finfish and shellfish impinged during that time interval.
- Following completion of each sampling time, the crew will promptly retrieve the catch from the fish holding pen and analyze the catch.
- If analysis cannot be done immediately the contents of the collection event will be put in a plastic bag, placed on ice and analyzed as soon as possible; this will preclude handling procedures of Sturgeon (see Section 6.4.4) and evaluations of initial impingement survival.
- After collection of the impingement sample, the fish will be separated from the debris and prepared for analysis.
- Collected finfish and shellfish will be processed and analyzed for identification, enumeration and length/weight measurements.
- Initial impingement survival data will be collected for the first 10 minutes of sample processing only during each hourly sampling (See Section 6.4.1).
- Water quality parameters (i.e., water temperature, dissolved oxygen (DO), pH, salinity and conductivity) will be taken from the fish return trough (inside the impingement building) and in the fish holding pen with a calibrated water quality analyzer (see instrument specifications above). In addition, water quality sampling will be conducted at the entrainment location at near-surface, mid-depth, and near-bottom depths approximately every 3 hours.
- A voucher collection will be maintained for the project representing each species collected during impingement. Vouchered fish will be collected from the site and fixed in unstained 10 percent formalin. After a period of at least 48 hours, the fish will be

transferred to 70 percent ethanol after being soaked in water for at least 48 hours and up to one week.

- Other climatic data such as rain, cloud cover, wind speed and direction, etc. shall also be recorded on the datasheet.
- At the end of each 24-hour sampling event the crew will notify the facility engineer or designee that impingement sampling has concluded.

6.3.1 Location

Impingement samples will be collected from the common fish return trough south of the Low-level CWIS. The water will be diverted into a fish holding pen in the impingement building adjacent to the fish return trough. See Figures 6-1 and 6-2 for the impingement sampling location, and pictures of the fish return trough, fish holding pen and the basket to cover the drain of the fish holding pen, respectively.

Figure 6-1. Surry Power Station Impingement Sampling Location, 2015 – 2016

Figure 6-2. Pictures of Surry Power Station Fish Return Trough, Fish Holding Pen and Basket to Cover the Drain of Fish Holding Pen

6.3.2 Equipment

Sampling equipment will be acquired and/or constructed according to specifications in this Study Plan. Adequate backup equipment will be provided to ensure the study design can be followed in the event of equipment failure or loss. Prior to initiation of sampling, equipment will be tested or otherwise confirmed to meet specifications. A calibration program will be instituted for equipment requiring calibration that must be consistent with Dominion's instrumentation calibration and maintenance practice document (See Appendix B).

The following list includes the minimum items expected to be required for impingement sample collection:

- Balance/Electronic Scale/Spring scale (accurate to the nearest gram)
- Calibrated weights
- Sorting bin
- Table to weigh and measure on
- Measuring boards (accurate to the nearest millimeter)
- Scissors, forceps

- Disposable Nitrile gloves
- Paper towels
- Field Binder w/ pens, pencils, SOP, data sheets, QC sheets, etc.
- Calculator
- Plastic buckets (both 2 quart & 5 gallon)
- Plastic bags (large, small, & Ziploc), labels, & twist ties
- Taxonomic keys
- Cooler(s) with ice
- Calibrated 5-gallon bucket for debris volume estimates
- Certified thermometers (2)
- pH pens (3) & standards
- Watch
- 500-ml plastic bottles for water quality QC
- Portable water quality meters (2) as described below[5]
    - Handheld Salinity, Conductivity & Temperature meters (2) with autoranging scales (e.g., YSI Model 30 or equivalent) with the following minimum specifications:
        - Conductivity ranges of 0 to 500 µS/cm and 0-200 mS/cm with an accuracy of +/- 0.5 % full scale
        - Salinity range of 0 to 80 ppt with an accuracy of +/- 2 % or +/- 0.1 ppt
        - Temperature range of -5 to 45 ˚C with an accuracy of +/- 0.2 ˚C
    - Handheld Dissolved Oxygen & Temperature meters (2) with autoranging scales (e.g., YSI Model 55 or equivalent) with the following minimum specifications:
        - Dissolved Oxygen % Saturation ranging from 0 to 200 % with an accuracy of +/- 2 %
        - Dissolved Oxygen mg/L ranging from 0 to 2 mg/L with an accuracy of +/- 0.3 mg/L
        - Temperature range of -5 to 45 ˚C with an accuracy of +/- 0.2 ˚C
    - Portable pH meters (2) with the following minimum specifications:
        - pH range of 0 to 14 units with an accuracy of +/- 0.2 units
- Calibration solutions as required for the water quality instrumentation
- Buckets/Containers with calibrated 0.5 gal. graduations; 1-, 3-, and 5-gallon sizes, or as dictated by debris load.
- Shovels/scoops as necessary
- Digital camera
- Nitrile or latex gloves
- Hand sanitizer
- Identification keys for aquatic vegetation

6.3.3 Sampling Schedule

The program anticipates sampling for 12 consecutive months with the 24 sampling events conducted over the August 1, 2015 – July 31, 2016 period. Each sampling event will encompass a 24-hour period with six, four-hour subsampling periods centered around 0100, 0500, 0900, 1300, 1700, and 2100 hours. Sampling events will be distributed within the first and third week

[5] A multiple parameter water quality meter may be used provided it meets the minimum specifications outlined for the individual meters.

of each month for the 12-month period. If a sampling event is missed due to weather or other events, the scheduled sampling event will be conducted within 96 hours of resolution of the complicating event.

6.3.4 Water Quality Measurements

Water quality parameters (i.e., water temperature, dissolved oxygen (DO), pH, salinity and conductivity) will be taken from the fish return trough (inside the impingement building) and in the fish holding pen with a calibrated water quality analyzer (see instrument specifications above). In addition, water quality sampling will be conducted at the entrainment location at near-surface, mid-depth, and near-bottom depths approximately every three hours.

Quality control for water quality data collection will be performed twice per sampling event (once per 12-hour shift) using either a second calibrated water quality meter or by collecting water samples for wet chemistry analysis. Calibration of water quality equipment will be consistent with the *Field Instrumentation: Calibration and Standardizations* requirements in Appendix B.

6.4 Collection Processing

The following collection processing will be accomplished on-site:

- All fish and macroinvertebrates will be identified to the lowest practical taxonomic level and enumerated.
- In addition, the following, fish and shellfish will be enumerated on site and preserved in 5% Formalin solution for laboratory identification and morphometrics:
    - Up to 20 age-0 or age-1 river herring (Alewife and Blueback Herring) per impingement sample will be preserved for laboratory identification by dissection (age-2 and older river herring are expected to be able to be identified to species in the field).

      If more than 20 age-0 and age-1 river herring are collected in a sample, these additional fish will be identified and enumerated as “river herring” or “*Alosa* spp.” on field datasheets. River herring will be identified in the laboratory by dissection and examination of the peritoneum. External identifying characteristics will also be noted for laboratory identified river herring in order to facilitate possible future field identification of these species.
    - Up to 10 shrimp per impingement sample will be preserved for laboratory identification and morphometrics.
- For each 4-hour sample period, up to 15 randomly selected live and fresh dead fish from each species collected will be measured for total length, maximum body width, and maximum body depth to the nearest millimeter and weighed to the nearest gram; no more than 100 measurements of each species are required within a 24-hour impingement sampling event.
- All balances will be checked against standard weights on each day that they are used and the results will be recorded.

- Threatened or endangered species will be processed immediately. Refer to Section 6.4.4 *Handling Procedures for Atlantic Sturgeon* for more detail.
- Debris collected during a sampling event will be categorized and an estimate of volume for each category will be recorded in the datasheet.
- Following analysis of the catch and categorization of the debris, all organisms and fish will be placed in an appropriate trash receptacle to eliminate potential for re-impingement.

Refer to Appendix C for a summary of key data to be collected during the study.

6.4.1 Initial Impingement Survival

Initial impingement survival data will be collected for only the first 10 minutes of sample processing during each hourly sampling. Field crews will select fish for processing at random across species and size classes present in the screen wash sample. Each fish and macroinvertebrate will be classified according to the following condition criteria and enumerated by category:

- Live, Undamaged – live with no apparent damage
- Live, Damaged – live with evidence or indication of abrasion or laceration
- Fresh Dead - no vital signs, no body or opercular movement, clear eyes, red gills and no obvious signs of decay
- Dead Decaying - no vital signs, cloudy eyes, soft flesh, pale gills, other obvious signs of decay.

6.4.2 Morphometrics

For each 4-hour sampling period, up to 15 randomly selected live and fresh dead fish from each taxon collected will be measured for total length, maximum body width, and maximum body depth to the nearest millimeter and weighed to the nearest gram. No more than 100 measurements of each species are required within a 24-hour impingement sampling event. Additionally, up to 10 randomly selected live and/or fresh dead blue crabs (*Callinectes sapidus*) will be measured for greatest body (carapace) length, width, and depth.

All balances will be checked against standard weights on each day that they are used and the results will be recorded on the appropriate form.

6.4.3 Debris Load Characterization

Upon completion of fish and shellfish catch processing, a debris load characterization will be completed for the impingement collection. Debris volume will be measured to the nearest 0.5 gallon by means of marked and calibrated buckets or other containers of varying sizes. At a minimum, one-, three- and five-gallon containers will be available; exact size and number of containers may be modified as is appropriate for the debris load at the facility. If feasible, debris types (outlined below) will be separated, and the volume of each measured. If this is not feasible, total debris volume will be measured, and the best possible estimation of volume of each debris type will be made. A photograph of the debris load will be required only if debris characterization or quantification is not possible. Data will be recorded on the impingement sampling data forms.

Debris types/categories will include at a minimum:

- Aquatic vegetation and algae, with taxonomic description as practicable
- Terrestrial vegetation – leafy/herbaceous
- Terrestrial vegetation – woody[6]
- Aquatic or terrestrial fauna (e.g. Ctenophora; Cnidaria; Insecta) not quantified in impingement sample, with taxonomic description as practical
- Sediments or other natural inorganic debris, with general description of size composition (e.g. gravel, sand, silt etc.)
- Man-made debris/refuse with general description of types (plastic, metal etc.)

If debris collected at a facility does not fall into one of the above categories, a new one may be created. Whenever pertinent, additional descriptions and photos of debris should be recorded. Following measurement and description, debris will be disposed of according to facility procedures.

6.4.4 Handling Procedures for Atlantic Sturgeon

Atlantic Sturgeon are not expected to be susceptible to impingement at SPS. In the improbable event of observation or collection of Atlantic Sturgeon, the Nuclear Regulatory Commission (NRC) will be notified by SPS within four hours of any state agency notification of an event pursuant to 10 CFR 50.72(b)(2)(xi), and the VDGIF will be contacted by Dominion (i.e., DES) within 24 hours of the event as per the requirements of the Scientific Collection Permit obtained prior to any sampling.

In addition, the following handling methods are provided in order to reduce stress, avoid injury and mortality, and quickly release Atlantic Sturgeon, in the improbable event that they are collected (procedures were developed based on Damon-Randall et al., 2010). Other sturgeon species are not documented from the vicinity of the SPS; there is no need to distinguish Atlantic Sturgeon from other species of sturgeon (NMFS 2012b).

1) Sturgeon will be removed from the collection gear as quickly and carefully as possible and total processing time, exclusive of resuscitation efforts, should not exceed 10 minutes.
2) Live Sturgeon will be placed into tubs filled and overflowing with ambient river water, which will be continuously supplied to the tubs while they contain fish.

[6] Branches and other woody debris that cannot conveniently be put into a bucket should be photographed.

3) In the absence of a continuous water source (pump and hose) or for Sturgeon that don't fit in tubs, buckets will be used to add ambient water or every few minutes or to keep sturgeon wet while they are being processed.

4) Each Sturgeon will be placed on the measuring board where live sturgeon will be kept wet throughout the data collection procedure. Large specimens will be measured using a tape measure. The following measurements (in mm) will be quickly recorded on Atlantic Sturgeon Data Sheet:

   o Total Length: straight line along the body axis from the tip of the snout to the tip of the tail (not following the curvature of the body)

   o Fork Length: straight line along the body axis from the tip of the snout to the posterior edge of the fork of the tail (not following the curvature of the body)

   o Interorbital Width: distance between the lateral margins of the bony skull at the midpoint of the orbit

   o Mouth Width: distance between the left and right inside corners of the mouth (i.e., excluding the lips); this should be measured with the mouth closed

5) Each individual will be examined for a Passive Integrated Transponder (PIT) tag and external injuries.

6) After making sure that the fish is wet enough, three photographs will be quickly taken to aid in species identification and document the condition of the fish. One will be taken of the top of the fish, one will be taken of the bottom of the fish (a good view of the mouth is important), and one will be taken of the side of the fish. A ruler will be included in the photograph for scale of the dorsal and ventral surface of the head. Injuries and physical abnormalities will also be photographed. After the requisite data has been collected, live fish will be returned to the area downriver from the impingement return pipe (not far from the impingement building), as quickly and as gently as possible to prevent mortality.

7) If Sturgeon appears nonresponsive, an attempt will be made to resuscitate them by flushing water over the gills until recovery is obvious by the fish's desire to escape. The best method is to use a pump and hose directed into or placed in the mouth (with a piece of sponge to protect the mouth). In the absence of a pump and hose, the sturgeon can be gently dragged back and pushed forward underwater. The drag back should be gentle and slower to protect the gills (Damon-Randall et al. 2010).

8) Sturgeon handling and reporting will comply with all conditions of the VDGIF Scientific Collection Permit.

9) If incidental death or injury of Sturgeon occurs, Dominion is to notify VDGIF at collectionpermits@dgif.virginia.gov within twenty-four (24) hours of occurrence. The following information must be reported: collector, date, species, location (county, quad, waterbody, and latitude and longitude to nearest second), and number collected. Dead Sturgeon will be retained by Dominion on ice or frozen until VDGIF specific handling guidance is obtained. Non-lethal injured Sturgeon will be returned to the source waterbody alive.

10) If incidental observation or collection and live release of Sturgeon occur, Dominion is required to notify VDGIF at collectionpermits@dgif.virginia.gov within seven (7) days, providing the same information as the above condition.

Refer to the following references for additional information on sturgeon handling practices:

- Moser, M.L., M. Bain, M.R. Collins, N. Haley, B. Kynard, J.C. O'Herron II, G. Rogers, and T.S. Squiers. 2000. A Protocol for Use of Shortnose and Atlantic Sturgeons. National Marine Fisheries Service, NOAAT Technical Memorandum NMFS-OPR-18.

Damon-Randall, K., R. Bohl, S. Bolden, D. Fox, C. Hager, B. Hickson, E. Hilton, J. Mohler, E. Robbins, T. Savoy, and A. Spells. 2010. Atlantic Sturgeon research techniques. NOAA Technical Memorandum NMFS-NE-215.

The following includes the minimum items expected to be needed to handle sturgeon, should they be collected in impingement samples:

- Large tank or tub (~5 feet x 2.5 feet x 2 feet)
- 12-volt pump for flow-through on holding tank with hoses & fittings as required
- Battery to operate pump
- 12 volt pig-tail adapter
- Fish sling (to hold & lift large fish safely for handling, transport & aid in release)
- PIT Tag Reader
- 5-Gallon Buckets
- Scale to weigh larger fish
- Measuring board (for smaller fish)
- Tape (for large fish)
- Calipers for interorbital and mouth measurements
- Camera
- Contact numbers

7 References

Atlantic States Marine Fisheries Commission (ASMFC). 2012. Habitat Addendum IV to Amendment 1 to the Interstate Fishery Management Plan for Atlantic Sturgeon.

Bain, M.B. 1997. Atlantic and shortnose sturgeons of the Hudson River: Common and divergent life history attributes. Environmental Biology of Fishes 48: 347-358.

Bain, M.B., N. Haley, D. Peterson, J.R. Waldman, and K. Arend. 2000. Harvest and habitats of Atlantic Sturgeon *Acipenser oxyrinchus* Mitchill, 1815, in the Hudson River estuary: Lessons for sturgeon conservation. Boletin-Instituto Español de Oceanografía 16: 43-53.

Balazik, G., C. Garman, and J.P. Van Eenennaam. 2012. Empirical Evidence of Fall Spawning by Atlantic Sturgeon in the James River, Virginia. Transactions of the American Fisheries Society 141: 1465-1471.

Bath, D.W., J.M. O'Conner, J.B. Alber, and L.G. Arvidson. 1981. Development and identification of larval Atlantic Sturgeon (*Acipenser oxyrhynchus*) and shortnose sturgeon (*A. brevirostrum*) from the Hudson River estuary, New York. Copeia 1981: 711–717.

CH2MHILL. 2006. Draft Comprehensive Demonstration Study for Surry Power Station. 2006.

Connelly, W.J. 2001. Growth patterns of three species of catfish (Ictaluridae) from three Virginia tributaries of the Chesapeake Bay. Master's Thesis. College of William and Mary, Williamsburg, VA. 153p.

Dominion. 2005. Proposal for Information Collection - SURRY POWER STATION.

EA Engineering and Technology. 2006. Entrainment Characterization Report; Surry Power Station.

Gilbert, C.R. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic Bight)--Atlantic and shortnose sturgeons. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.122). U.S. Army Corps of Engineers TR EL82-4. 28 pp.

Hager, C. 2011. Atlantic Sturgeon review: Gather data on reproducing subpopulation of Atlantic Sturgeon in the James River. Contract EA133FIOCN0317.

Hildebrand, S.F. and W.C. Schroeder. 1928. Fishes of Chesapeake Bay. Department of Commerce, Bulletin of the United States Bureau of Fisheries, Volume XLIII.

Jenkins, R.E. and N.M. Burkhead. 1993. Freshwater fishes of Virginia. American Fisheries Society, Bethesda, Maryland.

Johnson, R.I. 1970 The Systematics and Zoogeography of the Unionidae (Mollusca: Bivalvia) of the Southern Atlantic Slope Region. Bulletin of Museum of Comparative Zoology 140(6):263-449.

Kercher, D.M. 2006. Genetic Assessment of Rare Blackbanded Sunfish (*Enneacanthus Chaetodon*) Populations in Virginia. M.S. Thesis. Virginia Commonwealth University.

Kynard, B., D. Pugh and T. Parker. 2005. Experimental studies to develop a bypass for shortnose sturgeon at Holyoke Dam. Final report to Holyoke Gas and Electric, Holyoke, MA.

Kynard, B. and M. Horgan. 2002. Ontogenetic behavior and migration of Atlantic Sturgeon, *Acipenser oxyrinchus oxyrinchus*, and Shortnose Sturgeon, *A. brevirostrum*, with notes on social behavior. Environmental Behavior of Fishes 63: 137-150.

Moser, M. L. and S. W. Ross. 1995. Habitat use and movements of shortnose and Atlantic sturgeons in the lower Cape Fear River, North Carolina. Transactions of the American Fisheries Society 124: 225-234.

National Marine Fisheries Service (NMFS). 2012a. Biological Opinion of James River Federal Navigation Project: Tribell Shoal Channel to Richmond Harbor in Surry, James City, Prince George, Charles City, Henrico, and Chesterfield Counties and the Cities of Richmond and Hopewell, Virginia (FINER/2012/01183).

NMFS. 2012b. Letter of concurrence, from Mr. D.M. Morris, NMFS, to Ms. Amy Hull, Nuclear Regulatory Commission, that continued operation Surry Nuclear Power Station, Units 1 and 2 is not likely to adversely affect species listed by NMFS.

National Oceanic and Atmospheric Administration (NOAA). 2014. Chesapeake Bay Office. Invasive catfish. Retrieved September 10, 2014. http://chesapeakebay.noaa.gov/fish-facts/invasive-catfish

Smith, T.I.J., E.K. Dingley, and D.E. Marchette. 1980. Induced spawning and culture of the Atlantic Sturgeon, *Acipenser oxyrinchus* (Mitchill). Progressive Fish-Culturist 42: 147-151.

Snyder, D.E. 1988. Description and Identification of Shortnose and Atlantic Sturgeon Larvae. American Fisheries Society Symposium 5: 7-30.

U.S. Fish and Wildlife Service (USFWS), Raleigh Ecological Serices Field Office. 2012. Sensitive Joint-vetch (*Aeschynomene virginica*). Retrieved September 7, 2014. http://www.fws.gov/raleigh/species/es_sensitive_joint-vetch.html

Virginia Department of Game and Inland Fisheries (VDGIF). 2014a. Eastern chicken turtle (*Deirochelys reticularia reticularia*). Available online. Retrieved September 7, 2014. http://www.dgif.virginia.gov/wildlife/information/?s=030064

VDGIF. 2014b. Eastern tiger salamander (*Ambystoma tigrinum tigrinum*). Available online. Retrieved September 7, 2014. http://www.dgif.virginia.gov/wildlife/information/?s=020052

VDGIF. 2014c. Mabee's salamander (*Amybstoma mabeei*). Available online. Retrieved September 7, 2014. http://www.dgif.virginia.gov/wildlife/information/?s=020044

VDGIF. 2014d. Barking treefrog (*Hyla gratiosa*). Available online. Retrieved September 7, 2014. http://www.dgif.virginia.gov/wildlife/information/?s=020002

VDGIF. 2014e. Dismal Swamp southeastern shrew (*Sorex longisrostris fisheri*). Available online. Retrieved September 7, 2014. http://www.dgif.virginia.gov/wildlife/information/?s=050008

VEPCO. 1977. Section 316(a) Demonstration (Type 1). Surry Power Station - Units 1 and 2. Virginia Electric and Power Company. Richmond, VA.

VEPCO. 1980. Surry Power Station - Units 1 and 2 Cooling Water Intake Studies.

Watson, J. 2012. James River Mainstem Freshwater Mussel Surveys. Virginia Department of Game & Inland Fisheries, Bureau of Wildlife Resources. Accessed on November 13, 2013. http://www.google.com/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=4&ved=0CC8QFjAD&url=http%3A%2F%2Fncmollusks.wikispaces.com%2Ffile%2Fview%2FJamesRiverSurveys.pdf&ei=1QVmVIfDH_TesASBvICgBg&usg=AFQjCNHoLbYHINRMh89V_2H6BPNyEZT8cA&sig2=NR_T2jFldgg2ucIZqnJn_w&bvm=bv.79142246,d.cWc.

Appendix A

Atlantic Sturgeon Life History Information

Atlantic Sturgeon Life History Information

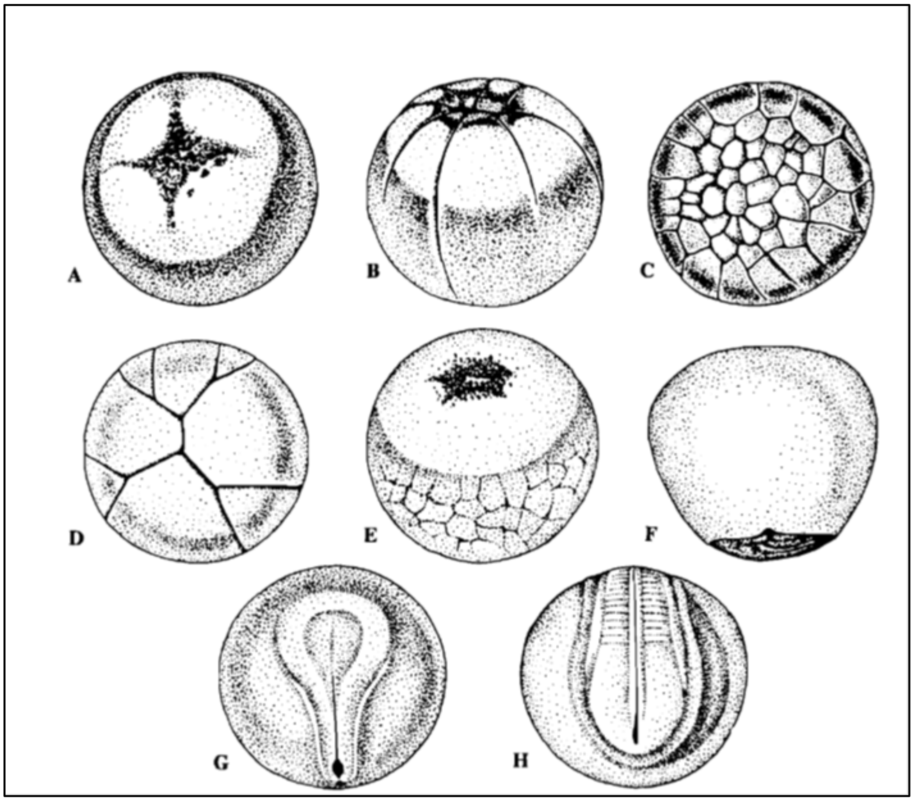
Atlantic Sturgeon (*Acipenser oxyrinchus*) originating from the New York Bight, Chesapeake Bay, South Atlantic and Carolina Distinct Population Segments (DPSs) are listed as endangered. Those originating from the Gulf of Maine DPS are listed as threatened. Atlantic Sturgeon from these five DPSs have the potential to occur in the James River and the vicinity of the cooling water intake of Surry Power Station (SPS). The marine range of all five DPSs extends along the Atlantic coast from Canada to Cape Canaveral, Florida (NMFS 2012a).

The James River has historically provided the largest stock of Atlantic Sturgeon in the Chesapeake and the majority of the adults in the river are likely to originate from the James River and thus, the Chesapeake Bay DPS (Hildebrand and Shroeder 1928; ASSRT 2007; Hager 2011; NMFS 2012a). Because early life stages (eggs and larvae), yearlings, and juveniles do not leave their natal river or estuary, any Atlantic Sturgeon from these life stages in the James River would have originated from the Chesapeake Bay DPS. Subadult Atlantic Sturgeon (greater than 50 cm but not yet sexually mature), move outside their natal rivers. Therefore, subadult Atlantic Sturgeon present in the James River and in the vicinity of the intake could be from any of the five DPSs.

Atlantic Sturgeon spawn in the James River. However, the spawning grounds are located at least 50 miles upstream of the SPS intake with a second area of seemingly suitable habitat also located approximately 25 miles upstream (NMFS 2012a). Spawning is expected to occur from the April through June; evidence exists that spawning might occur in the fall as well, with high adult usage in the river from August through November (Balazik et al. 2012, Secor et al. 2000). Virginia Marine Resources Commission restricts dredging in the James River from March 15 through June 30 to accommodate spring-spawning anadromous fish (Balazik et al. 2012) and NMFS (2012b) recently restricted dredging in the lower James River from February 15 to June 15th and in the rest of the river from February 15 to June 30 to protect anadromous fish during migration and spawning periods.

Eggs can hatch in 4 - 7 days depending on temperature (Gilbert 1989; Hildebrand and Schroeder 1928). Eggs are strongly adhesive and demersal, and occur only on the spawning grounds attaching to the substrate in 20 minutes (Jones et al. 1978). Atlantic Sturgeon eggs are approximately 2.6 mm in diameter (Hildebrand and Schroeder 1928) and hatch approximately 94, 140, and 168 hours after egg deposition at temperatures of 20°C, 18°C, and 17.8 °C, respectively (Gilbert 1989; Hildebrand and Schroeder 1928).

Ripe (unfertilized) Atlantic Sturgeon eggs are reported to be 2.5 - 2.6 mm in diameter, globular in shape, and of a light to dark brown color. Fertilized eggs are up to 2.9 mm in diameter, slate gray or light to dark brown, and become oval as development proceeds (Jones et al. 1978) (see Figure A-1). The germinal disc is evident in the unfertilized egg. A cross- or star-shaped pigment patch is apparent in the animal pole of the fertilized egg. The eggs are distinctly two-layered with the outer layer being a viscous substance.



Source: Jones et al. 1978 as presented in Gilbert 1989

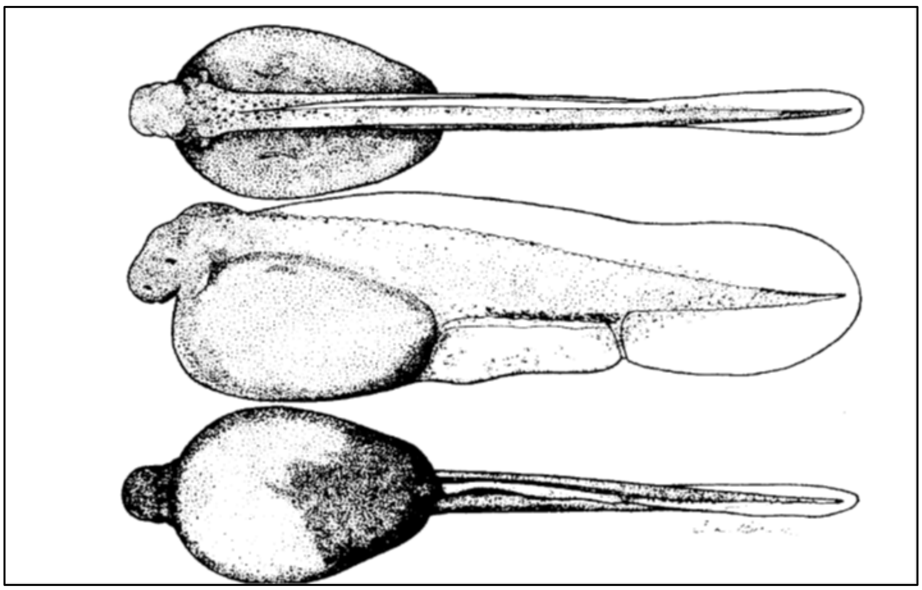
Figure A-1. Atlantic Sturgeon Egg Development from Unfertilized Egg to 48-hour Stage

Yolk-sac larvae are expected to inhabit the same areas where they were spawned (Bain et al. 2000; ASMFC 2012). Smith et al. (1980 in Gilbert 1989) also reported that the yolk-sac larvae were darkly pigmented and active swimmers. Hard substrate is important to larval Atlantic Sturgeon as it provides refuge from predators (Kieffer and Kynard 1996 and Fox et al. 2000 as cited in ASMFC 2012). Bath et al. (1981) only collected sturgeon larvae in bottom samples. Larvae are also active swimmers and leave the bottom when 8 to 10 days old to swim in the water column (Kynard and Horgan 2002).

The yolk-sac larval stage is completed in about 8 to12 days (Jones et al. [1978] reports 6 days), at which time the larvae move downstream to the rearing grounds (Kynard and Horgan 2002). During the first half of this migration, larvae move only at night and use benthic structure (e.g., gravel matrix) as refuge during the day (Kynard and Horgan 2002). During the latter half of migration to the rearing grounds, when larvae are more fully developed, movement occurs during both day and night. Larvae transition into the juvenile phase at approximately 30 mm total length (TL) and move further downstream into brackish waters, developing a tolerance to salinity as they go. Eventually they become residents in estuarine waters for months to years before emigrating to open ocean (ASSRT 2007, ASMFC 2012).

Atlantic Sturgeon larvae are expected to be approximately 7 - 9 mm TL at hatching (Bath et al. 1981, Smith 1980 as cited in Bain et al. 2000, Gilbert 1989, Snyder 1988), although Jones et al.

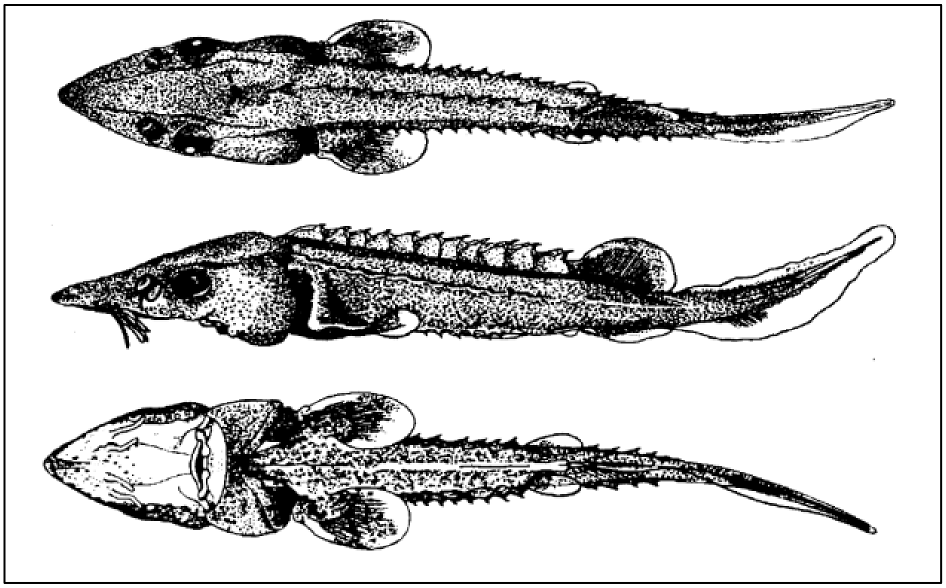
(1978) describe a newly hatched Atlantic Sturgeon larvae at 11.5 mm TL. The head width is 8% of standard length (SL) with a depth of 11 % of SL (behind the posterior margin of the eye). The yolk-sac maxima is 23 % of SL and the yolk-sac depth is 20% of SL (Snyder 1988). Jones et al. (1978) describes the newly hatched Atlantic Sturgeon larvae with a head and the tail that is darkly pigmented and a yolk that is a large "dirty yellow," vascular oval. The head is not deflected over the yolk (bent around the yolk). The mouth is formed. The eye is relatively small and is about the same size as the round auditory vesicles. The branchial arches are concealed by the opercular folds, the barbels are lacking, pectoral buds are present, and the origin of the dorsal finfold is in the occipital region. Bath et al. (1981) reports that a continuous finfold extends from behind the head dorsally around the notochord and ventrally to the posterior end of the yolk sac, a dorsal wedge-shaped cavity at the fourth ventricle in the posterior of the blunt head, and a vent extended through the finfold at 0.6 to 0.7 of the TL from the snout. The spiral valve was distinguishable, even in small specimens.



Source: Snyder 1988

Figure A-2. Atlantic Sturgeon Yolk Sac Larvae Just Hatched

Snyder (1988) reports that Atlantic Sturgeon complete yolk absorption by 13 - 14 mm SL in 6 - 7 days, acquire their first scutes between 17 and 20 mm SL at 13 - 29 days, acquire their first fin rays at 21 mm SL (13 - 29 days), and acquire a full complement of fin rays, except the caudal fin, between 47 and 58 mm SL at 29 - 100 days. A 29-day hatchery-reared larva is presented in Figure A-3. Mean myomere counts for shortnose and Atlantic Sturgeon are 38 preanal and 22 or 23 postanal. Snyder (1988) presents a detailed comparison of shortnose and Atlantic Sturgeon and provides details on the age and length of the onset of certain developmental events.



Source: Snyder 1988

Figure A-3. Atlantic Sturgeon, 28.9 mm SL, 29.3 MM TL, 29 Days After Hatching

Juvenile Atlantic Sturgeon demonstrate a lot of variation with regard to salinity tolerance (ASMFC 2012). Atlantic Sturgeon spawn in their natal river and remain in the river until approximately age two and at lengths of approximately 76 - 92 cm (30 - 36 inches; ASSRT 2007). Yearlings are known to occupy freshwater portions of their natal river (Secor et al. 2000) and their distribution in the James River is expected to follow this pattern. Juveniles in the river are also restricted to low salinity areas, with overwintering known to occur in deep water areas near river mile 25 (NMFS 2012).

Hager (2011) used telemetry to establish movement patterns of adult and subadult Atlantic Sturgeon in the James River. Thirty-two adults and thirty-three subadults were outfitted with telemetry tags and telemetry receivers were placed throughout the river to record the presence of tagged fish when they are within approximately one kilometer of the receivers.

Results of Hager (2011) indicate that adult Atlantic Sturgeon enter the James River in spring when water temperatures are around 17°C, and occur from river mile 29 to river mile 67 before departing from the river in June when water temperatures are around 24° C. Data collected in 2010 demonstrated a congregation of sturgeon in freshwater areas near river mile 48, suggesting the possibility of spawning in this area (Hager 2011). Adult sturgeon appear to be absent from the James River for most of the summer until late August when tagged fish are once again detected in the river (Hager 2011). During the late summer-early fall residency (August-October), fish ascend the river rapidly and congregate in upriver sites between river mile 48 and the fall line near Richmond, VA; possibly in response to physiologically stressful conditions (e.g., low dissolved oxygen and elevated water temperature) in the lower James River and Chesapeake Bay (Hager 2011). As temperature declines in late September or early October, adults disperse through downriver sites and begin to move out of the river (Hager 2011). By November, adults occupy only lower river sites (Hager 2011). By December, adults are undetected on the tracking array and, thus, are presumed to be out of the river (Hager 2011).

The highest number of subadults are present in the river in the spring and fall with the lowest numbers present in August when ambient water temperatures in the river are the highest. At this time of year, most subadults leave the river and any Atlantic Sturgeon remaining in the river are holding in cool water refugia (Hager 2011). The number of subadults in the river peaks in October. Many subadults leave the river for overwintering with some known to overwinter off the coast of North Carolina. Subadults overwintering within the river are located downstream of Hog Island.

Literature Cited

Atlantic States Marine Fisheries Commission (ASMFC). 2012. Habitat Addendum IV to Amendment 1 to the Interstate Fishery Management Plan for Atlantic Sturgeon.

Atlantic Sturgeon Status Review Team (ASSRT). 2007. Status Review of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). Report to National Marine Fisheries Service, Northeast Regional Office. February 23, 2007. 174 pp.

Balazik, G. C. Garman, and J.P. Van Eenennaam. 2012. Empirical Evidence of Fall Spawning by Atlantic Sturgeon in the James River, Virginia. Transactions of the American Fisheries Society 141: 1465-1471.

Bain, M.B., N. Haley, D. Peterson, J.R. Waldman, and K. Arend. 2000. Harvest and habitats of Atlantic sturgeon *Acipenser oxyrinchus* Mitchill, 1815, in the Hudson River estuary: Lessons for sturgeon conservation. Boletin-Instituto Español de Oceanografía 16: 43-53.

Bath, D.W., J.M. O'Conner, J.B. Alber, and L.G. Arvidson. 1981. Development and identification of larval Atlantic sturgeon (*Acipenser oxyrhynchus*) and shortnose sturgeon (*A. brevirostrum*) from the Hudson River estuary, New York. Copeia 1981: 711–717.

Fox, D. 2006. History of Atlantic Sturgeon Fishery. Power Point presentation presented to Delaware Department of Natural Resources, courtesy of Greg Murphy (DEDNR) April 13, 2006.

Gilbert, C.R. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic Bight)--Atlantic and shortnose sturgeons. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.122). U.S. Army Corps of Engineers TR EL82-4. 28 pp.

Hager, C. 2011. Atlantic sturgeon review: Gather data on reproducing subpopulation of Atlantic sturgeon in the James River. Contract EA133FlOCN0317.

Hildebrand, S.F. and W.C. Schroeder. 1928. Fishes of Chesapeake Bay. Department of Commerce, Bulletin of the United States Bureau of Fisheries, Volume XLIII.

Jones, P. W., Martin, F. D., and Hardy, J. D. Jr. 1978: Development of fishes of the Mid-Atlantic Bight. An atlas of egg, larval and juvenile stages. Volume I Acipenseridae through Ictaluridae. U. S. Dep. Interior, Fish Wildl. Serv., Biol. Serv. Prog. FWS/OBS-78/12. 366 pp.

Kercher, D.M. 2006. Genetic Assessment of Rare Blackbanded Sunfish (*Enneacanthus chaetodon*) Populations in Virginia. M.S. Thesis. Virginia Commonwealth University.

Kieffer, M. C. and B. Kynard. 1993. Annual movements of shortnose and Atlantic sturgeons in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society 122: 1088-1103.

Kynard, B. and M. Horgan. 2002. Ontogenetic behavior and migration of Atlantic sturgeon, *Acipenser oxyrinchus oxyrinchus*, and shortnose sturgeon, *A. brevirostrum*, with notes on social behavior. Environmental Behavior of Fishes 63: 137-150.

Kynard, B., D. Pugh, and T. Parker. 2005. Experimental studies to develop a bypass for shortnose sturgeon at Holyoke Dam. Final report to Holyoke Gas and Electric, Holyoke, MA.

National Marine Fisheries Service (NMFS). 2012a. Letter of concurrence, from Mr. D.M. Morris, NMFS, to Ms. Amy Hull, Nuclear Regulatory Commission, that continued operation Surry Nuclear Power Station, Units 1 and 2 is not likely to adversely affect species listed by NMFS.

NMFS. 2012b. Biological Opinion of James River Federal Navigation Project: Tribell Shoal Channel to Richmond Harbor in Surry, James City, Prince George, Charles City, Henrico, and Chesterfield Counties and the Cities of Richmond and Hopewell, Virginia (FINER/2012/01183).

Smith, T.I.J., E.K. Dingley, and D.E. Marchette. 1980. Induced spawning and culture of the Atlantic sturgeon, *Acipenser oxyrinchus* (Mitchill). Progressive Fish-Culturist 42: 147-151.

Secor, D.H., E.J. Niklitschek, J.T. Stevenson, T.E. Gunderson, S.P. Minkkinen, B. Richardson, B. Florence, M. Mangold, J. Skjeveland, and A. Henderson-Arzapalo. 2000. Dispersal and growth of yearling Atlantic sturgeon, *Acipenser oxyrinchus*, released into Chesapeake Bay. Fishery Bulletin 98: 800-810.

Snyder, D.E. 1988. Description and Identification of Shortnose and Atlantic Sturgeon Larvae. American Fisheries Society Symposium 5: 7-30.

Appendix B

Field Instrumentation:
Calibrations and Standardizations

WORK PRACTICE DOCUMENT

Field Instrumentation:

Calibrations and Standardizations

Dominion Environmental Services

Table of Contents

WORK PRACTICE DOCUMENT

Calibrations and Standardizations

Electric Environmental Biology

Written Date: 8/16/2011

Revision Date:

Document Owner: Casey Seelig

1.0 Introduction

Dominion is required to monitor a variety of physicochemical parameters in the environment. These parameters are monitored with various types and models of scientific instrumentation. Instruments must be either calibrated or standardized and properly maintained to ensure the accuracy and precision of the data being collected. **Calibration** is a process of physically adjusting an instrument to accurately read a known standard or series of standards. **Standardization** is a process of checking an instrument against a known standard or series of standards to document its accuracy. Standardization, without a physical adjustment to the instrument, checks that the instrument is functioning to its design specifications and, if not the instrument can either be calibrated, serviced by the operator, or sent back to the manufacturer for repair. The manufacturer's recommended calibration and maintenance procedures for a particular instrument are designed to keep the equipment performing to the manufacturer's specifications. Every instrument's accuracy should be verified and documented to ensure it meets the acceptability criteria established for the work.

2.0 Scope

The purpose of this work practice document is to provide the protocols necessary to ensure all field instrumentation and test methods, which are used to measure environmental parameters, are providing data of acceptable accuracy. This work practice document defines the proper methods, frequencies, and acceptance criteria for documenting field instrument and test kit accuracy using calibrations and standardizations. The procedures in this document are general in nature. Due to the number and variety of field instrumentation used, specific calibration procedures for each instrument are beyond the scope of this document. The user's manual should be consulted for specific calibration and standardization procedures.

3.0 Dominion Employees Covered

This work practice applies to all Dominion Environmental Services (DES) employees using field instrumentation to monitor environmental parameters as well as any contractors employed by DES that conduct environmental analyses for monitoring studies. The guidelines and procedures listed in this work practice document apply to instruments used in the field. This does not cover the calibration or standardization of laboratory equipment.

4.0 Work Practice Description

The field instrumentation calibrations and standardizations work practice provides guidance on how to prepare for and safely conduct calibrations and equipment accuracy checks on field instrumentation. This work practice is intended for experienced field technicians or for those under the direct supervision of employees trained in proper calibration and standardization methods used for equipment and reagents required in the collection of environmental data.

5.0 Safety

Safety is a core Dominion principle and all calibration and standardization work must incorporate safe work practices. It is the responsibility of every employee and contractor to work safely. Safety of each employee, contractor, their co-workers and the general public are the first priority of every job. The conduct of all work should conform to the expectations described in the Dominion Safety Policy, the Safety Work Practice for Dominion Environmental Services, the Safety Work Practice for Biology, and the policies of the business unit where the work is being done. The types of Personal Protective Equipment (PPE) necessary for calibrating and standardizing field instruments must be reviewed prior to starting calibrations or standardizations to identify and mitigate any hazards.

1. Specific hazards associated with the type of instruments to be calibrated or standardized must be known prior to the start of the calibration or standardization. Examples of such hazards might include: health and safety concerns associated with the use of pH standards as identified by the Material Safety Data Sheet (MSDS).

2. Where the mitigation of hazards is not possible, Personal Protective Equipment (PPE) must be worn to safely complete the calibration/standardization. A hazard assessment must be performed to evaluate each calibration or standardization task and the proper PPE needs to be worn as outlined in the MSDS and any governing Laboratory Chemical Hygiene Plan. The need for safety glasses, gloves, and appropriate clothing should be considered in every hazard assessment.

3. All employees are required, at a minimum, to be familiar with the Hazard Communication Program for their business unit. The Hazard Communication Program outlines safety expectations when handling and using chemical products, including employee training, chemical labeling, and access to MSDS.

6.0 Work Practice Requirements

1. Personnel that will be calibrating or standardizing instruments or test kits for readings will, at a minimum:

a) Be cognizant of the safe handling and waste disposal of calibration or standardization chemicals.
b) Have training in the use of instrumentation;
c) Have training for the proper use of required PPE;
d) Have a thorough understanding of the proper methods outlined by the manufacturer to maintain, calibrate or standardize the instrument or test kit.

2. Verify state and federal protocols for accuracy and precision of measurements:
   a) Review acceptance criteria required by the state and agencies (current acceptance criteria are listed in calibration procedures below and in Table1);
   b) Document all calibrations and standardizations of monitoring instruments and test kits.
3. Pre-Calibration/Standardization Preparation
   a) Review the manufacturer's recommendations and procedures;
   b) Locate and fill out the appropriate calibration/standardization log sheet;
   c) Verify the expiration/certification date of all standards to be used in the calibration/standardization process;
   d) Verify the instrument's or test kit's make, model, and serial number or unique identifier and record it on the log sheet;
4. Instrument or Test kit Calibration/Standardization
   a) Document the date, time, and the person(s) conducting the calibration/standardization;
   b) Select a range of standards to be used for calibration or to be checked for the instrument/test kit's accuracy, which will bracket expected field/laboratory survey results;
   c) Document the results (standard verses reading) and verify that they meet the acceptance criteria;
   e) If the equipment fails calibration/standardization, service and clean the equipment and re-calibrate/standardize;
   f) If the equipment continues to fail, label "Inactive Status" and remove the equipment from service (send the equipment back to the manufacturer for servicing) and document this on the log sheet;

Note: If an instrument or test kit does not comply with the established acceptance criteria, it must not be used for collecting data and must be removed from service.

   g) Properly label and dispose of all waste chemicals and materials. Dispose of any hazardous wastes according to the Hazard Waste Management Guidance Document.
5. Verification
   a) DES personnel must record the instrument/test kit identifier (e.g., serial number) on field and boat log sheets to provide a traceable accuracy for every measurement collected;
   b) Annual reviews of calibration/standardization logs should be performed to verify compliance. Calibration/standardization logs should be checked to verify that records are complete, legible, and up to date.

7.0 Calibration and Standardization Protocols

Many instruments and test kits are not able to be calibrated in the field or by the user. These instruments and test kits need to be checked routinely using known standards to establish and document their accuracy. For example it is not possible to adjust a capillary thermometer; therefore accuracy needs to be compared to a reference thermometer of certified accuracy. In many cases checking standards and documenting the instrument's accuracy in the range of conditions it will be used can be more efficient than calibration procedures. In all cases, follow the manufacturer's recommended maintenance and calibration directives.

The following frequencies (Table 1) established for documenting calibrations and standardizations are for instruments and test kits routinely being used for weekly or monthly monitoring studies. If equipment is being used daily for recording large amounts of data, calibration/standardization frequencies must be increased (see Table 1) or standards must be run with samples. For infrequently used equipment (once a quarter or year), calibrations and standardizations should occur prior to use. Data loggers which are being deployed for extended periods of time (>1 month) must be calibrated/standardized immediately prior to and following deployment in the field.

Prior to calibration, all instrument probes must be cleaned according to the manufacturers instructions. Failure to perform this step (proper maintenance) can lead to erratic measurements. When calibrating instruments care must be taken to insure that the volume of the calibration solutions is sufficient to cover both the probe and temperature sensor and be free of air bubbles (see manufacturer's instructions for additional information).

A record of each calibration must be made in the calibration log. The record needs to include at a minimum:

- serial number of the instrument
- parameters which were calibrated
- standards used in calibration
- date and time of calibration
- initials of technician

7.1 Chlorine

Chlorine testing in the field is usually done using a colorimeter. There are two methods of standardization: 1) gel standards (once a week or prior to use) and 2) ampule standards (recommended every 13 weeks). Prior to reading the standards, zero the colorimeter with a blank (deionized water) and record measurements to 0.01 mg/L. Acceptance criterion for the gel standards (0.20, 0.83, and 1.53 mg/L) is ±15% and for the ampule standards (0.12, 0.60, 1.20 mg/L) is ±20%. If expected chlorine levels are higher than the range of these standards, select standards that bracket the expected field results.

7.2 Conductivity and Salinity

Conductivity is used to measure the ability of an aqueous solution to carry an electrical current. Specific conductance is the conductivity value corrected to 25°C. There are a variety of instruments available to measure conductivity, specific conductance, salinity, and temperature. Most instruments are calibrated against a single standard which is near, but below the specific conductance of the environmental samples. A second standard which is above the environmental sample specific conductance is used to check the linearity of the instrument in the range of measurements.

If cleaning electrical connections, changing batteries (recharging), or changing sensors does not correct standardization failures, then the unit should be sent back to the manufacturer for servicing. Freshwater standards (0.05-1.00 mS/cm) or Seawater standards (40-60 mS/cm) are recommended for standardizations checks every 13 weeks. These standardizations should be conducted at a temperature of $25^{o}C \pm 1^{o}C$. The acceptance criterion is ±5%. The temperature probes of these meters should be checked for accuracy (acceptance criterion $\pm 0.5^{o}C$) at the same time because temperature is factored into the meters program for calculating conductivity, specific conductance and salinity. Standardizations can be done with a specifically designated and labeled "Reference Meter", which must be standardized with standard water samples every 4 weeks. Refractometers (salinity/density) must be standardized (acceptance criterion ±1.0 ppt) every 13 weeks or prior to use with a "Reference Meter." Before using a refractometer for recording salinity data, verify that it meets or exceeds the precision requirements for the data being collected.

Calibration Procedure

1. Allow the calibration standard to equilibrate to the ambient temperature.

2. Remove probe from its storage container, rinse the probe with a small amount of the conductivity/specific conductance standard (discard the rinsate), and place the probe into the conductivity/specific conductance standard.

3. Select monitoring/run mode. Wait until the probe temperature has stabilized.

4. Look up the conductivity value at this temperature from the conductivity versus temperature correction table usually found on the standard bottle or on the standard instruction sheet. You may need to interpolate the conductivity value between temperatures. Select calibration mode, then conductivity. Enter the temperature corrected conductivity value into the instrument.

5. Select monitoring/run mode. The reading should remain within manufacturer's specifications. If it does not, re-calibrate. If readings continue to change after recalibration, consult manufacturer.

6. Read the specific conductance on the instrument and compare the value to the specific conductance value on the standard. The instrument value should agree with the standard within the manufacturer's specifications. If not, re-calibrate. If the re-calibration does not correct the problem, the probe may need to be cleaned or serviced by the instrument manufacturer.

7. Remove probe from the standard, rinse the probe with a small amount of the second conductivity/specific conductance standard (discard the rinsate), and place the probe into the second conductivity/specific conductance standard. The second standard will serve to verify the linearity of the instrument. Read the specific conductance value from the instrument and compare the value to the specific conductance on the standard. The two values should agree within the specifications of the instrument. If they do not agree, recalibrate. If readings do not compare, then the second standard may be outside the linear range of the instrument. Use a standard that is closer, but above the first standard and repeat the verification. If values still do not compare, try cleaning the probe or consult the manufacturer.

8. When monitoring groundwater or surface water, use the specific conductance readings.

7.3 Dissolved Oxygen (D.O.)

Dissolved oxygen (DO) content in water is measured using a membrane electrode. The DO probe's membrane and electrolyte solution should be replaced prior to the sampling period. Failure to perform this step may lead to erratic measurements. There are a variety of instruments available to measure dissolved oxygen (% saturation & mg/L) and temperature.

If cleaning electrical connections, changing batteries (recharging), or changing the permeable membrane on the sensor does not correct standardization failures, then the unit should be sent back to the manufacturer for servicing. If the unit has an air calibration function, air calibrate (100% saturation) the meter prior to use or follow manufacture's directives. Newer instruments utilize a luminescent dissolved oxygen probe (LDO). LDO sensor caps need to be replaced based on the manufacturer's maintenance schedule. LDO sensors are calibrated using air saturated water.

Calibration Procedure

1. Gently dry the temperature sensor according to manufacturer's instructions.

2. Place a wet sponge or a wet paper towel on the bottom of the DO calibration container.

3. Place the DO probe into the container without the probe coming in contact with the wet sponge or paper towel. The probe must fit tightly into the container to prevent the escape of moisture evaporating from the sponge or towel.

4. Allow the confined air to become saturated with water vapor (saturation occurs in approximately 10 to 15 minutes). During this time, turn-on the instrument to allow the DO probe to warm-up. Select monitoring/run mode. Check temperature readings. Temperature readings must stabilize before continuing to the next step.

5. Select calibration mode; then select "DO %".

6. Enter the local barometric pressure (usually in mm of mercury) for the sampling location into the instrument. This measurement must be determined from an on-site barometer. Do not use barometric pressure obtained from the local weather services unless the pressure is corrected for the elevation of the sampling location. [Note: inches of mercury times 25.4 mm/inch equals mm of mercury or consult Oxygen Solubility at Indicated Pressure, Table 2].

7. The instrument should indicate that the calibration is in progress. The instrument will take approximately one minute to calibrate. After calibration, the instrument should display percent saturated DO.

8. Select monitoring/run mode. Compare the DO mg/l reading to the Oxygen Solubility at Indicated Pressure chart (Table 2). The numbers should agree. If they do not agree to the accuracy of the instrument (usually ± 0.2 mg/L), repeat calibration. If this does not work, change the membrane and electrolyte solution. Insure that there are no air bubbles trapped below the membrane.

9. Remove the probe from the container and place it into a 0.0 mg/L DO standard. The standard must be filled to the top of its container and the DO probe must fit tightly into the standard's container (no head space). Check temperature readings. They must stabilize before continuing.

10. Wait until the "mg/l DO" readings have stabilized. The instrument should read 0.0 mg/L or to the accuracy of the instrument (usually ± 0.2 mg/L). If the instrument cannot reach these values, it will be necessary to clean the probe, and change the membrane and electrolyte solution. If this does not work, prepare a new 0.0 mg/L DO standard. If these measures do not work, contact manufacturer.

Note: To prepare a zero mg/L DO standard follow the procedure stated in Standard Methods (4500-O G; 18th edition). The method states to add excess sodium sulfite (until no more dissolves) and a trace amount of cobalt chloride to water. The standard container must be completely filled (no head space). This solution is prepared prior to the sampling event. If some of the solution is lost during instrument calibration, add more water to the container so that the standard is stored with no head space.

7.4 pH Meters

The pH of a sample is determined electrometrically using a glass electrode. There are a variety of instruments available to measure pH and temperature. There are pH test strips, indicator solutions, data loggers (e.g., Hydrolab minisonde) with pH sensors and hand-held DC powered pH meters. A pH meter must be calibrated/standardized daily prior to use (Standard Methods 4500-H^+ B; 18th Edition). If standardizing, select standard buffer solutions that bracket the pH range of the samples to be measured. The acceptance criterion is ±0.1 su. If pH standards 2 and 10 are used, pH 7 should be used as a check. When calibrating (two point calibration), use fresh (unused) buffer standards. The temperature probes of pH meters (if there is a readout displayed) should be checked for accuracy (acceptance criterion (±0.5°C) at the same time as pH calibration/standardization because temperature adjustments are made by the meters program in calculating the pH value. Properly label and dispose of all waste chemicals and materials. Dispose of hazardous wastes according with the Hazard Waste Management Guidance Document.

Calibration Procedure

1. Allow the fresh buffered standards to equilibrate to the ambient temperature.

2. Fill calibration containers with the fresh buffered standards so each standard will cover the pH probe and temperature sensor.

3. Remove probe from its storage container, rinse with distilled water, and blot dry with soft tissue.

4. Select monitoring/run mode. Immerse probe into the initial standard (e.g., pH 7).

5. Stir the standard until the readings stabilize. If the reading does not change within 30 seconds, select calibration mode and then select "pH". Enter the buffered standard value into instrument. Select monitoring/run mode. The readings should remain within manufacturer's specifications; if they change, re-calibrate. If readings continue to change after re-calibration, consult manufacturer.

6. Remove probe from the initial standard, rinse with distilled water, and blot dry.

7. Immerse probe into the second standard (e.g., pH 4). Repeat step 5.

8. Remove probe from the second standard, rinse with distilled water, and blot dry. If instrument only accepts two standards, the calibration is complete. Go to step 11. Otherwise continue.

9. Immerse probe in third buffered standard (e.g., pH 10) and repeat step 5.

10. Remove probe from the third standard, rinse with distilled water, and blot dry.

11. Select monitoring/run mode, if not already selected. To ensure that the initial calibration standard (e.g., pH 7) has not changed; immerse the probe into the initial standard. Wait for the readings to stabilize. The reading should read the initial standard value within the manufacturer's specifications. If not, re-calibrate the instrument. If recalibration does not help, the calibration range may be too great. Reduce calibration range by using standards that are closer together.

12. The calibration is complete. Place pH probe in its storage container.

7.5 Flowmeters

Flowmeters (e.g., General Oceanics, Inc.) are used in the openings of plankton nets to estimate the volume of water passing through the net during sampling. These mechanical meters record the revolutions of the impellers; the revolutions per unit time are used to calculate flow through the net. Flowmeters must be standardized once every 52 weeks. The accuracy of these meters is based on how freely the impeller spins, which is verified using a General Oceanics, Inc. Calibration Frame. The frame imparts a torsionally precise spin to the rotor and a count difference is noted in the flowmeter window. A minimum count is necessary for the flowmeter to be within calibration. The acceptance criterion for a General Oceanics, Inc. flowmeter is 80 revolutions per standard spin.

7.6 Temperature

Temperature data are collected with data loggers, thermometers, and thermistors in a variety of multiparameter meters (e.g., pH, D.O., and Conductivity/Salinity). Each instrument must have the accuracy of its temperature component verified because many of the other parameters change with temperature. "Reference Thermometers" are glass, capillary thermometers that have a read out accuracy 0.1°C and they have their accuracy verified with a certified thermometer once every 52 weeks. The acceptance criterion for Reference Thermometers is ±0.2°C. All other capillary thermometers used in the collection of data are standardized to the Reference Thermometers every 52 weeks (the acceptance criterion is ±0.5°C). Data loggers are standardized every 26 weeks (the acceptance criterion is ±0.5°C). Thermistors in multimeters are standardized every 13 weeks (the acceptance criterion is ±0.5°C).

Verification Procedure

1. Allow a container filled with water to come to room temperature.

2. Place a thermometer that is traceable to the National Institute of Standards and Technology (NIST) and the instrument's temperature sensor into the water and wait for both temperature readings to stabilize.

3. Compare the two measurements. The instrument's temperature sensor must agree with the reference thermometer measurement within the accuracy of the sensor (usually ±0.15°C). If the measurements do not agree, the instrument may not be working properly and the manufacturer needs to be consulted.

7.7 Turbidity

Turbidity meters are standardized with primary standards once every 13 weeks and with secondary standards prior to use. The meters are zeroed with de-ionized water prior to standardization and use. Primary standards are made up from mixing a powder in de-ionized water (4 standards are measured: <1, 20, 100, & 800 NTU) and the acceptance criterion is ±5%. Secondary standards are gels in the range of 5, 50, 500

NTU and the acceptance criterion is ±10%. De-ionized water is measured three times prior to measuring the gel standards.

The turbidity is based upon a comparison of intensity of light scattered by a sample under defined conditions with the intensity of light scattered by a standard reference suspension. A turbidimeter is a nephelometer with a visible light source for illuminating the sample and one or more photo-electric detectors placed ninety degrees to the path of the light source. Some instruments will only accept one standard. For these instruments, the standards will serve as check points.

Calibration Procedures

1. Allow the calibration standards to equilibrate at the ambient temperature. The use of commercially available polymer primary standards (AMCO-AEPA-1) is preferred, however, the standards can be prepared using Formazin according to the EPA analytical Method 180.1.

2. If the standard cuvette is not sealed, rinse a cuvette with deionized water. Shake the cuvette to remove as much water as possible. Do not wipe dry the inside of the cuvette because lint from the wipe may remain in the cuvette. Add the standard to the cuvette.

3. Before performing the calibration procedure, make sure the cuvettes are not scratched and the outside surfaces are dry, free from fingerprints and dust. If the cuvette is scratched or dirty, discard or clean the cuvette respectively.

4. Zero the instrument by using either a zero or 0.02 NTU standard. A zero standard (approximately 0 NTU) can be prepared by passing distilled water through a 0.45 micron pore size membrane filter.

5. Using a standard in the range of 5 - 20 NTUs, calibrate according to manufacturer's instructions or verify calibration if instrument will not accept a second standard. If verifying, the instrument should read standard value to within the specifications of the instrument. If the instrument has range of scales, check each range that will be used during the sampling event with a standard that falls within that range.

7. Using a standard between 20 and 100 NTUs, calibrate according to manufacturer's instructions or verify calibration if instrument does not accept a third standard. If verifying, the instrument should read standard value to within the specifications of the instrument. If the instrument has range of scales, check each range that will be used with the proper standard for that scale.

7.8 Weight

Precision balances with an accuracy of 0.001 to 0.00001 grams are calibrated once every 52 weeks by a vendor. All scales and balances used for collecting environmental data are standardized with a minimum of three standard weights (Class 4 or better) every 4 weeks. Personnel using balances to collect weight data need to check the calibration sticker for the standardization expiration date and the range of the standardization. If weight measurements are being made outside the documented standardization range, a new weight range bracketing the expected measurements needs to be used in standardizing the balance.

7.9 Oxidation/Reduction Potential (ORP)

The oxidation/reduction potential is the electrometric difference measured in a solution between an inert indicator electrode and a suitable reference electrode. The electrometric difference is measured in millivolts (mV) and is temperature dependent. ORP is calibrated using one-point calibration with a Zobell solution. The acceptance criteria for ORP standard potential should be within ±10 mV at a defined temperature.

Calibration Procedure

1. Allow the calibration standard (a Zobell solution) to equilibrate to ambient temperature.

2. Remove the probe from its storage container, and place it into the standard.

3. Select monitoring/run mode.

4. While stirring the standard, wait for the probe temperature to stabilize, and then read the temperature.

5. Look up the millivolt (mv) value at this temperature from the millivolt versus Temperature (Table 3) correction table usually found on the standard bottle or on the standard instruction sheet. You may need to interpolate millivolt value between temperatures. Select "calibration mode", then "ORP". Enter the temperature-corrected ORP value into the instrument.

6. Select monitoring/run mode. The readings should remain unchanged within manufacturer's specifications. If they change, re-calibrate. If readings continue to change after re-calibration, consult manufacturer.

7. If the instrument instruction manual states that the instrument is factory calibrated, then verify the factory calibration against the standard. If they do not agree within the specifications of the instrument, the instrument will need to be re-calibrated by the manufacturer.

8.0 Contacts

Name	Office	Cell
Karen Canody (Manager Biology)	804-273-3893 804-271-5304	804-627-3262
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Raymond Heller (EB Millstone)	860-447-1791 ext. 5054	860-333-3832
Keith German (GES)	304-627-3947 ext. 4836	412-736-2983
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9.0 Tables

Table 1. Calibration and Standardization Protocols

Parameter	Method	Interval	Standard	Acceptance Criterion	Calib./Stand. Method	Comments
Chlorine	Test Kit (gel standard)	Weekly	0.20 mg/L, 0.83 mg/L, 1.53 mg/L	±15%	Standardization	Zero meter to blank prior to measuring gel standards.
	Test Kit (ampule standard)	13 wks	Total Chlorine 0.12 (0.02 to 0.22) mg/L 0.60 (0.40 to 0.80) mg/L 1.20 (0.90 to 1.50) mg/L	±20%	Standardization	Record concentrations to 0.01 mg/L. Zero meter to blank prior to measuring standards.
Conductivity (specific conductance)	Instrument/Meter	13 wks	Freshwater 0.05-1.00 mS/cm	±5%	Standardization	If standard temperature is 25°C±1, standardize to specific conductance or conductivity.
			Seawater 40-60 mS/cm	±5%	Standardization	
	Reference Meter	4 wks	Freshwater 0.05-1.00 mS/cm	±5%	Standardization	
			Seawater 40-60 mS/cm	±5%	Standardization	

Parameter	Method	Interval	Standard	Acceptance Criterion	Calib./Stand. Method	Comments
Dissolved Oxygen	Reference/Instrument/Meter	4 wks	Azide – Winkler method using potassium iodide – iodate solution with an equivalent DO concentration of about 10 mg/L	±0.05 mg/L	Standardization	For dissolved oxygen, air calibrate prior to comparing to standard and record the temperature of standard.
	Optical DO Meter	4 wks	Azide – Winkler method using potassium iodide – iodate solution with an equivalent DO concentration of about 10 mg/L or Reference Meter	±0.05 mg/L	Standardization	
	Test Kit	52 wks	Azide – Winkler method using potassium iodide – iodate solution with an equivalent DO concentration of about 10 mg/L or Reference Meter	±0.05 mg/L	Standardization	
	Test Kit Instrument/Meter	Air calibrate prior to use	Azide – Winkler method using potassium iodide – iodate solution with an equivalent DO concentration of about 10 mg/L or Reference Meter	±0.05 mg/L	Standardization	
ORP	Instrument/Meter	Prior to use	Zobell's Solution	±10mV	Calibration	

Parameter	Method	Interval	Standard	Acceptance Criterion	Calib./Stand. Method	Comments
pH	AC Counter Top Units	Daily/Weekly	4.0, 7.0, and 10.0 Buffers	±0.1 su	Two Point Calibration or Standardization	Daily when meter is first turned on or weekly if meter remains on
	Battery Powered Portable Units	Day-of-Use	4.0, 7.0, and 10.0 Buffers	±0.1 su	Two Point Calibration or Standardization	Day-of-Use = 24 hour period following the last meter calibration or standardization
Flowmeter	Calibration Fame	52 wks	Standard spin	at least 80 revolutions	Standardization	General Oceanics Inc. Method
Salinity (specific conductance)	Visual Inspection	13 wks	Manufacturer's recommendations	Good condition	Equipment Check	Batteries are replaced every 13 weeks
	Reference Meter	4 wks	Freshwater 0.05-1.00 mS/cm	±5%	Standardization	If standard temperature is 25°C±1, standardize to specific conductance or conductivity.
	Instrument/Meter	13 wks	Seawater 40-60 mS/cm	±5%	Standardization	
	Instrument/Meter	13 wks	Freshwater 0.05-1.00 mS/cm	±5%	Standardization	
	Instrument/Meter	13 wks	Seawater 40-60 mS/cm	±5%	Standardization	

Parameter	Method	Interval	Standard	Acceptance Criterion	Calib./Stand. Method	Comments
Temperature	Reference Thermometer	52 wks	Certified Thermometer	±0.2°C	Three Temperatures to 0.1 °C accuracy	If deviation is greater than 0.1 °C, attach a tag with the correction factor to 0.1 °C or replace the thermometer
	Thermistor	13 wks	Reference Thermometer	±0.5°C	One temperature to 0.1 °C accuracy	
	Thermometer	52 wks	Reference Thermometer	±0.5°C	One temperature to 0.1 °C accuracy	For thermometers with 1 °C increments, record temperature to 0.2 °C and for thermometers with 0.1 °C increments to 0.1 °C
	Data Logger	26 wks	Reference Thermometer	±0.5°C	One temperature to 0.1 °C accuracy	
Turbidity	Primary Standard	13 wks	4 Standards (<1, 20, 100, & 800 NTU)	±5%	Standardization	Zero meter to de-ionized water.
	Secondary Standard	Prior to Use	Gel Standards (0-10, 10-100, 100-1000 NTU)	±10%	Standardization	Measure de-ionized water three times prior to measuring gel standards.
Weight	Balance	4 wks	Minimum of three reference weights	±5% Reference Weight	Standardization	Two weights should bracket the expected range for which the balance will be used and the third weight should be at an approximate mid-range.

Table 2. Oxygen Solubility (mg/L) at Indicated Pressure

	Atmospheric Pressure (mm Hg)						
Temp. °C	760	755	750	745	740	735	730
0	14.57	14.47	14.38	14.28	14.18	14.09	13.99
1	14.17	14.08	13.98	13.89	13.79	13.70	13.61
2	13.79	13.70	13.61	13.52	13.42	13.33	13.24
3	13.43	13.34	13.25	13.16	13.07	12.98	12.90
4	13.08	12.99	12.91	12.82	12.73	12.65	12.56
5	12.74	12.66	12.57	12.49	12.40	12.32	12.23
6	12.42	12.34	12.26	12.17	12.09	12.01	11.93
7	12.11	12.03	11.95	11.87	11.79	11.71	11.63
8	11.81	11.73	11.65	11.57	11.50	11.42	11.34
9	11.53	11.45	11.38	11.30	11.22	11.15	11.07
10	11.28	11.19	11.11	11.04	10.96	10.89	10.81
11	10.99	10.92	10.84	10.77	10.70	10.62	10.55
12	10.74	10.67	10.60	10.53	10.45	10.38	10.31
13	10.50	10.43	10.36	10.29	10.22	10.15	10.08
14	10.27	10.20	10.13	10.06	10.00	9.93	9.86
15	10.05	9.98	9.92	9.85	9.78	9.71	9.65
16	9.83	9.76	9.70	9.63	9.57	9.50	9.43
17	9.63	9.57	9.50	9.44	9.37	9.31	9.24
18	9.43	9.37	9.30	9.24	9.18	9.11	9.05
19	9.24	9.18	9.12	9.05	8.99	8.93	8.87
20	9.06	9.00	8.94	8.88	8.82	8.75	8.69
21	8.88	8.82	8.76	8.70	8.64	8.58	8.52
22	8.71	8.65	8.59	8.53	8.47	8.42	8.36
23	8.55	8.49	8.43	8.38	8.32	8.26	8.20
24	8.39	8.33	8.28	8.22	8.16	8.11	8.05
25	8.24	8.18	8.13	8.07	8.02	7.96	7.90
26	8.09	8.03	7.98	7.92	7.87	7.81	7.76
27	7.95	7.90	7.84	7.79	7.73	7.68	7.62
28	7.81	7.76	7.70	7.65	7.60	7.54	7.49
29	7.68	7.63	7.57	7.52	7.47	7.42	7.36
30	7.55	7.50	7.45	7.39	7.34	7.29	7.24
31	7.42	7.37	7.32	7.27	7.22	7.16	7.11
32	7.30	7.25	7.20	7.15	7.10	7.05	7.00
33	7.08	7.13	7.08	7.03	6.98	6.93	6.88

34	7.07	7.02	6.97	6.92	6.87	6.82	6.78
35	6.95	6.90	6.85	6.80	6.76	6.71	6.66
36	6.84	6.79	6.76	6.70	6.65	6.60	6.55
37	6.73	6.68	6.64	6.59	6.54	6.49	6.45
38	6.63	6.58	6.54	6.49	6.44	6.40	6.35
39	6.52	6.47	6.43	6.38	6.35	6.29	6.24
40	6.42	6.37	6.33	6.28	6.24	6.19	6.15
41	6.32	6.27	6.23	6.18	6.14	6.09	6.05
42	6.22	6.18	6.13	6.09	6.04	6.00	5.95
43	6.13	6.09	6.04	6.00	5.95	5.91	5.87
44	6.03	5.99	5.94	5.90	5.86	5.81	5.77
45	5.94	5.90	5.85	5.81	5.77	5.72	5.68

Table 2 (cont'd). Oxygen Solubility (mg/L) at Indicated Pressure

	Atmospheric Pressure (mm Hg)							
Temp. °C	725	720	715	710	705	700	695	690
0	13.89	13.80	13.70	13.61	13.51	13.41	13.32	13.22
1	13.51	13.42	13.33	13.23	13.14	13.04	12.95	12.86
2	13.15	13.06	12.07	12.88	12.79	12.69	12.60	12.51
3	12.81	12.72	12.63	12.54	12.45	12.36	12.27	12.18
4	12.47	12.39	12.30	12.21	12.13	12.04	11.95	11.87
5	12.15	12.06	11.98	11.89	11.81	11.73	11.64	11.56
6	11.84	11.73	11.68	11.60	11.51	11.43	11.35	11.27
7	11.55	11.47	11.39	11.31	11.22	11.14	11.06	10.98
8	11.26	11.18	11.10	11.02	10.95	10.87	10.79	10.71
9	10.99	10.92	10.84	10.76	10.69	10.61	10.53	10.46
10	10.74	10.66	10.59	10.51	10.44	10.36	10.29	10.21
11	10.48	10.40	10.33	10.28	10.18	10.11	10.04	9.96
12	10.24	10.17	10.10	10.02	9.95	9.88	9.81	9.46
13	10.01	9.94	9.87	9.80	9.73	9.66	9.59	9.52
14	9.79	9.72	9.65	9.68	9.51	9.45	9.38	9.31
15	9.58	9.51	9.44	9.58	9.31	9.24	9.18	9.11
16	9.37	9.30	9.24	9.17	9.11	9.04	8.97	8.91
17	9.18	9.11	9.05	8.98	8.92	8.85	8.79	8.73
18	8.99	8.92	8.86	8.80	8.73	8.67	8.61	8.54
19	8.81	8.74	8.68	8.62	8.56	8.49	8.43	8.37

20	8.63	8.57	8.51	8.45	8.39	8.33	8.27	8.21
21	8.46	8.40	8.34	8.28	8.22	8.16	8.10	8.04
22	8.30	8.24	8.18	8.12	8.06	8.00	7.95	7.89
23	8.15	8.09	8.03	7.97	7.91	7.86	7.80	7.74
24	7.99	7.94	7.88	7.82	7.76	7.71	7.65	7.59
25	7.85	7.79	7.74	7.68	7.60	7.57	7.51	7.46
26	7.70	7.65	7.59	7.54	7.48	7.43	7.37	7.32
27	7.57	7.52	7.46	7.41	7.35	7.30	7.25	7.19
28	7.44	7.38	7.33	7.28	7.22	7.17	7.12	7.06
29	7.31	7.26	7.21	7.15	7.10	7.05	7.00	6.94
30	7.19	7.14	7.08	7.03	6.98	6.93	6.88	6.82
31	7.06	7.01	6.96	6.91	6.86	6.81	6.76	6.70
32	6.95	6.90	6.85	6.80	6.70	6.70	6.64	6.59
33	6.83	6.78	6.73	6.68	6.83	6.58	6.53	6.48
34	6.73	6.68	6.63	6.58	6.53	6.48	6.43	6.38
35	6.61	6.56	6.51	6.47	6.42	6.37	6.36	6.27
36	6.51	6.46	6.41	6.36	6.31	6.27	6.22	6.17
37	6.40	6.35	6.31	6.26	6.21	6.16	6.12	6.07
38	6.30	6.26	6.21	6.16	6.12	6.07	6.02	5.98
39	6.26	6.15	6.11	6.06	6.01	5.97	5.92	5.87
40	6.10	6.06	6.01	5.96	5.92	5.86	5.83	5.78
41	6.00	5.96	5.91	5.87	5.82	5.78	5.73	5.69
42	5.91	5.86	5.82	5.77	5.73	5.69	5.64	5.60
43	5.82	5.78	5.73	5.69	5.65	5.60	5.56	5.51
44	5.72	5.68	5.64	5.59	5.55	5.51	5.46	5.42
45	5.64	5.59	5.55	5.51	5.47	5.42	5.38	5.34

Table 3. Temperature Dependency of Zobell's ORP Standard

Temp. °C	mV
10	243.5
15	236.0
20	228.5
25	221.1

11.0

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Electric Environmental Services
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Christopher Todd
Jim Levin
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Judy Box
Mike Leger

Appendix C

Lists of Data to be Collected and Recorded for Field Collection and Processing

Impingement Sample Collection Data Sheet

Category	Parameter	Value				
General Information	Crew Names Date Time (military) Tidal Phase					
Weather condition	Air Temp. (°C) Wind Direction Wind Speed (MPH) Sky Precipitation (in.) Wave Height (ft)					
Facility Operation	Circulation Pump Screen Status Screen Wash Method					
Water Quality	Time (military) Depth (ft) Temp. (°C) DO (mg/L) Specific Cond. (µs) Specific Cond. @ 25 Salinity (ppt) pH	 Reading Meter Meter Meter Calculated Calculated Meter				
Water Quality QC	Temp. (°C) DO (mg/L) Specific Cond. (µs) pH	Bottle Bottle Bottle Bottle				
Gear Used	Mesh size (µm) Dimension Configuration					
Sample Collection	Time (military) Volume	Start Reading	End			
Collection Processing	Species Name	Live, Undamaged Count	Live, Damaged Count	Fresh Dead Count	Dead/decaying Count	Batch Species Weight
	Comments					
Length/Weight	Species Name	Length (mm)	Max Depth (mm)	Max Width (mm)	Weight (g)	
Atlantic Sturgeon	See *Handling Procedures for Atlantic Sturgeon* (Section 6.4.4)	Total Length (mm)	Fork Length (mm)	Interorbital Width (mm)	Mouth Width (mm)	Weight (g)
Debris Load	Total Debris Volume	gallons				
	Debris Volume by Type	Percentage	Aquatic vegetation and algae	Terrestrial vegetation – leafy/herbaceous		Terrestrial vegetation – woody
			Aquatic or terrestrial fauna not quantified in impingement sample, with description (exact taxonomic identification if feasible but not necessary, e.g. aquatic insect larvae)			
			Sediments or other natural inorganic debris, with general description of size composition (e.g. gravel, sand, silt etc.)			
			Man-made debris/refuse with general description of types (plastic, metal etc.)			
			"Other" with description			
Crew Signature						

Example Impingement Identification and Enumeration Quality Control Results Data Sheet

Category	Value	
Date		
Project Location		
QC Analyzer		
Original Analyzer		
QC Program:		
Model 1		
Model 2		
QC#		
Sample Number		
Date		
Species		
Original Count		
QC Count		
% Efficiency	I.D.	Count
Comments		

From: Sumalee Hoskin [[redacted]
Sent: Wednesday, December 09, 2015 11:31 AM
To: Matt Overton (Services - 6)
Cc: Karen K Canody (Services - 6)
Subject: RE: Surry Power Station Clearing

Matt,
We do not have any documented hibernacula or roost trees in Surry Co. They are free to clear the trees next week.
Sumalee

****
Sumalee Hoskin
US Fish & Wildlife Service
6669 Short Lane
Gloucester, VA 23061

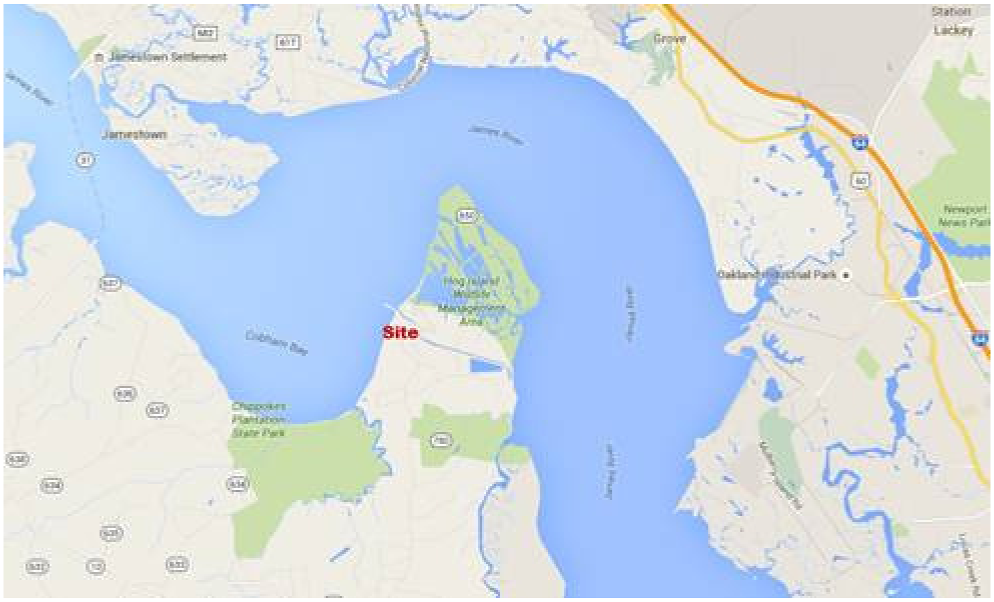
[redacted]4
Visit us at http://www.fws.gov/northeast/virginiafield/

From: Matt Overton (Services - 6) [[redacted]
Sent: Wednesday, December 09, 2015 11:23 AM
To: Hoskin, Sumalee
Cc: Karen K Canody (Services - 6)
Subject: Surry Power Station Clearing

Ms. Hoskins:

At our Surry Nuclear Power Station, they have a requirement to monitor the air surrounding the station for any potential harmful releases from the power station. In order to keep the air sampler operating correctly, they must clear a limited amount of trees in a 50-foot radius around the sampler. This equates to 0.2 acres of tree clearing. Station personnel are proposing to clear these trees in the next week (off-season). I wanted to confirm that this area is greater than 0.25-miles from a known hibernaculum and/or roost tree for NLEB. The station is located in Surry County (map below). Could you please confirm the presence/absence of known resources and if the project may proceed in the off season.

Thanks for your help.



P. Matt Overton, PWD
Environmental Biology
4111 Castlewood Road
Richmond, Virginia 23234
[redacted]

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VPDES PERMIT FACT SHEET

This document gives pertinent information concerning the **reissuance** of the VPDES permit listed below. This permit is being processed as a **Major,** Industrial permit. The industrial discharges result from the generation of electricity (station capacity of 1625 megawatts) with steam produced by the fission of nuclear fuel. The permit also addresses the discharge from a privately owned sewage treatment plant, as well as discharge from the storage of petroleum in above ground storage tanks. The effluent limitations contained in this permit will maintain the Water Quality Standards of 9 VAC 25-260 et seq. This permit action consists of evaluating effluent data, revising permit limitations and monitoring requirements, and revising permit special conditions.

1.	Facility Name and Address:	Surry Power Station & Gravel Neck 5570 Hog Island Road Surry, VA 23883
	Facility Contact Name: Title: Telephone: Email:	Phyllis G. Wells Environmental Compliance Coordinator (757) 365-2377 phyllis.g.wells@dom.com
	SIC:	4911 – Electric Services
2.	Permit Number: Permit Expiration Date:	VA0004090 January 21, 2012
3.	Owner Name and Address:	Virginia Electric & Power Company 5000 Dominion Boulevard Glen Allen, VA 23060
	Owner Contact Name: Title: Telephone: Email:	Cathy C. Taylor Director, Electric Environmental Services (804) 273-2929 catherine.c.taylor@dom.com

4. Application Complete: Date: July 11, 2011
Permit Drafted By: Jeremy Kazio Date: October 5, 2012, November 13, 2012

Reviewed By:		
	Emilee Adamson	Date: December 19, 2012, December 27, 2012
	Curt Linderman	Date: March 5, 2013, March 22, 2013
	Kyle Winter	Date: March 25, 2013
	EPA Region III	Date:

Public Comment Period Dates: from to

Published Dates: and in *Sussex-Surry Dispatch*

5. Receiving Stream Information:

	Process Discharge		Storm Water Runoff			
	Outfall 001	**Outfall 002**	**Outfall 050**	**Outfall 051**	**Outfall 052**	**Outfall 053**
Receiving Stream Name:	James River	Unnamed Tributary to James River	Unnamed Tributary to James River	Unnamed Tributary to Hog Island Creek	James River	James River
Basin:	James River (Lower)	James River (Lower)	James River (Lower)	James River (Lower)	James River (Lower)	James River (Lower)
Subbasin:	NA	NA	NA	N/A	NA	NA
Section:	1	1a	1a	1	1	1
Class:	II	III	III	II	II	II
Special Standards:	a, bb	None	None	None	a, bb	a, bb
Rivermile:	2-JMS037.30	2-XTD002.15	2-XTD001.80	2-CXBO000.42	2-JMS029.34	2-JMS029.27
Tidal Receiving Stream?	YES	NO	NO	NO	YES	YES
On 303(d) List?	YES	NO	NO	YES	YES	YES
7-Day, 10-Year Low Flow (7Q10):	NA - Tidal	0 MGD	NA – Storm Water			
1-Day, 10-Year Low Flow (1Q10):		0 MGD				
30-Day, 5-Year Low Flow (30Q5):		0 MGD				
30-Day, 10-Year Low Flow (30Q10):		0 MGD				
7Q10 High Flow:		0 MGD				
1Q10 High Flow:		0 MGD				
Harmonic Mean Flow (HM):		0 MGD				

Tidal Dilution Muliplier (Applicable to **Outfall 001 ONLY**)		
Acute	ESR = 0.70:1	DM = **1.43**
Chronic	ESR = 0.69:1	DM = **1.45**
Human Health	ESR = 0.66:1	DM = **1.52**

ESR = Effluent to Stream Ratio (Concentration of whole effluent in stream, in parts)

DM = Dilution Multiplier (Parts stream divided by parts effluent)

Please see **Attachment A** for Flow Frequency Memo by J.V. Palmore revised 10/3/2012 and *Mixing and Dilution of the Surry Nuclear Power Plant Cooling Water Discharge in the James River* by J.M. Hamrick, A.Y

Kuo, and J. Shen dated July 1995 and submitted to DEQ on August 11, 1995 (see Table 4 – "Maximum tidal cycle averaged relative concentrations with respect to concentrations in the cooling canal discharge").

6. Operator License Requirements: Class III (Sewage Treatment Plant). Licensed operator not required for discharges from Outfalls 001 and 002 because there are no forms of biological, chemical, or physical treatment as intended by the requirements contained in 9 VAC 25-31-200.C of the *VPDES Permit Regulation*

7. Reliability Class: Class II (Sewage Treatment Plant)

8. Permit Characterization:

(X) Existing Discharge
(X) Water Quality Limited
(X) Industrial (SIC=4911)
(X) PVOTW
(X) Private
(X) Compliance Schedule Required
(X) Reissuance
(X) Interim Limits in Permit
(X) Discharge to 303(d) Listed Segment
(X) Toxics Management Program Required
(X) Storm Water Management Plan
(X) Effluent Limited

9. Discharge Description

Outfalls Limited and Monitored in Part I.A.1				
Outfall No.	**Discharge Source**	**Description**	**Treatment**	**Max. 30-day flow (MGD)**
001	Units 1 & 2 Condensers (and internal outfalls 101 through 122)	Once-through non-contact cooling water & Internal Outfalls 101-122	Mixing, cooling, and periodic disinfection for biofouling control.	2300.396

Outfalls Limited and Monitored in Part I.A.3				
Outfall No.	**Discharge Source**	**Description**	**Treatment**	**Max. 30-day flow (MGD)**
101	Sewage Treatment Plant	The treatment plant treats domestic wastewater originating from Surry Power Station's sanitary drains.	Flow equalization, screening, settling, grinding, activated sludge, disinfection (chlorination), aerobic digestion (sludge), sludge drying beds (rarely used).	0.038238 (design flow = 0.085)

Outfalls Limited and Monitored in Part I.A.5				
Outfall No.	**Discharge Source**	**Description**	**Treatment**	**Max. 30-day flow (MGD)**
102	Turbine Sump A	The turbine sumps collect water and hydraulic/lube oil leakage from components within the turbine building.	Flotation, settling, oil skimmer.	0.0234
103	Turbine Sump B			0.05
106	Turbine Sump C			0.0234

Outfalls Limited and Monitored in Part I.A.6				
Outfall No.	**Discharge Source**	**Description**	**Treatment**	**Max. 30-day flow (MGD)**
116	Unit 1 Recirculation Spray Heat Exchanger (RSHX)	The RSHXs are part of an emergency system that maintains appropriate atmospheric pressure within the nuclear containment area. The RSHXs remove heat from water that collects in the containment sump. The supply water to these heat exchangers is James River water from the intake canal. The RSHXs are typically drained and maintained in a dry ready condition, but are tested once every other outage.	None	0.023
117	Unit 2 Recirculation Spray Heat Exchanger		None	2.982 (from application)

Outfalls Limited and Monitored in Part I.A.7				
Outfall No.	**Discharge Source**	**Description**	**Treatment**	**Max. 30-day flow (MGD)**
104	Reverse Osmosis (RO) Reject & Membrane Backwash	Well water is treated by reverse osmosis to provide makeup water to the Polishing Building.	None	0.0216
109	Radwaste Facility	The Radwaste Facility processes radioactive liquid waste.	Ion exchange, reverse osmosis	0.0181
110	Unit 1A Waste Neutralization Sump	The waste neutralization sumps collect and treat non-neutral pH wastewater produced during routine operation of the Condensate Polishing System and resin regeneration process. The treated wastewater can be discharged to the Settling Pond or to the Discharge Canal.	Settling, neutralization	0.0279
111	Unit 1B Waste Neutralization Sump			0.0279
112	Unit 2A Waste Neutralization Sump			0.0279
113	Unit 2B Waste Neutralization Sump			0.0279
120	Low Conductivity Sump	This sump collects wastewater from the Condensate Polishing System operation and associated resin regeneration process. Only wastewater with neutral pH is discharged via this internal outfall. Wastewater outside of the neutral pH range is directed to the Waste Neutralization Sumps for additional treatment prior to release (Outfalls 110, 111, 112, and 113). This sump can be discharged to the Settling Pond or to the Discharge Canal.	Settling, neutralization	0.038

Outfalls Limited and Monitored in Part I.A.8				
Outfall No.	**Discharge Source**	**Description**	**Treatment**	**Max. 30-day flow (MGD)**
107	Package Boilers A & B	The auxiliary boilers provide steam to the Auxiliary Steam System when both nuclear reactors are shut down. These boilers are also performance tested once per year. Boiler wastewater (primarily boiler blowdown) is discharged.	None	0.0031
114	Unit 1 Steam Generator Blowdown	Each Unit has 3 separate Steam Generators and 3 separate Steam Generator Blowdown Systems. The water used for the Steam Generators is treated by ion exchange, conditioned with additives for pH and corrosion control, and is recirculated within the system. Blowdown (i.e. purging of a specific volume of recirculated water) is necessary to regulate the chemistry of the recirculating water. The blowdown can be discharged to the discharge canal via these internal outfalls, or to the condenser hotwells for recirculation back into the steam system.	None	0.0429
115	Unit 2 Steam Generator Blowdown			0.0429
118	Unit 1 Condenser Hotwell Drain	The Condenser Hotwells (where steam condensate collects) are periodically drained for maintenance and inspection. Steam Generator Blowdown (see Outfalls 114 and 115 above) may be directed to these condenser hotwells.	None	0.09
119	Unit 2 Condenser Hotwell Drain			0.09
121	Unit 1 Steam Generator Hydrolance	Periodically, deionized water is used to clean the steam generators using a hydrolance (water blasting) process.	Filtration	0.0005
122	Unit 2 Steam Generator Hydrolance		Filtration	0.1025 (from application)

Outfalls Limited and Monitored in Part I.A.9				
Outfall No.	Discharge Source	Description	Treatment	Max. 30-day flow (MGD)
105	Oil Storage Tank Dike	The 210,000 gallon fuel oil tank located adjacent to the Discharge Canal serves the Auxiliary Boiler and Emergency Diesel Generators. The concrete dike provides emergency holding in the event of tank failure. Storm water collected within the dike is released via a gate valve to the Discharge Canal.	None. Collected storm water is visually inspected for petroleum, which if present is removed prior to release.	0.05891

Outfalls Limited and Monitored in Part I.A.11				
Outfall No.	Discharge Source	Description	Treatment	Max. 30-day flow (MGD)
108	Settling Pond	The Settling Pond receives discharges from internal outfalls 110, 111, 112, 113, and 120 (see outfall descriptions above). The Settling Pond also receives the discharge from the Gravel Neck oil/water separator, which is pumped to the Settling Pond via a lift station. Influent to the Gravel Neck oil/water separator includes discharges from:	Sedimentation, aeration	0.049318
		1) oil/water separators for individual combustion turbine units 3, 4, 5, & 6;		
		2) compressor wash water and floor drains from combustion turbine units 3, 4, 5, & 6;		
		3) RO reject from the mobile RO systems;		
		4) Gravel Neck AST truck off-loading drains and emergency spill tank;		
		5) storm water collected within Gravel Neck fuel oil AST containment dike;		
		6) water collected within Gravel Neck fuel oil AST dike from periodic pressure washing exterior of tanks;		
		7) storm water collected within Surry Power Stations' various fuel oil AST containment dikes		

Outfalls Limited and Monitored in Part I.A.12				
Outfall No.	**Discharge Source**	**Description**	**Treatment**	**Max. 30-day flow (MGD)**
002	Gravel Neck Gas Turbine Containment Dike	The 320,000 gallon fuel oil tank located between the newer combustion turbines and the intake canal serves the older backup combustion turbines. The dirt dike provides emergency holding in the event of tank failure. Storm water collected within the dike is released via a gate valve.	None. Collected storm water is visually inspected for petroleum, which if present is removed prior to release.	0.02127

Outfalls Limited and Monitored in Part I.A.15				
Outfall No.	**Discharge Source**	**Description**	**Treatment**	**Max. 30-day flow (MGD)**
050	Storm water runoff from ~272 acres of drainage area located in the central portion of the Surry Power Station and Gravel Neck sites	Storm water runoff	None	Weather dependent
051	Storm water runoff from ~84 acres of drainage area located adjacent to and East of the drainage area contributing to Outfall 050			
052	Storm water runoff from ~10 acres of drainage area located adjacent to and North of the high level intake structure			
053	Storm water runoff from ~10 acres drainage area located adjacent to and South of the high level intake structure			

Please see **Attachment B** for facility flow diagram, outfall location map, sewage treatment plant diagram and sludge haul route, storm water outfall locations and drainage maps, and well location map.

10. Sewage Sludge Use or Disposal: Sewage sludge generated by the Surry Power Station Sewage Treatment Plant (Outfall 101) is hauled offsite by Duck's Septage Company (DSC). The sludge is either placed into an aerated septage lagoon that is operated by DSC or taken to the Sussex Service Authority's Black Swamp Regional Wastewater Treatment Plant in Waverly, VA. See **Attachment B** for sewage sludge haul directions and map.

It has not historically been necessary to remove sludge from the Settling Pond (Outfall 108). If it becomes necessary in the future, it is expected of the permittee that all solids removal and handling activities will be in conformance with the facility's Operations and Maintenance Manual in accordance with Part I.C.5.f of the 2013 permit.

11. Discharge Location Description*:*
See **Attachment C** for topographic map and aerial photographs. See below for external outfalls coordinates.

Map Name: Hog Island (066B) Quadrangle

External Outfall No.	Latitude	Longitude
Outfall 001	37.17133	-76.70423
Outfall 002	37.16100	-76.69285
Outfall 050	37.16712	-76.68959
Outfall 051	37.16167	-76.68315
Outfall 052	37.15707	-76.67109
Outfall 053	37.15472	-76.67109

12. Material Storage:
See **Attachment D** for chemicals that are or will be stored and/or used onsite within the 2013 permit cycle. The, handling, storage, and use of these chemicals are expected to be in accordance with Part I.C.2 (Materials Handling/Storage) and Part I.C.26 (Best Management Practices) of the 2013 permit.

In addition, the Surry Power Station and Gravel Neck facilities have multiple ASTs and other containers used for fuel oil or chemical storage located outdoors. The nature of stored material and maximum volume of each tank/container is listed below. Please note that chemical storage does not occur outdoors at the Gravel Neck site:

Surry Power Station – Petroleum ASTs			
Container Name / ID No.	**Product Stored**	**Total Capacity (gal)**	**Secondary Containment Volume (gal) / Type**
1-HS-TK-1	No. 2 Fuel Oil	210,000	228,904 / Concrete Floor and Wall
1-UO-TK-1	Used Oil	10,000	12,320 / Concrete Floor and Walls
Administration Building EDG Fuel Tank	No. 2 Fuel Oil	1,500	1,621 / Integral Steel
Base Tank 1	No. 2 Fuel Oil	550	1,550 / EDG Room with Concrete Curb
Base Tank 2	No. 2 Fuel Oil	550	1,550 / EDG Room with Concrete Curb
Base Tank 3	No. 2 Fuel Oil	550	1,550 / EDG Room with Concrete Curb
EDG 1 Day Tank (1-EE-TK-3)	No. 2 Fuel Oil	541	832 / EDG Room with Concrete Curb

Surry Power Station – Petroleum ASTs			
Container Name / ID No.	**Product Stored**	**Total Capacity (gal)**	**Secondary Containment Volume (gal) / Type**
EDG 2 Day Tank (2-EE-TK-3)	No. 2 Fuel Oil	541	832 / EDG Room with Concrete Curb
EDG 3 Day Tank (1-EE-TK-4)	No. 2 Fuel Oil	541	832 / EDG Room with Concrete Curb
EDG/ISFSI	No. 2 Fuel Oil	205	>205 / Double-walled tank
Emergency Service Water Pump Fuel Tank (1- SW-TK-1)	No. 2 Fuel Oil	4,800	6,488 / Room with Concrete Curb
Fire Water Diesel Fuel Tank (1-FP-TK-4)	No. 2 Fuel Oil	370	570 / Fire Pump House with Concrete Curb
NSS Garage Engine Oil Tank (VP-75-T-2)	Engine Oil	580	/ Double wall tank
NSS Garage Hydraulic Oil Tank (vP-75-T-3)	Hydraulic Oil	580	/ Double wall tank
NSS Garage Used Oil Tank / (VP-75-T-1)	Used Oil	300	/ Double wall tank
Oil Recovery System Tank (1-UO-TK-3)	Oil	300	>300 / Metal curbed concrete pad & sump
SBO Generator Tank (Blackout Diesel) (0-BFO-TK-1)	No. 2 Fuel Oil	1,217	1,676 / Concrete Floor and Dike
Security EDG 0-SE-DG-3 Base Tank	Diesel Fuel	300	/ Double wall tank
Security FAP EDG Tank / 0-SE-EG-2	No. 2 Fuel Oil	112	>112 / Double-Walled Tank
Turbine Lube Clean Oil (1-LO-TK-2)	Turbine Lube Oil	22,000	62,313 / Enclosed Concrete Area
Turbine Lube Used Oil (1-LO-TK-3)	Turbine Lube Oil	22,000	62,313 / Enclosed Concrete Area
Total Petroleum AST Volume -->		**277,537**	

Surry Power Station – Chemical Container Storage			
Container Name / ID No.	**Product Stored**	**Total Capacity (gal)**	**Secondary Containment Volume (gal) / Type**
No ID # Six - Polyurethane 3 for Unit 1 and 3 for Unit 2 High level Chemical Injection System	Sodium hypochlorite - 15% max / balance water, typical value of 13%	Each 3000 gal (max) tanks,	Poleyurethane containment for each tank can hold the entire 12,000 gallon for system

Surry Power Station – Chemical Container Storage			
Container Name / ID No.	**Product Stored**	**Total Capacity (gal)**	**Secondary Containment Volume (gal) / Type**
No ID # Two - Polyurethane 1 for Unit 1 and 1 for Unit 2 High level Chemical Injection System	Acti-Brom 1318 - 30 to 60% / balance water, typical value 43%.	Each 3000 gal (max) tanks,	Poleyurethane containment for each tank can hold the entire 12,000 gallon for system
1-CS-TK-2 Unit 1 RWST* Chemical Addition Tank	17-18% NaOH (Sodium Hydroxide)	4311 gallons	No
2-CS-TK-2 Unit 2 RWST Chemical Addition Tank	17-18% NaOH (Sodium Hydroxide)	4311 gallons	No

Gravel Neck – Petroleum ASTs			
Container Name / ID No.	**Product Stored**	**Total Capacity (gal)**	**Secondary Containment Volume (gal) / Type**
00-FO-TK-1A	Fuel Oil No. 2	3,177,000	3,190,208/Diked Area
00-FO-TK-1B	Fuel Oil No. 2	3,177,000	3,190,208/Diked Area
02-FO-TK-1C	Fuel Oil No. 2	320,000	312,782/Diked Area
Filter Drain Tank	Used Oil	270	1,000/OWS to VPDES Sump and Pond
Mist Vapor Holding Tank 1	Fuel Oil No. 2	250	1,000/OWS to VPDES Sump and Pond
Mist Vapor Holding Tank 2	Fuel Oil No. 2	250	1,000/OWS to VPDES Sump and Pond
Mobile Oil Tank	Used Oil	500	1,000/OWS to VPDES Sump and Pond
Unit 1 and 2 Emergency Diesel Generator	Diesel Fuel	171	235,100/Stormwater basin
Unit 1 Oil Sump	Fuel Oil No. 2	434	235,100/Stormwater Retention Basin
Unit 2 Diesel Fuel Tank	Diesel Fuel	203	235,100/Stormwater basin
Total Petroleum AST Volume -->		**6,676,078**	

13. <u>Ambient Water Quality Information (Outfalls 001 and 002 ONLY, not applicable to storm water outfalls)</u>:

Outfall 001 - Water quality information used for the evaluation of the discharge from Outfall 001 are derived from data collected at DEQ's ambient monitoring station 2-JMS041.27. The station is located at the Scotland Ferry pier approximately 3.97 miles upstream of the discharge. However, hardness data were not collected at this station; therefore hardness data from station 2-JMS050.57 were used. The station is located at buoy 66 above the confluence with the Chickahominy River and is 13.27 miles upstream of the discharge.

Outfall 002 – The receiving stream for Outfall 002 is considered to be intermittent, therefore, statistical low flows used for the evaluation of the discharge are considered to be 'zero' for permitting purposes. Since flows within the receiving stream may be made up entirely of effluent at various times during the year, effluent quality information was used in place of ambient water quality information for the evaluation of the discharge from Outfall 002.

(see **Attachment E** for raw data and statistically derived values from monitoring stations 2-JMS041.27 and 2-JMS050.57).

14. <u>Antidegradation Review & Comments</u>: Outfall 001: Tier 1 __X__ Tier 2 _____ Tier 3 _____
Outfall 002: Tier 1 __X__ Tier 2 _____ Tier 3 _____

The State Water Control Board's Water Quality Standards includes an antidegradation policy (9 VAC 25-260-30). All state surface waters are provided one of three levels of antidegradation protection. For Tier 1 or existing use protection, existing uses of the water body and the water quality to protect those uses must be maintained. Tier 2 water bodies have water quality that is better than the water quality standards. Significant lowering of the water quality of Tier 2 waters is not allowed without an evaluation of the economic and social impacts. Tier 3 water bodies are exceptional waters and are so designated by regulatory amendment. The antidegradation policy prohibits new or expanded discharges into exceptional waters.

The anti-degradation review begins with a Tier determination.

Outfall 001 & Outfall 052: The James River had previously been considered a Tier 2 water at the discharge points. However, due to the benthic impairment in the oligohaline mainstem segment, the James is considered to be designated a Tier 1 waterbody.

Outfall 053: The James River had previously been considered a Tier 2 water at the discharge point. However, due to the benthic impairment in the mesohaline mainstem segment during the 2010 Assessment Cycle, the James is considered to be designated a Tier 1 waterbody.

Outfall 002, Outfall 050, & Outfall 051: Due to their intermittent natures, the receiving streams are considered to be Tier 1 water bodies.

(See **Attachment A** for Flow Frequency Memorandum by Jennifer V. Palmore, P.G. revised 10/3/2012)

15. <u>Site Inspection</u>: Date: <u>November 9, 2010</u>
Performed by: <u>Charles Stitzer</u> (See **Attachment F**)

16. <u>Effluent Screening & Limitation Development</u>:

Effluent Screening:

Effluent testing results submitted by the permittee in order to satisfy the requirements of EPA Form 2C and Attachment A for Outfall 001 and Outfall 002 have been summarized in **Attachment G** of this fact sheet. Also included in this attachment are DMR data submitted to DEQ between March 2007 and February 2012.

If it is feasible that a specific pollutant for which in-stream criteria are given in the *Virginia Water Quality Standards* (9 VAC 25-260 et.seq.) may exist in the facility's effluent, a Reasonable Potential Analysis must be conducted in order to determine if it is statistically probable that the permittee's future discharge may contain that pollutant in concentrations which are harmful to aquatic life and/or human health within the receiving stream. The first step of the analysis is to calculate the pollutant's wasteload allocations (WLAs), which are defined as the pollutant concentration that may be discharged by the facility over specific periods of time which will maintain the in-stream criteria at the boundary of the effluent's mixing zone within the receiving stream. The WLAs are determined using a DEQ-sourced Excel spreadsheet called MSTRANTI, which requires inputs representing site specific data for critical flows, dilution, mixing, and water quality for both the receiving stream and the effluent.

For aquatic life Reasonable Potential evaluations, a desktop computer application called STATS is utilized to determine if future pollutant concentrations may exceed the aquatic life WLAs. The STATS application projects the WLA inputs, as well as observed effluent data, onto respective lognormal distributions. If the projected effluent distribution exceeds the most restrictive aquatic life WLA distribution, then a limitation is deemed necessary. The limitation is equal to the concentration expected to be observed at the required monitoring frequency of the most protective WLA distribution.

For human health reasonable potential evaluations, the WLAs are compared directly to the reported test results for the respective pollutant. If the test results exceed the human health WLA, then a limitation is deemed necessary. The human health WLA is directly applied as the monthly limitation, and the maximum daily or weekly average limitations are derived using multiplication factors in accordance with the January 10, 2001 memorandum by Dale Philips titled "Advice for Daily Maximum and Weekly Average Limits for Human Health Based Limits".

The table in **Attachment G** mentioned above lists the WLAs for each pollutant of concern, as well as the determination of whether a limitation is needed after the aforementioned Reasonable Potential evaluations were applied. The following tables represent those pollutants for which limitations were determined to be necessary for the 2013 permit. Please note that the permittee submitted total recoverable metals data for internal Outfall 101, however, these data were not evaluated because this effluent stream is reflected by Outfall 001, and because WLAs cannot be calculated for internal outfalls.

Outfall 002								
Pollutant	Test Results (µg/L)	2012 Wasteload Allocations (µg/L)				Basis for Proposed Limitation	Limitations (µg/L)	
		WLA_a	WLA_c	WLA_{HH-PWS}	WLA_{HH}		Mon. Avg.	Max.
Copper, dissolved	**8**, 22, 29, 4, 7, 7,16, 6, 32, 6	3.6	2.7	1300	--	WLA_a	3.6	3.6
Nickel, dissolved	<5 (entered as 5)	56	6.3	610	4600	WLA_c	9.2	9.2
Zinc, dissolved	**37,**182, 77, 231, 180, 282, 22, 72, 59, 119	36	36	7400	26000	WLA_a	36	36

Please note that Nickel at Outfall 002 was reported below a QL that is greater than the DEQ-recommended QL for that pollutant. Consequently, the value was treated as concentration data equal to the QL for the purposes of this permit evaluation. Also note that the test results for Copper and Zinc at Outfall 002 submitted with the 2011 application (in bold under the "Test Results" column) were combined with monitoring data submitted to DEQ between August 2008 and March 2012. The permittee was required to monitor for dissolved Copper and Zinc during the 2007-2012 permit cycle due to elevated levels of these pollutants reported in the 2006 application for Outfall 002.

Please also note that the permittee submitted bacteriological test results for both *E.coli* and *Enterococcus* of 75 N/CML and >2420 N/CML, respectively, taken at the Outfall 001 discharge. The main source of effluent from this outfall is once through cooling water. There are no processes at this facility which contribute bacteria to the effluent other than the Sewage Treatment Plant, which discharges to the effluent canal through internal Outfall 101. The effluent from the Sewage Treatment Plant is limited for Fecal Coliform bacteria, and additionally, the permittee has demonstrated adequate disinfection through a successful

Bacteria Demonstration Study conducted during the 2007 permit cycle. Between March 2007 and February 2012 the permittee did not violate their Fecal Coliform or minimum TRC limitations. Therefore, it is staff's judgment that the source of the elevated bacterial levels discharged through Outfall 001 may be attributed to background levels within the James River. Please note that the James River is not impaired for the Recreation Use at the Outfall 001 location, and thus the discharge has not caused, nor does it currently contribute to, any bacteriological impairments within the receiving water body.

Please see **Attachment H** for MSTRANTI and STATS printouts.

Permit Limitations and Monitoring Requirements Rationale:

▼ Basis for Effluent Limitations: Outfall 001 (Final Effluent Canal)

EFFLUENT CHARACT.	BASIS	DISCHARGE LIMITATIONS				MONITORING REQUIREMENTS	
		MONTHLY AVERAGE	WEEKLY AVERAGE	MIN.	MAX.	FREQ.	SAMPLE TYPE
Flow (MGD)	NA	NL	NA	NA	NL	Continuous	Recorded
pH (Standard Units)	1, 3	NA	NA	6.0	9.0	2 per Month	Grab
Total Residual Chlorine (mg/L)	1, 3	0.0080	NA	NA	0.016	1 per Day	Grab
Heat Rejected (BTU/HR)	4	Heat rejected shall not exceed a daily maximum of 12.6 x 10^9				Continuous	Recorded
Intake pH (Standard Units)	NA	NA	NA	NL	NL	2 per Month	Grab
Intake Total Suspended Solids (mg/L)	NA	NL	NA	NA	NL	1 per Month	Grab
Thallium, total recoverable (µg/L)	NA	NL	NA	NA	NL	1 per Year	Grab

Basis for Limitations:
1) Water Quality Standards (9 VAC 25-260)
2) Federal Effluent Guidelines (40 CFR 423.12)
3) Best Engineering Judgment (BEJ)
4) 316(a) Demonstration Report

pH: GM95-012 suggests that pH limits **not** be applied to once-through cooling water discharges that intake from and discharge to the same water body due to a lack of reasonable potential that pH would be changed by the process, even in the event of equipment failure. Additionally, GM95-012 advises that the permittee has no control over the pH of the intake water and no reasonable remedy in the event that the intake water fails to meet the Water Quality Standards. For this facility, even though once-through cooling water comprises the bulk of the discharge through Outfall 001, this outfall also includes multiple low volume internal outfalls which may have a bearing on the pH levels of the discharge, especially during plant outages or in the event of equipment failure. Consequently, in accordance with the "Exclusions" section of GM95-012 (Pg. 3), pH limitations are considered to be appropriate for the facility's discharge because ". . . chemical additives, routine operation, equipment failure or leakage could change the pH of the cooling water." The pH limitations required in 40 CFR 423.12(b)(1) of the Federal Effluent Guidelines (6.0-9.0 SU) are specifically exempted from being applied to once-through cooling water discharges, and therefore, the pH limitations required in the 2013 permit for Outfall 001 are based on the Water Quality Standards (9 VAC 25-260-50.- Class II Estuarine Waters).

However, with regard for the abovementioned statement in GM95-012 concerning the permittee having no control over intake pH levels, footnote (b) in Part I.A.1 of the 2013 permit allows that pH be maintained within

0.5 SU's of the intake pH values when intake pH values are observed outside of the limitation range. This permit requirement aids in ensuring that the permittee consistently provides controls for the overall influence that the facility's daily processes may have on the influent pH levels. It should be noted that pH data reported with DMRs submitted between March 2007- February 2012 for the Outfall 001 discharge included a 5 year maximum of 8.5 SU and minimum of 6.9 SU, while the intake pH data for the same time period included a 5 year maximum of 8.46 SU and minimum of 6.43 SU. These values are within the 2007 permit limits as well as the 2013 proposed permit limits of 6.0-9.0 SU.

Total Residual Chlorine (TRC): Chlorine compounds may be added to the facility's service water as an anti-biofouling agent. Additionally, chlorine is also used for disinfection at the onsite wastewater treatment plant discharging through Outfall 101. In accordance with GM10-2003 (IN-3, Pg.21), if chlorine has the potential to exist in the discharge, a TRC limit should be placed in the permit that reflects the more stringent of either water quality-based limit or an applicable effluent guideline technology-based limit. The applicable Federal Effluent Guideline for this facility (40 CFR 423.13(b)(1)) includes a maximum TRC limitation of 0.20 mg/L. In order to determine if this value is more or less stringent than the water quality based limit, a Reasonable Potential and Limitation Evaluation was conducted for TRC as explained above. GM 00-2011 requires that an effluent value of 20 mg/L be entered into STATS as effluent data in order to bypass the program's Reasonable Potential Analysis in cases where TRC is purposely introduced or known to exist in the facility's effluent. The resulting limitations for TRC are 0.016 mg/L maximum and 0.0080 mg/L monthly average, which are more stringent than the FEG based limitation. Please note that the TRC limitation in the 2013 permit is more stringent than the TRC limitation in the 2007 permit because the WLAs for Chlorine Producing Oxidants were used instead of TRC due to: 1) the WLAs being more stringent than the TRC WLAs, and 2) the permittee's close proximity to the border between estuarine waters and transition waters on the James River. Chlorinated effluents which are discharged to salt water react to produce chlorine produced oxidants that have a toxic impact similar to TRC in freshwater. It is assumed that CPO in salt water receiving streams is controlled by the effluent TRC limit and are therefore interchangeable. A compliance schedule for the new TRC limitation is not included for the 2013 permit because it is staff's judgment that the permittee will be able to meet the new limitation immediately upon permit reissuance based on historic DMR data.

Heat Rejected: Pursuant to a Study Plan approved by the Board, Virginia Power conducted a 316(a) study and submitted a §316(a) Demonstration Report on September 1, 1977. The Board reviewed the report and found that effluent limitations more stringent than the thermal limitations included in the 2013 permit are not necessary to assure the protection and propagation of a balanced, indigenous community of shellfish, fish, and wildlife in the James River. 9 VAC 25-260-90 of the *Virginia Water Quality Standards* state that a satisfactory showing made in conformance with § 316(a) shall be deemed compliance with the general standard and with the temperature requirements of the standards. Virginia Power declared in the 2011 permit renewal application that there have been no substantial changes in the conditions described in the 316(a) Demonstration Report. The 316(a) variance is therefore, continued.

Intake pH: Monitoring only is included in the 2013 permit so that the impact of the power station on pH at Outfall 001 can be accurately determined. See pH limitation rationale above.

Intake Total Suspended Solids: Monitoring only is included in the 2013 permit so that the net increase produced by Outfalls 102, 103, 106, 116, and 117 can be calculated. These internal outfalls include the discharge of water sourced from the facility's intake canal. See Item 9 of this fact sheet for outfall descriptions.

Thallium: Monitoring for Thallium has been included in the 2013 permit due to concentrations observed in the effluent greater than the human health WLAs. See the chart below for concentration data submitted with the 2011 permit application. On September 27, 2012 Dominion provided additional Thallium data indicating a concentration less than a QL of 5 µg/L at Outfall 001. Due to the data variability, it is staff's judgment that a limitation is not warranted at this time, but that additional data should be collected through regular monitoring for Thallium to determine if a limitation may be necessary in a future permit reissuance.

Pollutant	Test Results (µg/L)		2012 Wasteload Allocations (µg/L)			
	2011 Application	9/27/2012	WLA_a	WLA_c	WLA_{HH-PWS}	WLA_{HH}
Thallium	Dissolved = 6.2 Total Rec. = 8.1	<5	NA	NA	0.24	0.71

▼ Basis for Effluent Limitations: Outfall 101 (Wastewater Treatment Plant)

EFFLUENT CHARACT.	BASIS	DISCHARGE LIMITATIONS				MONITORING REQUIREMENTS	
		MONTHLY AVERAGE	WEEKLY AVERAGE	MIN.	MAX.	FREQ.	SAMPLE TYPE
Flow (MGD)	NA	NL	NA	NA	NL	Continuous	Recorded
pH (Standard Units)	2	NA	NA	6.0	9.0	1 per Day	Grab
BOD_5 (mg/L)	2	30	NA	NA	45	1 per 2 Months	4 HC
Total Suspended Solids (mg/L)	2	30	NA	NA	45	1 per 6 Months	4 HC
Enterococci (n/100 mL)	1, 3	35 geometric mean	NA	NA	NA	4 Days per Month (between 10 a.m. and 4 p.m.)	Grab
Fecal coliform (n/100 mL)	3	200 geometric mean	NA	NA	NA	4 Days per Month (between 10 a.m. and 4 p.m.)	Grab

Basis for Limitations:
1) Water Quality Standards (9 VAC 25-260)
2) Federal Effluent Guidelines (40 CFR 133.102)
3) Best Engineering Judgment (BEJ)

pH, BOD_5, and TSS: These limitations are based on 40 CFR 133.102 of the Federal Effluent Guidelines (FEGs) for Secondary Treatment Standards. Please note that the weekly (7-day) average limitations for BOD_5 and TSS recommended by the FEGs have been applied as maximum limitations in the 2013 permit in order to align with the permit limitations at other industrial internal outfalls which discharge to Outfall 001.

Enterococci: The limitation for Enterococci is expected to protect the primary contact recreation use bacteria criteria outlined in 9 VAC 25-260-170 (Water Quality Standards). The primary contact recreation bacterial in-stream criteria for protection of saltwater is 35N/100 mL colony forming units (CFU) of Enterococci bacteria is based on a monthly geometric mean resulting from at least 4 weekly samples. The 2007 permit reissuance incorporated a new limitation for Enterococci, but allowed the permittee the option of performing a Bacteria Demonstration Study. If the requirements of the Study were met, the permittee would have been allowed to eliminate the bacterial limitation in lieu of utilizing chlorine concentration to demonstrate that proper disinfection was being performed. The permittee successfully completed the demonstration study and submitted the results to DEQ on 6/21/2007, and consequently, the Enterococci limitation did not become effective during the 2007-2013 permit term. However, due to recent guidance from EPA prohibiting the use of surrogate parameters (i.e. in this case, TRC), the limitation has been included in the 2013 permit reissuance.

Fecal Coliform: The fecal coliform limitation is based on BEJ due to the internal outfall contributing to Outfall 001 which ultimately discharges to shellfish waters. Fecal coliform monitoring provides data directly applicable to the protection of shellfish waters. Although the Water Quality Standards have been amended to remove the reference to this effluent limit in shellfish waters, the Virginia Department of Health, Bureau of Shellfish Sanitation still uses fecal coliform as an indicator for determining the quality of shellfish waters, and it is necessary to ensure discharges meet this level. Since it has historically maintained the in-stream water quality criteria for fecal coliform of 14/43 per 100 milliliters, the 200 per 100 milliliters effluent limit will be used in shellfish waters in order to continue meeting the in-stream criteria and for protection of shellfish under the general standard.

▼ Basis for Effluent Limitations: Outfalls 102, 103, 106 (Low Volume Waste Sources)

EFFLUENT CHARACT.	BASIS	DISCHARGE LIMITATIONS				MONITORING REQUIREMENTS	
		MONTHLY AVERAGE	WEEKLY AVERAGE	MIN.	MAX.	FREQ.	SAMPLE TYPE
Flow (MGD)	NA	NL	NA	NA	NL	1 per 6 Months	Estimate
pH (Standard Units)	3	NA	NA	NL	NL	1 per 6 Months	Grab
Total Suspended Solids – Net Increase (mg/L)	2	30	NA	NA	100	1 per 6 Months	Grab
Oil and Grease (mg/L)	2	15	NA	NA	20	1 per 6 Months	Grab

Basis for Limitations:
1) Water Quality Standards (9 VAC 25-260)
2) Federal Effluent Guidelines (40 CFR 423.12)
3) Best Engineering Judgment (BEJ)

pH: Monitoring only is required based on BEJ. Since pH is ultimately limited in accordance with the Water Quality Standards at Outfall 001, the technology based pH limitations contained 40 CFR 423.12(b)(1) of the FEGs are not necessary at this internal outfall. However, monitoring is required in order to aid in determining which contributing process may be the cause of pH violations, if any are observed, at Outfall 001.

Total Suspended Solids – Net Increase: Limitation is based on 40 CFR 423.12(b)(3) of the FEGs for low volume waste sources. The limitation is applied as a net increase with respect to the intake canal because the source water for these discharges is derived from the intake canal. Application as a net limitation is allowed by 9 VAC 25-31-230.G.2 (VPDES Permit Regulation) because the permittee has demonstrated, through reporting of DMR data between March 2007-February 2012 showing a consistent net increase of zero, that the ". . .constituents of the generic measure in the effluent are substantially similar to the constituents of the generic measure in the intake water . . .".

Oil and Grease: Limitation is based on 40 CFR 423.12(b)(3) of the FEGs for low volume waste sources.

▼ Basis for Effluent Limitations: Outfalls 116, 117 (Low Volume Waste Sources)

EFFLUENT CHARACT.	BASIS	DISCHARGE LIMITATIONS				MONITORING REQUIREMENTS	
		MONTHLY AVERAGE	WEEKLY AVERAGE	MIN.	MAX.	FREQ.	SAMPLE TYPE
Flow (MGD)	NA	NL	NA	NA	NL	1 per Month	Estimate
pH (Standard Units)	3	NA	NA	NL	NL	1 per Month	Grab
Total Suspended Solids – Net Increase (mg/L)	2	30	NA	NA	100	1 per Month	Grab
Oil and Grease (mg/L)	2	15	NA	NA	20	1 per Month	Grab

Basis for Limitations:
1) Water Quality Standards (9 VAC 25-260)
2) Federal Effluent Guidelines (40 CFR 423.12)
3) Best Engineering Judgment (BEJ)

pH: Monitoring only is required based on BEJ. Since pH is ultimately limited in accordance with the Water Quality Standards at Outfall 001, the technology based pH limitations contained 40 CFR 423.12(b)(1) of the FEGs are not necessary at this internal outfall. However, monitoring is required in order to aid in determining which contributing process may be the cause of pH violations, if any are observed, at Outfall 001.

Total Suspended Solids – Net Increase: Limitation is based on 40 CFR 423.12(b)(3) of the FEGs for low volume waste sources. The limitation is applied as a net increase with respect to the intake canal because the source water for these discharges is derived from the intake canal. Application as a net limitation is allowed by 9 VAC 25-31-230.G.2 (VPDES Permit Regulation) because the permittee has demonstrated, through reporting of DMR data between March 2007-February 2012 showing a consistent net increase of zero, that the ". . .constituents of the generic measure in the effluent are substantially similar to the constituents of the generic measure in the intake water . . .".

Oil and Grease: Limitation is based on 40 CFR 423.12(b)(3) of the FEGs for low volume waste sources.

▼ Basis for Effluent Limitations: Outfalls 104, 109, 110, 111, 112, 113, 120 (Low Volume Waste Sources)

EFFLUENT CHARACT.	BASIS	DISCHARGE LIMITATIONS				MONITORING REQUIREMENTS	
		MONTHLY AVERAGE	WEEKLY AVERAGE	MIN.	MAX.	FREQ.	SAMPLE TYPE
Flow (MGD)	NA	NL	NA	NA	NL	1 per 6 Months	Estimate
pH (Standard Units)	3	NA	NA	NL	NL	1 per 6 Months	Grab
Total Suspended Solids (mg/L)	2	30	NA	NA	100	1 per 6 Months	Grab
Oil and Grease (mg/L)	2	15	NA	NA	20	1 per 6 Months	Grab

Basis for Limitations:
1) Water Quality Standards (9 VAC 25-260)
2) Federal Effluent Guidelines (40 CFR 423.12)
3) Best Engineering Judgment (BEJ)

pH: Monitoring only is required based on BEJ. Since pH is ultimately limited in accordance with the Water Quality Standards at Outfall 001, the technology based pH limitations contained 40 CFR 423.12(b)(1) of the FEGs are not necessary at this internal outfall. However, monitoring is required in order to aid in determining which contributing process may be the cause of pH violations, if any are observed, at Outfall 001.

Total Suspended Solids: Limitation is based on 40 CFR 423.12(b)(3) of the FEGs for low volume waste sources.

Oil and Grease: Limitation is based on 40 CFR 423.12(b)(3) of the FEGs for low volume waste sources.

▼ Basis for Effluent Limitations: Outfalls 107, 114, 115, 118, 119,121, 122 (Low Volume Waste Sources)

EFFLUENT CHARACT.	BASIS	DISCHARGE LIMITATIONS				MONITORING REQUIREMENTS	
		MONTHLY AVERAGE	WEEKLY AVERAGE	MIN.	MAX.	FREQ.	SAMPLE TYPE
Flow (MGD)	NA	NL	NA	NA	NL	1 per Month	Estimate
pH (Standard Units)	3	NA	NA	NL	NL	1 per Month	Grab
Total Suspended Solids (mg/L)	2	30	NA	NA	100	1 per Month	Grab
Oil and Grease (mg/L)	2	15	NA	NA	20	1 per Month	Grab

1) Water Quality Standards (9 VAC 25-260)
2) Federal Effluent Guidelines (40 CFR 423.12)
3) Best Engineering Judgment (BEJ)

pH: Monitoring only is required based on BEJ. Since pH is ultimately limited in accordance with the Water Quality Standards at Outfall 001, the technology based pH limitations contained 40 CFR 423.12(b)(1) of the FEGs are not necessary at this internal outfall. However, monitoring is required in order to aid in determining which contributing process may be the cause of pH violations, if any are observed, at Outfall 001.

Total Suspended Solids: Limitation is based on 40 CFR 423.12(b)(3) of the FEGs for low volume waste sources.

Oil and Grease: Limitation is based on 40 CFR 423.12(b)(3) of the FEGs for low volume waste sources.

▼ Basis for Effluent Limitations: Outfall 105 (Oil Storage Tank Dike [Low Volume Waste Source])

EFFLUENT CHARACT.	BASIS	DISCHARGE LIMITATIONS				MONITORING REQUIREMENTS	
		MONTHLY AVERAGE	WEEKLY AVERAGE	MIN.	MAX.	FREQ.	SAMPLE TYPE
Flow (MGD)	NA	NL	NA	NA	NL	1 per Month	Estimate
pH (Standard Units)	3	NA	NA	NL	NL	1 per Month	Grab
Total Suspended Solids (mg/L)	2	30	NA	NA	100	1 per Month	Grab
Total Petroleum Hydrocarbons (TPH) (mg/L)	3	NL	NA	NA	NA	1 per Month	Grab
Oil and Grease (mg/L)	2	15	NA	NA	20	1 per Month	Grab

Basis for Limitations:
1) Water Quality Standards (9 VAC 25-260)
2) Federal Effluent Guidelines (40 CFR 423.12)
3) Best Engineering Judgment (BEJ)

pH: Monitoring only is required based on BEJ. Since pH is ultimately limited in accordance with the Water Quality Standards at Outfall 001, the technology based pH limitations contained 40 CFR 423.12(b)(1) of the FEGs are not necessary at this internal outfall. However, monitoring is required in order to aid in determining which contributing process may be the cause of pH violations, if any are observed, at Outfall 001.

Total Suspended Solids: Limitation is based on 40 CFR 423.12(b)(3) of the FEGs for low volume waste sources.

Total Petroleum Hydrocarbons (TPH): Oil and grease limitations are required for low volume waste sources per 40 CFR 423.12(b)(3) of the FEGs. According to GM96-002 (entire document) and GM08-2006 (Fact Sheet, Section 6.1, Pg. 6), however, TPH is considered to be a good indicator of non-gasoline petroleum contamination. Therefore, based on BEJ, monitoring for TPH is required for the 2013 permit due to the nature of the potential source for contamination from this discharge point. Please note that requirements specifying that particular TPH test methods for diesel range organics (DRO) and gasoline range organics (GRO) be used by the permittee to determine compliance with the limitation have been added to the 2013 permit in order to match those required in DEQ's *General VPDES Permit for Petroleum Contamination Sites, Groundwater Remediation, and Hydrostatic Tests (*9 VAC 25-120*)*.

Oil and Grease: Limitation is based on 40 CFR 423.12(b)(3) of the FEGs for low volume waste sources.

▼ Basis for Effluent Limitations: Outfall 108 (Settling Pond [Low Volume Waste Source])

EFFLUENT CHARACT.	BASIS	DISCHARGE LIMITATIONS				MONITORING REQUIREMENTS	
		MONTHLY AVERAGE	WEEKLY AVERAGE	MIN.	MAX.	FREQ.	SAMPLE TYPE
Flow (MGD)	NA	NL	NA	NA	NL	1 per Month	Measured
pH (Standard Units)	3	NA	NA	NL	NL	1 per Month	Grab
Total Suspended Solids (mg/L)	2	30	NA	NA	100	1 per Month	Grab
Total Organic Carbon (mg/L)	3	NA	NA	NA	110	1 per Month	Grab
Total Petroleum Hydrocarbons (TPH) (mg/l)	3	NL	NA	NA	NA	1 per Month	Grab
Oil and Grease (mg/L)	2	15	NA	NA	20	1 per Month	Grab

Basis for Limitations:
1) Water Quality Standards (9 VAC 25-260)
2) Federal Effluent Guidelines (40 CFR 423.12)
3) Best Engineering Judgment (BEJ)

pH: Monitoring only is required based on BEJ. Since pH is ultimately limited in accordance with the Water Quality Standards at Outfall 001, the technology based pH limitations contained 40 CFR 423.12(b)(1) of the FEGs are not necessary at this internal outfall. However, monitoring is required in order to aid in determining which contributing process may be the cause of pH violations, if any are observed, at Outfall 001.

Total Suspended Solids: Limitation is based on 40 CFR 423.12(b)(3) of the FEGs for low volume waste sources.

Total Organic Carbon (TOC): The limitation for TOC is carried over from the 2007 permit reissuance to the 2013 permit reissuance because the permittee has previously demonstrated compliance with this limit and therefore it cannot be removed due to antibacksliding policies. The TOC limitation was initially based on BEJ and originates from previous agency guidance for permitting of Bulk Oil Storage Facilities (Permit Manual, issued July 1995, Appendix IN – Industrial, Part F.2.d). TOC is also utilized as an indicator parameter for non-petroleum organic substances in the *General Virginia Pollutant Discharge Elimination System (VPDES) Permit Regulation for Discharges from Petroleum Contaminated Sites, Groundwater Remediation, and Hydrostatic Tests* (VAG83) (see GM08-2006 Fact Sheet, Pg. 17). A large portion of contributing flow to this outfall is from the oil/water separator which serves the various drains around the Gravel Neck Combustion Turbine (CT) Station (see Item 9 of this fact sheet for a description of contributing flows to the oil/water separator). A large volume of number two fuel oil is stored at this site for use as an auxiliary fuel for the CT generators, and therefore, the potential for non-gasoline petroleum product contamination supports the limitation for TOC applied to this outfall.

Total Petroleum Hydrocarbons (TPH): Oil and grease limitations are required for low volume waste sources per 40 CFR 423.12(b)(3). According to GM96-002 and GM08-2006 (Fact Sheet, Section 6.1, Pg. 6), however, TPH is considered to be a better indicator of non-gasoline petroleum contamination than oil and grease. Therefore, based on BEJ, monitoring for TPH is required for the 2013 permit due to the nature of the potential source for contamination from this discharge point. Please note that requirements specifying that particular TPH test methods for diesel range organics (DRO) and gasoline range organics (GRO) be used by the permittee to determine compliance with the limitation have been added to the 2013 permit in order to match those required in DEQ's *General VPDES Permit for Petroleum Contamination Sites, Groundwater Remediation, and Hydrostatic Tests (*9 VAC 25-120*)*.

Oil and Grease: Limitation is based on 40 CFR 423.12(b)(3) of the FEGs for low volume waste sources.

▼ Basis for Effluent Limitations: Outfall 002 (Gravel Neck AST Containment Dike)

EFFLUENT CHARACT.	BASIS	DISCHARGE LIMITATIONS				MONITORING REQUIREMENTS	
		MONTHLY AVERAGE	WEEKLY AVERAGE	MIN.	MAX.	FREQ.	SAMPLE TYPE
Flow (MGD)	NA	NL	NA	NA	NL	1 per Month	Estimate
pH (Standard Units)	1	NA	NA	6.0	9.0	1 per Month	Grab
Rainwater pH (Standard Units)	2	NA	NA	NL	NL	1 per Month	Grab
Total Suspended Solids (mg/L)	2	30	NA	NA	100	1 per Month	Grab
Total Organic Carbon (mg/L)	2	NA	NA	NA	110	1 per Month	Grab
Total Petroleum Hydrocarbons (TPH) (mg/L)	2	NL	NA	NA	15	1 per Month	Grab
Copper, total recoverable (µg/L)	1	3.6	NA	NA	3.6	1 per Month	Grab
Nickel, total recoverable (µg/L)	1	9.2	NA	NA	9.2	1 per Month	Grab
Zinc, total recoverable (µg/L)	1	36	NA	NA	36	1 per Month	Grab

Basis for Limitations:
1) Water Quality Standards (9 VAC 25-260)
2) Best Engineering Judgment (BEJ)

pH: The pH limit is derived from 9 VAC 25-260-50 (Water Quality Standards) for discharges to Class II or Class III waters in the Piedmont and Coastal Zones.

Rainwater pH: Footnote (a) in Part I.A.12 of the 2013 permit allows that pH be maintained within 0.5 SU's of the rainwater pH values when rainwater pH values are observed outside of the limitation range. This permit requirement aids in ensuring that the permittee consistently provides controls for the overall influence that the facility's daily processes may have on the rainwater pH levels.

Total Suspended Solids: Limitation is based on BEJ. Activities which contribute to the discharge from this outfall are not covered by any part of the Federal Effluent Guidelines. It is unknown when the TSS limitation for this outfall first became effective, but because the permittee has previously demonstrated compliance with this limit, it cannot be removed due to antibacksliding policies.

Total Organic Carbon (TOC): Limitation is based on BEJ. Activities which contribute to the discharge from this outfall are not covered by any part of the Federal Effluent Guidelines. The limitation for TOC is carried over from the 2007 permit reissuance to the 2013 permit reissuance because the permittee has previously demonstrated compliance with this limit and therefore it cannot be removed due to antibacksliding policies. The TOC limitation is originally derived from previous agency guidance for permitting of Bulk Oil Storage Facilities (Permit Manual, issued July 1995, Appendix IN – Industrial, Part F.2.d). TOC is also utilized as an indicator parameter for non-petroleum organic substances in the *General Virginia Pollutant Discharge Elimination System (VPDES) Permit Regulation for Discharges from Petroleum Contaminated Sites, Groundwater Remediation, and Hydrostatic Tests* (see GM08-2006 Fact Sheet, Pg. 17).

Total Petroleum Hydrocarbons (TPH): Limitation is based on BEJ. Activities which contribute to the discharge from this outfall are not covered by any part of the Federal Effluent Guidelines. The TPH is limitation is derived from current agency guidance (Permit Manual, Section IN-5, Pg.5) for permitting of Bulk Petroleum Storage facilities. Additionally, according to GM08-2006 (Fact Sheet, Section 6.1, Pg. 6), TPH is considered to be an indicator parameter for contamination from non-gasoline petroleum products, and is thus limited in the *General Virginia Pollutant Discharge Elimination System (VPDES) Permit Regulation for Discharges from Petroleum Contaminated Sites, Groundwater Remediation, and Hydrostatic Tests*. Please note that requirements specifying that particular TPH test methods for diesel range organics (DRO) and gasoline range organics (GRO) be used by the permittee to determine compliance with the limitation have been added to the 2013 permit in order to match those required in DEQ's *General VPDES Permit for Petroleum Contamination Sites, Groundwater Remediation, and Hydrostatic Tests (*9 VAC 25-120*)*.

Copper, Nickel, and Zinc: Limitations for these pollutants were determined to be necessary in accordance with the Reasonable Potential and Limitation Analyses described in the first part of this fact sheet section.

Please see **Attachment I** for a copy of 40 CFR 423, the Federal Effluent Guidelines for *Steam Electric Power Generating Point Source Category*.

17. Antibacksliding Statement : All limits in the 2013 permit are at least as stringent as the 2007 permit. The Total Phosphorus limitation formerly applied to Outfall 001 has been removed from the 2013 permit. During previous permit re-issuances, the Water Quality Standards assigned Special Standards NEW-19 to the receiving water body section, designating it as a Nutrient Enriched Water (NEW). Therefore, in accordance with 9 VAC 25-40-30 A. (Policy for Nutrient Enriched Waters), a limitation for Total Phosphorus was required. For the 2013 reissuance, the current Water Quality Standards (January 2011) have repealed the NEW designation to the receiving water body section, and consequently, the associated Total Phosphorus limitation is no longer applicable to this discharge. Therefore, in accordance with Guidance Memo 07-2008, Amendment 2 (Page 15), removal of the former TP limitation does not violate antibacksliding policies because: a) the facility is a non-significant industrial facility and therefore the discharge of nutrients are covered under the Watershed General Permit (see Item 23 of this fact sheet for further information); b) the limit is technology-based, so backsliding is permissible; c) a discharge to the Chesapeake Bay watershed is exempt from the 2.0 mg/L limit per 9VAC 25-40-30.D (Policy for Nutrient Enriched Waters); d) the facility has not installed nutrient control treatment; and e) the facility has not undertaken any process or site management changes in order to comply with the TP limit.

18. Special Conditions:

Part I.B. - Additional TRC Limitations and Bacterial Limitations and Monitoring Requirements–Outfall 101 (Sewage Treatment Plant)
Rationale: Required by Sewage Collection and Treatment Regulations, 9VAC25-790 and Water Quality Standards 9VAC25-260-170, Bacteria; Other Recreational Waters. Also, 40 CFR 122.41(e) requires the permittee, at all times, to properly operate and maintain all facilities and systems of treatment in order to comply with the permit. This ensures proper operation of chlorination equipment to maintain adequate disinfection.
Part I.C – Other Requirements or Special Conditions

C1 - Notification Levels
Rationale: Required by VPDES Permit Regulation, 9 VAC 25-31-200 A for all manufacturing, commercial, mining, and silvicultural dischargers.

C2 - Materials Handling and Storage
Rationale: 9 VAC 25-31-50 A prohibits the discharge of any wastes into State waters unless authorized by permit. Code of Virginia § 62.1-44.16 and 62.1-44.17 authorizes the Board to regulate the discharge of industrial waste or other waste.

C3 – Licensed Operator Requirement (Sewage Treatment Plant)
Rationale: The VPDES Permit Regulation, 9 VAC 25-31-200 C and the Code of Virginia § 54.1-2300 et seq., Rules and Regulations for Waterworks and Wastewater Works Operators and Onsite Sewage System Professionals(18 VAC 160-20-10 et seq.), require licensure of operators.

C4 - TMDL / Nutrient Reopener
Rationale: Section 303(d) of the Clean Water Act requires that Total Maximum Daily Loads (TMDLs) be developed for streams listed as impaired. This special condition is to allow the permit to be reopened if necessary to bring it into compliance with any applicable TMDL approved for the receiving stream. The re-opener recognizes that, according to Section 402(o)(1) of the Clean Water Act, limits and/or conditions may be either more or less stringent than those contained in this permit. Specifically, they can be relaxed it they are the result of a TMDL, basin plan, or other wasteload allocation prepared under section 303 of the Act. 9 VAC 25-40-70 A authorizes DEQ to include technology-based annual concentration limits in the permits of facilities that have installed nutrient control equipment, whether by new construction, expansion or upgrade. 9 VAC 25-31-390.A authorizes DEQ to modify VPDES permits to promulgate amended water quality standards.

C5 - Operation and Maintenance Manual Requirement
Rationale: Required by Code of Virginia § 62.1-44.16; VPDES Permit Regulation, 9 VAC 25-31-190 E, and 40 CFR 122.41(e). These require proper operation and maintenance of the permitted facility. Compliance with an O & M manual ensures this.

C6 - Compliance Reporting
Rationale: Authorized by VPDES Permit Regulation, 9 VAC 25-31-190 J 4 and 220 I. This condition is necessary when pollutants are monitored by the permittee and a maximum level of quantification and/or a specific analytical method is required in order to assess compliance with a permit limit or to compare effluent quality with a numeric criterion. The condition also established protocols for calculation of reported values. Quantification levels (QLs) for TSS, Oil & Grease, TPH, and TRC are recommended by current agency guidance (GM10-2003, Attachment A, and GM00-2011). The BOD_5 QL of 2 mg/L is consistent with recently adopted VPDES General Permit regulations. The QLs for Copper, Nickel, and Zinc are the lesser of 0.4 or 0.6 multiplied by the acute WLA or chronic WLA, respectively, as advised in GM10-2003 (IN-3, Pg. 7).

C7 - Effluent Monitoring Frequencies
Rationale: Permittees are granted a reduction in monitoring frequency based on a history of permit compliance. To remain eligible for the reduction, the permittee should not have violations related to the effluent limits for which reduced frequencies were granted. If permittees fail to maintain the previous level of performance, the baseline monitoring frequencies should be reinstated for those parameters that were previously granted a monitoring frequency reduction.

C8 - Oil Storage Ground Water Monitoring Reopener
Rationale: Facilities with *less* than 1,000,000 gallons of regulated aboveground petroleum storage are required to provide a means for early leak detection in the event of AST failure, and facilities with *greater* than 1,000,000 gallons of regulated aboveground petroleum storage are required to regularly monitor ground water and submit results to DEQ under the *Facility and Aboveground Storage Tank Regulation* (9 VAC 25-91-10 et seq.) (AST Regulation).

The Surry Power Station stores approximately 278,000 gallons of petroleum product in aboveground storage tanks. Virginia Power has elected to conduct groundwater monitoring in order to fulfill the AST Regulation requirements for early leak detection. If monitoring proves inadequate to properly evaluate potential impacts to ground water, the VPDES permit, under Code of Virginia § 62.1-44.21, can be modified to incorporate appropriate monitoring.

The Gravel Neck Station stores greater than 1,000,000 gallons of petroleum product in aboveground storage tanks, and consequently Virginia Power is required to conduct regular groundwater monitoring in accordance with the AST Regulation. If monitoring proves inadequate to properly evaluate potential impacts to ground water, the VPDES permit, under Code of Virginia § 62.1-44.21, can be modified to incorporate appropriate monitoring.

C9 - Tank Bottom Waters and Pump and Haul Activities
Rationale: State Water Control Law §62.1-44.21 authorizes the Board to request information needed to determine possible impacts on State waters. This special condition requires the permittee to report any pump and haul activities regarding the removal of tank bottom waters. The requirement is carried forward from the 1996, 2001, and 2007 permit reissuances and allows DEQ to be kept apprised of tank bottom pump and haul activities.

C10 - Intake Trash Racks
Rationale: This special condition prohibits the return of debris collected on the intake trash racks to the waterway.

C11 - No Discharge of PCBs
Rationale: This special condition implements a prohibition against the discharge of polychlorinated biphenyl compounds in accordance with 40 CFR 423.12(b)(2) of the Federal Effluent Guidelines.

C12 - Discharge of Uncontaminated Water
Rational: This special condition identifies miscellaneous point source discharges at the power station that should consist only of uncontaminated river water or ground water. As such, effluent limitations and monitoring requirements are not necessary.

C13 - Discharge of Chlorine in Cooling Water
Rationale: This special condition prohibits the discharge of chlorine from any one power generating unit for more than 2 hours in any one day unless the utility can demonstrate that the unit cannot operate with this restriction. This 2-hour prohibition is in accordance with 40 CFR 423.13(b)(2) of the Federal Effluent Guidelines.

C14 - Radioactivity Regulated by NRC
Rationale: This special condition recognizes that the Nuclear Regulatory Commission (NRC) is the proper agency to regulate discharges of radioactivity.

C15 - No Discharge of Tank Bottom Waters
Rationale: This special condition prohibits the discharge of tank bottom waters from bulk fuel oil or waste oil storage facilities. This prohibition is consistent with the regulation of bulk petroleum handling facilities and is applicable to this facility because large quantities of fuel oil are stored. This special condition does not prohibit the discharge of tank bottom waters from highly refined lubricating oil tanks.

C16 - Water Quality Criteria Reopener
Rationale: VPDES Permit Regulation, 9 VAC 25-31-220 D requires effluent limitations to be established which will contribute to the attainment or maintenance of the water quality standards.

C17 - §316(b) Requirements
Rationale: The facility includes a cooling water intake structure governed by §316(b) of the Clean Water Act which requires that the location, design, construction and capacity of the cooling water intake structures reflect the "best technology available for minimizing adverse environmental impact". The Surry Power Station November 1980 environmental report on impingement and entrainment studies conducted at the facility indicated minimal or no adverse environmental impact. The special condition requires continued compliance with §316(b). Collected data and any changes to the intake structures or conditions will be reevaluated at each reissuance to monitor continued compliance with the requirement. The condition also includes a reopener, should further §316(b) related conditions become necessary once the EPA Phase II rule is finalized or a new BPJ determination is required.

C18 - Treatment Works Closure Plan
Rationale: Code of Virginia § 62.1-44.16 of the State Water Control Law. This condition establishes the requirement to submit a closure plan for the wastewater treatment facility if the treatment facility is being replaced or is expected to close.

C19 - 95% Capacity Reopener (Sewage Treatment Plant)
Rationale: Required by VPDES Permit Regulation, 9 VAC 25-31-200 B 4 for all POTW and PVOTW permits.

C20 - CTC, CTO Requirement (Sewage Treatment Plant)
Rationale: Required by Code of Virginia § 62.1-44.19; Sewage Collection and Treatment Regulations, 9 VAC 25-790-50. 9VAC 25-40-70.A authorizes DEQ to include technology-based annual concentration limits in the permits of facilities that have installed nutrient control equipment, whether by new construction, expansion or upgrade.

C21 - Reliability Class (Sewage Treatment Plant)
Rationale: Required by Sewage Collection and Treatment Regulations, 9 VAC 25-790 for all municipal facilities.

C22 - Sludge Reopener (Sewage Treatment Plant)
Rationale: Required by VPDES Permit Regulation 9 VAC 25-31-220 C for all permits issued to treatment works treating domestic sewage.

C23 - Sludge Use and Disposal (Sewage Treatment Plant)
Rationale: VPDES Permit Regulation, 9 VAC 25-31-100 P; 220 B 2, and 420 through 720; and 40 CFR Part 503 require all treatment works treating domestic sewage to submit information on sludge use and disposal practices and to meet specified standards for sludge use and disposal.

C24 - Monitoring Frequencies Encompassing Multiple Months
Rationale: Clarifies monitoring and reporting schedules.

C25 - Concept Engineering Report (CER)
Rationale: § 62.1-44.16 of the Code of Virginia requires industrial facilities to obtain DEQ approval for proposed discharges of industrial wastewater. A CER means a document setting forth preliminary concepts or basic information for the design of industrial wastewater treatment facilities and the supporting calculations for sizing the treatment operations. 9VAC 25-40-70.A authorizes DEQ to include technology-based annual concentration limits in the permits of facilities that have installed nutrient control equipment, whether by new construction, expansion or upgrade.

C26 – Schedule of Compliance
Rationale: The VPDES Permit Regulation at 9 VAC 25-31-250 allows for schedules that will lead to compliance with the Clean Water Act, the State Water Control Law, and regulations promulgated under them. A compliance schedule has been provided for Copper, Nickel, and Zinc for the 2013 permit reissuance.

C27 - Whole Effluent Toxicity (WET) Monitoring Program
Rationale: VPDES Permit Regulation, 9 VAC 25-31-210 and 220 I, requires monitoring in the permit to provide for and assure compliance with all applicable requirements of the State Water Control Law and the Clean Water Act. WET testing requirements and language were provided by OWP&CA. Please see **Attachment J** for WET evaluation and the above referenced guidance from OWP&CA.

Part I.D – Storm Water Management Conditions
Rationale: VPDES Permit Regulation, 9 VAC 25-31-10 defines discharges of storm water from industrial activity. 9 VAC 25-31-120 requires a permit for these discharges. The General Storm Water Special Conditions, Storm Water Pollution Prevention Plan requirements, and Benchmark Monitoring requirements of the permit are derived from the VPDES general permit for discharges of storm water associated with industrial activity (VAR05), 9 VAC 25-151-10 et seq. VPDES Permit Regulation, 9 VAC 25-31-220 K, requires use of best management practices where applicable to control or abate the discharge of pollutants when numerical effluent limits are infeasible or the practices are necessary to achieve effluent limits or to carry out the purpose and intent of the Clean Water Act and State Water Control Law. General storm water requirements, SWPPP requirements, and monitoring requirements have been included in accordance with the GM10-2003 Permit Manual, Section IN-4 and in accordance with the VAR05 Industrial Storm Water General Permit (9VAC25-151-10 et seq.). The Sector Specific Requirements contained in

Parts I.D.4 and I.D.5 of the 2013 permit reflect Sector O, Steam Electric Generating Facilities, but have been revised to remove references to activities relating to coal and ash/residue handling areas because these activities are not relevant to this site.

Part II, Conditions Applicable to All Permits
Rationale: VPDES Permit Regulation, 9 VAC 25-31-190 requires all VPDES permits to contain or specifically cite the conditions listed.

19. NPDES Permit Rating Work Sheet: Total Score: 600 (see **Attachment K**)

20. Changes to Permit:

Outfall 001 – Changes to Limitations and Monitoring Requirements

EFFLUENT CHARACT.	2008 Permit Modification Limitations & Monitoring						2013 Permit Limitations & Monitoring						Reason for Change
	DISCHARGE LIMITATIONS				MON. REQ'S		DISCHARGE LIMITATIONS				MON. REQ'S		
	MO AVG	WE AVG	MIN	MAX	FREQ	SAMPL	MO AVG	WE AVG	MIN	MAX	FREQ	SAMPL	
Flow (MGD)	NL	NA	NA	NL	Continuous	Recorded	NL	NA	NA	NL	Continuous	Recorded	No Changes
pH (Standard Units)	NA	NA	6.0	9.0	2 / Month	Grab	NA	NA	6.0	9.0	2 per Month	Grab	
Total Residual Chlorine (mg/L)	0.011	NA	NA	0.023	1 / Day	Grab	0.0080	NA	NA	0.016	1 per Day	Grab	The TRC limitation is more stringent due to WLAs for chlorine producing oxidants being used in lieu of TRC WLAs in the limitation evaluation. See Item 16 for further information
Heat Rejected (BTU/HR)	Heat rejected shall not exceed a daily maximum of 12.6×10^9				Continuous	Recorded	Heat rejected shall not exceed a daily maximum of 12.6×10^9				Continuous	Recorded	No Changes
Intake pH (Standard Units)	NA	NA	NL	NL	2 / Month	Grab	NA	NA	NL	NL	2 per Month	Grab	
Intake Total Suspended Solids (mg/L)	NL	NA	NA	NL	1 / 6 Months	Grab	NL	NA	NA	NL	1 per Month	Grab	Monitoring frequency increased in order to match minimum TSS monitoring frequencies for internal outfalls 116 and 117.
Total Phosphorus (mg/L	2.0	NA	NA	NL	1 / Year	Grab	--	--	--	--	--	--	Limitation removed. See Item 17 of this fact sheet for further information.
Thallium, total (µg/L)	--	--	--	--	--	--	NL	NA	NA	NL	1 per Year	Grab	Monitoring only added. See item 16 of this fact sheet for further information.

Outfall 101 – Changes to Limitations and Monitoring Requirements

EFFLUENT CHARACT.	2008 Permit Modification Limitations & Monitoring						2013 Permit Limitations & Monitoring						Reason for Change
	DISCHARGE LIMITATIONS				MON. REQ'S		DISCHARGE LIMITATIONS				MON. REQ'S		
	MO AVG	WE AVG	MIN	MAX	FREQ	SAMPL	MO AVG	WE AVG	MIN	MA X	FREQ	SAMPL	
Flow (MGD)	NL	NA	NA	NL	Continuous	Recorded	NL	NA	NA	NL	Continuous	Recorded	No Changes
pH (Standard Units)	NA	NA	6.0	9.0	1 / Day	Grab	NA	NA	6.0	9.0	1 per Day	Grab	
BOD_5 (mg/L)	30	NA	NA	45	1 / Week	4 HC	30	NA	NA	45	1 per 2 Months	4 HC	Monitoring frequency reduction granted in accordance with GM10-2003 (IN-2, Pgs.51-52)
Total Suspended Solids (mg/L)	30	NA	NA	45	1 / Month	4 HC	30	NA	NA	45	1 per 6 Months	4 HC	
Total Residual Chlorine (mg/L)	NA	NA	NA	NA	3 / Day at 4 Hr. Intervals	Grab	Removed						TRC monitoring and limitations are explained in Part I.B of the 2013 permit. This line item is unnecessary and redundant
Fecal coliform (n/100 mL)	200 geometric mean	NA	NA	NA	1 / Week	Grab	200 geometric mean	NA	NA	NA	4 Days per Month (between 10 a.m. and 4 p.m.)	Grab	Monitoring frequency changed to match recommended frequency in GM10-2003 (MN-2, Pg.2) when chlorine disinfection is used.
Enterococci (n/100 mL)	--	--	--	--	--	--	35 geometric mean	NA	NA	NA	4 Days per Month (between 10 a.m. and 4 p.m.)	Grab	See Item 16 of this fact sheet for information regarding the addition of this limitation to the 2013 permit.

Outfalls 102, 103, 106 – Changes to Limitations and Monitoring Requirements

EFFLUENT CHARACT.	2008 Permit Modification Limitations & Monitoring						2013 Permit Limitations & Monitoring						Reason for Change
	DISCHARGE LIMITATIONS				MON. REQ'S		DISCHARGE LIMITATIONS				MON. REQ'S		
	MO AVG	WE AVG	MIN	MAX	FREQ	SAMPL	MO AVG	WE AVG	MIN	MAX	FREQ	SAMPL	
Flow (MGD)	NL	NA	NA	NL	1 / 6 Months	Estimate	NL	NA	NA	NL	1 per 6 Months	Estimate	No Changes
pH (Standard Units)	NA	NA	NL	NL	1 / 6 Months	Grab	NA	NA	NL	NL	1 per 6 Months	Grab	
Total Suspended Solids – Net Increase (mg/L)	30	NA	NA	100	1 / 6 Months	Grab	30	NA	NA	100	1 per 6 Months	Grab	
Oil and Grease (mg/L)	15	NA	NA	20	1 / 6 Months	Grab	15	NA	NA	20	1 per 6 Months	Grab	

Outfalls 116, 117 – Changes to Limitations and Monitoring Requirements

EFFLUENT CHARACT.	2008 Permit Modification Limitations & Monitoring						2013 Permit Limitations & Monitoring						Reason for Change
	DISCHARGE LIMITATIONS				MON. REQ'S		DISCHARGE LIMITATIONS				MON. REQ'S		
	MO AVG	WE AVG	MIN	MAX	FREQ	SAMPL	MO AVG	WE AVG	MIN	MAX	FREQ	SAMPL	
Flow (MGD)	NL	NA	NA	NL	1 / 6 Months	Estimate	NL	NA	NA	NL	1 per Month	Estimate	Baseline monitoring frequencies applied because these outfalls discharge on an intermittent basis, and monitoring frequency reductions are not allowed for intermittent discharges (GM10-2003, IN-2, Pg. 53).
pH (Standard Units)	NA	NA	NL	NL	1 / 6 Months	Grab	NA	NA	NL	NL	1 per Month	Grab	
Total Suspended Solids – Net Increase (mg/L)	30	NA	NA	100	1 / 6 Months	Grab	30	NA	NA	100	1 per Month	Grab	
Oil and Grease (mg/L)	15	NA	NA	20	1 / 6 Months	Grab	15	NA	NA	20	1 per Month	Grab	

EFFLUENT CHARACT.	Outfalls 104, 109, 110, 111, 112, 113, 120 – Changes to Limitations and Monitoring Requirements												
	2008 Permit Modification Limitations & Monitoring						2013 Permit Limitations & Monitoring						Reason for Change
	DISCHARGE LIMITATIONS				MON. REQ'S		DISCHARGE LIMITATIONS				MON. REQ'S		
	MO AVG	WE AVG	MIN	MAX	FREQ	SAMPL	MO AVG	WE AVG	MIN	MAX	FREQ	SAMPL	
Flow (MGD)	NL	NA	NA	NL	1 / 6 Months	Estimate	NL	NA	NA	NL	1 per 6 Months	Estimate	No Changes
pH (Standard Units)	NA	NA	NL	NL	1 / 6 Months	Grab	NA	NA	NL	NL	1 per 6 Months	Grab	
Total Suspended Solids (mg/L)	30	NA	NA	100	1 / 6 Months	Grab	30	NA	NA	100	1 per 6 Months	Grab	
Oil and Grease (mg/L)	15	NA	NA	20	1 / 6 Months	Grab	15	NA	NA	20	1 per 6 Months	Grab	

EFFLUENT CHARACT.	Outfalls 107, 114, 115, 118, 119, 121, 122 – Changes to Limitations and Monitoring Requirements												
	2008 Permit Modification Limitations & Monitoring						2013 Permit Limitations & Monitoring						Reason for Change
	DISCHARGE LIMITATIONS				MON. REQ'S		DISCHARGE LIMITATIONS				MON. REQ'S		
	MO AVG	WE AVG	MIN	MAX	FREQ	SAMPL	MO AVG	WE AVG	MIN	MAX	FREQ	SAMPL	
Flow (MGD)	NL	NA	NA	NL	1 / 6 Months	Estimate	NL	NA	NA	NL	1 per Month	Estimate	Baseline monitoring frequencies applied because these outfalls discharge on an intermittent basis, and monitoring frequency reductions are not allowed for intermittent discharges (GM10-2003, IN-2, Pg. 53)
pH (Standard Units)	NA	NA	NL	NL	1 / 6 Months	Grab	NA	NA	NL	NL	1 per Month	Grab	
Total Suspended Solids (mg/L)	30	NA	NA	100	1 / 6 Months	Grab	30	NA	NA	100	1 per Month	Grab	
Oil and Grease (mg/L)	15	NA	NA	20	1 / 6 Months	Grab	15	NA	NA	20	1 per Month	Grab	

Outfall 105 – Changes to Limitations and Monitoring Requirements

EFFLUENT CHARACT.	2008 Permit Modification Limitations & Monitoring						2013 Permit Limitations & Monitoring						Reason for Change
	DISCHARGE LIMITATIONS				MON. REQ'S		DISCHARGE LIMITATIONS				MON. REQ'S		
	MO AVG	WE AVG	MIN	MAX	FREQ	SAMPL	MO AVG	WE AVG	MIN	MAX	FREQ	SAMPL	
Flow (MGD)	NL	NA	NA	NL	1 / 6 Months	Estimate	NL	NA	NA	NL	1 per Month	Estimate	Baseline frequencies applied because these outfalls discharge on an intermittent basis, and monitoring frequency reductions are not allowed for intermittent discharges (GM10-2003, IN-2, Pg. 53)
pH (Standard Units)	NA	NA	NL	NL	1 / 6 Months	Grab	NA	NA	NL	NL	1 per Month	Grab	
Total Suspended Solids (mg/L)	30	NA	NA	100	1 / 6 Months	Grab	30	NA	NA	100	1 per Month	Grab	
Total Petroleum Hydrocarbons (TPH) (mg/L)	NL	NA	NA	NA	1 / Year	Grab	NL	NA	NA	NA	1 per Month	Grab	
Oil and Grease (mg/L)	15	NA	NA	20	1 / 6 Months	Grab	15	NA	NA	20	1 per Month	Grab	

Outfall 108 – Changes to Limitations and Monitoring Requirements

EFFLUENT CHARACT.	2008 Permit Modification Limitations & Monitoring						2013 Permit Limitations & Monitoring						Reason for Change
	DISCHARGE LIMITATIONS				MON. REQ'S		DISCHARGE LIMITATIONS				MON. REQ'S		
	MO AVG	WE AVG	MIN	MAX	FREQ	SAMPL	MO AVG	WE AVG	MIN	MAX	FREQ	SAMPL	
Flow (MGD)	NL	NA	NA	NL	1 / Month	Measured	NL	NA	NA	NL	1 per Month	Estimate	Baseline monitoring frequencies applied because this outfall discharges on an intermittent basis, and monitoring frequency reductions are not allowed for intermittent discharges (GM10-2003, IN-2, Pg. 53)
pH (Standard Units)	NA	NA	NL	NL	1 / Month	Grab	NA	NA	NL	NL	1 per Month	Grab	
Total Suspended Solids (mg/L)	30	NA	NA	100	1 / Month	Grab	30	NA	NA	100	1 per Month	Grab	
Total Organic Carbon (mg/L)	NA	NA	NA	110	1 / 6 Months	Grab	NA	NA	NA	110	1 per Month	Grab	
Total Petroleum Hydrocarbons (TPH) (mg/L)	NL	NA	NA	NA	1 / Year	Grab	NL	NA	NA	NA	1 per Month	Grab	
Oil and Grease (mg/L)	15	NA	NA	20	1 / Month	Grab	15	NA	NA	20	1 per Month	Grab	

	Outfall 002 – Changes to Limitations and Monitoring Requirements												
	2008 Permit Modification Limitations & Monitoring						2013 Permit Limitations & Monitoring						Reason for Change
EFFLUENT CHARACT.	DISCHARGE LIMITATIONS				MON. REQ'S		DISCHARGE LIMITATIONS				MON. REQ'S		
	MO AVG	WE AVG	MIN	MAX	FREQ	SAMPL	MO AVG	WE AVG	MIN	MAX	FREQ	SAMPL	
Flow (MGD)	NL	NA	NA	NL	1 / 6 Month	Measured	NL	NA	NA	NL	1 per Month	Estimate	Baseline monitoring frequencies applied because this outfall discharges on an intermittent basis, and monitoring frequency reductions are not allowed for intermittent discharges (GM10-2003, IN-2, Pg. 53)
pH (Standard Units)	NA	NA	NL	NL	1 / 6 Month	Grab	NA	NA	NL	NL	1 per Month	Grab	
Total Suspended Solids (mg/L)	30	NA	NA	100	1 / 6 Month	Grab	30	NA	NA	100	1 per Month	Grab	
Total Organic Carbon (mg/L)	NA	NA	NA	110	1 / 6 Months	Grab	NA	NA	NA	110	1 per Month	Grab	
Total Petroleum Hydrocarbons (TPH) (mg/L)	NL	NA	NA	NA	1 / Year	Grab	NL	NA	NA	NA	1 per Month	Grab	
Copper, total recoverable (µg/L)	NL	NA	NA	NL	1 / 6 Months	Grab	3.6	NA	NA	3.6	1 per Month	Grab	New limitations, see Item 16 of this fact sheet for further information. Please note that the 2007 permit required monitoring only for Dissolved Copper and Zinc due to high concentrations observed in effluent screening data submitted with the 2006 application. Permit limitations for Total Recoverable Copper and Zinc have replaced the former monitoring requirements in the 2013 permit.
Nickel, total recoverable (µg/L)	--	--	--	--	--	--	9.2	NA	NA	9.2	1 per Month	Grab	
Zinc, total recoverable (µg/L)	NL	NA	NA	NL	1 / 6 Months	Grab	36	NA	NA	36	1 per Month	Grab	

Outfall 002 – Changes to Limitations and Monitoring Requirements													
	2008 Permit Modification Limitations & Monitoring						2013 Permit Limitations & Monitoring						Reason for Change
EFFLUENT CHARACT.	DISCHARGE LIMITATIONS				MON. REQ'S		DISCHARGE LIMITATIONS				MON. REQ'S		
	MO AVG	WE AVG	MIN	MAX	FREQ	SAMPL	MO AVG	WE AVG	MIN	MAX	FREQ	SAMPL	
Rainwater pH	--	--	--	--	--	--	NA	NA	NL	NL	1 per Month	Grab	Line item for Rainwater pH added to clarify the existing requirement listed as a footnote for this outfall. See Item 16 of this fact sheet for further information.
PCB 1260 (µg/L)	NL	NA	NA	NL	1 / 5 years	Grab	--	--	--	--	--	--	PCB monitoring first appeared in the 2007 permit because effluent screening data submitted by the permittee reflected PCB concentrations less than a QL that was greater than the DEQ-required QL at the time. The permittee subsequently submitted acceptable PCB monitoring data to fulfill this permit requirement on 4/10/2007, and therefore, it has been removed from the 2013 permit.
PCB 1242 (µg/L)	NL	NA	NA	NL	1 / 5 years	Grab	--	--	--	--	--	--	
PCB 1254 (µg/L)	NL	NA	NA	NL	1 / 5 years	Grab	--	--	--	--	--	--	
PCB 1221 (µg/L)	NL	NA	NA	NL	1 / 5 years	Grab	--	--	--	--	--	--	
PCB 1232 (µg/L)	NL	NA	NA	NL	1 / 5 years	Grab	--	--	--	--	--	--	
PCB 1248 (µg/L)	NL	NA	NA	NL	1 / 5 years	Grab	--	--	--	--	--	--	
PCB 1016 (µg/L)	NL	NA	NA	NL	1 / 5 years	Grab	--	--	--	--	--	--	

	Outfalls 050, 051, 052, 053 – Changes to Limitations and Monitoring Requirements												
	2008 Permit Modification Limitations & Monitoring						2013 Permit Limitations & Monitoring						Reason for Change
EFFLUENT CHARACT.	DISCHARGE LIMITATIONS				MON. REQ'S		DISCHARGE LIMITATIONS				MON. REQ'S		
	MO AVG	WE AVG	MIN	MAX	FREQ	SAMPL	MO AVG	WE AVG	MIN	MAX	FREQ	SAMPL	
Flow (MGD)	--	--	--	--	--	--	NA	NA	NA	NL	1 per 3 Months	Estimate	Monitoring for Sector O benchmark parameters added due to the addition of storm water requirements in the 2013 permit.
Iron, total (mg/L)	--	--	--	--	--	--	NA	NA	NA	NL	1 per 3 Months	Grab	

Changes to Special Conditions and Other Changes			
From	**To**	**Special Condition Changed**	**Rationale**
Cover Page	Cover Page	--	The structure and language of the cover page have been modified in accordance with new agency procedures and for streamlining purposes. Signatory requirements have also changed in accordance with the October 2008 DEQ Agency Policy Statement 2-09, "Delegations of Authority". The facility name and locations have been revised to match those provided in the 2011 permit application. The authorization to discharge storm water from Outfalls 050, 051, 052, and 053 was added at the permittee's request.
Part I.A.1 & Part I.A.1.a	Part I.A.1	Limitations & Monitoring Page Preamble	Structure and language revised and combined for acuity and streamlining purposes.
Part I.A.1.a(1)	Part I.A.1(a)	Cooling Pump Operation Equivalent to Flow	No Change
Part I.A.1.a(2)	Part I.A.1(b)	Maintain pH within 0.5 SU of Intake pH	No Change
Part I.A.1.a(3)	Part I.A.1(c)	Compliance Reporting Reference	No Change
Part I.A.1.a(4)	Part I.A.1(d)	TRC Sampling Coincide with Addition	Revised wording for acuity purposes
Part I.A.1.a(5)	Part I.A.1(e)	TSS Intake Sampling	Revised wording for acuity purposes
Part I.A.1.b	Part I.A.2	Visible Effluent Quality	Revised to reflect prohibition of discharge of water with visible sheen.
Part I.A.2 & Part I.A.2.a	Part I.A.3	Limitations & Monitoring Preamble.	Structure and language revised and combined for acuity and streamlining purposes.
Part I.A.2.a(1)	Part I.A.3(a)	Design Flow	Added reference to 95% Capacity Reopener special condition for clarity.
Part I.A.2.a(3)	Part I.A.3(b)	Additional TRC Requirements Reference	Spelled out TRC acronym for acuity purposes
--	Part I.A.3(c)	4 Days per Month Monitoring Frequency Clarification	New, added to clarify expected monitoring schedule.
--	Part I.A.3(d)	Monitoring Frequencies Encompassing Multiple Months	New, added to clarify expected monitoring schedule.
Part I.A.2.a(2)	Part I.A.3(e)	Significant Figures	Wording revised for clarity
Part I.A.2.b	Part I.A.4	85% Removal	No Change
Part I.A.3	Part I.A.5	Limitations & Monitoring Page Preamble	Structure and language revised and combined for acuity and streamlining purposes. Removed Outfalls 116 & 117 from the 2013 permit Part I.A grouping because they are intermittent discharges and, therefore, monitoring frequencies were matched to baseline (see explanation in limitations and monitoring changes section of this fact sheet section above). The discharges from Outfall 102, 103, & 106, however, are eligible for monitoring frequency reductions for the 2013 permit, and consequently, were grouped in the Part I.A page addressed by this change explanation.
Part I.A.3(1)	Part I.A.5(a)	Effluent Monitoring Frequencies	No Change
--	Part I.A.5(b)	Monitoring Frequencies Encompassing Multiple Months	New, added to clarify expected monitoring schedule.
Part I.A.3(2)	Part I.A.5(c)	Significant Figures	Wording revised for clarity

Changes to Special Conditions and Other Changes			
From	**To**	**Special Condition Changed**	**Rationale**
[Part I.A.3]	Part I.A.6	Limitations & Monitoring Page Preamble	This is a new limitations and monitoring requirements page (i.e. "Part I.A" page) created in order to separate and group those outfalls which have the same limitations and monitoring requirements. The outfalls addressed in this 2013 permit Part I.A page were formerly grouped under Part I.A.3 of the 2008 permit modification. However, due to the intermittent discharge from these outfalls, baseline monitoring frequencies have been applied rather than the formerly reduced monitoring frequencies.
--	Part I.A.6(a)	Monthly Sampling Requirements	The intermittent discharge frequency from these outfalls may prevent a sampling event from occurring on a minimum basis of once per month. Therefore further sampling instructions have been added via this footnote for months in which no discharge occurs in order that the permittee remains consistent with previous sampling practices and current agency policy.
[Part I.A.3(2)]	Part I.A.6(b)	Significant Figures	Wording revised for clarity
Part I.A.4	Part I.A.7	Limitations & Monitoring Page Preamble	Structure and language revised and combined for acuity and streamlining purposes. Removed Outfalls 107, 114, 115, 118, 119, 121, & 122 from the 2013 permit Part I.A grouping because they are intermittent discharges and, therefore, monitoring frequencies were matched to baseline (see explanation in limitations and monitoring changes section of this fact sheet section above). The discharges from Outfalls 101, 102, 103, 104, 109, 110, 111, 112, 113, & 120, however, are eligible for monitoring frequency reductions for the 2013 permit, and consequently, are grouped in the Part I.A page addressed by this change explanation.
Part I.A.4(1)	Part I.A.7(a)	Effluent Monitoring Frequencies	No Change
--	Part I.A.7(b)	Monitoring Frequencies Encompassing Multiple Months	New, added to clarify expected monitoring schedule.
Part I.A.4(2)	Part I.A.7(c)	Significant Figures	Wording revised for clarity
[Part I.A.4]	Part I.A.8	Limitations & Monitoring Page Preamble	This is a new limitations and monitoring requirements page (i.e. "Part I.A" page) created in order to separate and group those outfalls which have the same limitations and monitoring requirements. The outfalls addressed in this 2013 permit Part I.A page were formerly grouped under Part I.A.3 of the 2008 permit modification. However, due to the intermittent discharge from these outfalls, baseline monitoring frequencies have been applied rather than the formerly reduced monitoring frequencies.
--	Part I.A.8(a)	Monthly Sampling Requirements	The intermittent discharge frequency from these outfalls may prevent a sampling event from occurring on a minimum basis of once per month. Therefore further sampling instructions have been added via this footnote for months in which no discharge occurs in order that the permittee remains consistent with previous sampling practices and current agency policy.
[Part I.A.4(2)]	Part I.A.8(b)	Significant Figures	Wording revised for clarity
Part I.A.5	Part I.A.9	Limitations & Monitoring Page Preamble	Structure and language revised and combined for acuity and streamlining purposes.
--	Part I.A.9(a)	TPH Test Method Requirements	New, reflects most recent TPH analysis procedures required in accordance with the *General VPDES Permit for Petroleum Contamination Sites, Groundwater Remediation, and Hydrostatic Tests (*9 VAC 25-120*)*.

Changes to Special Conditions and Other Changes			
From	**To**	**Special Condition Changed**	**Rationale**
--	Part I.A.9(b)	Monthly Sampling Requirements	The intermittent discharge frequency from these outfalls may prevent a sampling event from occurring on a minimum basis of once per month. Therefore further sampling instructions have been added via this footnote for months in which no discharge occurs in order that the permittee remains consistent with previous sampling practices and current agency policy.
Part I.A.5(2)	Part I.A.9(c)	Significant Figures	Wording revised for clarity
Part I.A.5.b	Part I.A.10	No Discharge of Tank Bottom Waters	No Change
Part I.A.6	Part I.A.11	Limitations & Monitoring Page Preamble	Structure and language revised and combined for acuity and streamlining purposes.
--	Part I.A.11(a)	TPH Test Method Requirements	New, reflects most recent TPH analysis procedures required in accordance with the *General VPDES Permit for Petroleum Contamination Sites, Groundwater Remediation, and Hydrostatic Tests (*9 VAC 25-120*)*.
--	Part I.A.11(b)	Monthly Sampling Requirements	The intermittent discharge frequency from these outfalls may prevent a sampling event from occurring on a minimum basis of once per month. Therefore further sampling instructions have been added via this footnote for months in which no discharge occurs in order that the permittee remains consistent with previous sampling practices and current agency policy.
Part I.A.5(2)	Part I.A.11(c)	Significant Figures	Wording revised for clarity
Part I.A.7	Part I.A.12	Limitations & Monitoring Page Preamble	Structure and language revised and combined for acuity and streamlining purposes.
Part I.A.7.a(2)	Part I.A.12(a)	Maintain pH within 0.5 SU of Rainfall pH	Revised for the purposes of enforceability and for clarity.
Part I.A.7.a(4)	Part I.A.12(b)	Quantification Levels	No Change
--	Part I.A.12(c)	Monthly Sampling Requirements	The intermittent discharge frequency from this outfall may prevent a sampling event from occurring on a minimum basis of once per month. Therefore further sampling instructions have been added via this footnote for months in which no discharge occurs in order that the permittee remains consistent with previous sampling practices and current agency policy.
Part I.A.7.a(3)	Part I.A.12(d)	Significant Figures	Wording revised for clarity
--	Part I.A.12(e)	Schedule of Compliance Reference	Added because a Schedule of Compliance has been granted to the permittee in order to meet new permit limitations at this outfall.
--	Part I.A.12(f)	TPH Test Method Requirements	New, reflects most recent TPH analysis procedures required in accordance with the *General VPDES Permit for Petroleum Contamination Sites, Groundwater Remediation, and Hydrostatic Tests (*9 VAC 25-120*)*.
Part I.A.7.b	Part I.A.13	Visible Effluent Quality	Revised to reflect prohibition of discharge of water with visible sheen.
Part I.A.7.c	Part I.A.14	No Discharge of Tank Bottom Waters	No Change
--	Part I.A.15, Part I.A.15(a) Part I.A.15(b) Part I.A.15(c)	Storm Water Benchmark Monitoring Requirements	Added due to the permittee's request that storm water management requirements be added to the 2013 permit.

Changes to Special Conditions and Other Changes			
From	**To**	**Special Condition Changed**	**Rationale**
Part I.B	Part I.B	TRC and Additional Bacteria Requirements (Outfall 101)	Wording and structure changed for acuity purposes. Minimum TRC limitation revised to reflect two significant figures. Fecal coliform limitation added in the event that disinfection is by means other than chlorination. Enterococci demonstration study requirements removed because the permittee successfully completed the study and submitted results to DEQ on 6/21/2007.
Part I.C.1	Part I.C.1	Notification Levels	Revised threshold value for Antimony to reflect 2 significant figures.
Part I.C.2	Part I.C.2	Materials Handling and Storage	Revised to require consistency with Best Management Practices.
Part I.C.3	Part I.C.3	Licensed Operator Requirements	DPOR regulation name changed to match current regulation
Part I.C.18 / Part I.C.4	Part I.C.4	TMDL / Nutrient Reopener	Revised combined language addresses both nutrient reopener and TMDL reopener.
Part I.C.5	Part I.C.5	O & M Manual Requirement	Revised to reflect boilerplate language released by OWP&CA on 4/3/2012
Part I.C.6	Part I.C.6	Compliance Reporting	Revised to reflect current agency guidance (GM10-2003, IN-3,Pg.15). Language further revised according to regional procedure and for clarity purposes. BOD_5 QL revised from 5 mg/L to 2 mg/L for consistency with recently adopted VPDES General Permit regulations. QL for Nickel added to reflect current target value in accordance with agency guidance. QL for TPH revised to match QL for Oil & Grease. PCB and TP QLs removed as the parameters are no longer limited or monitored in the permit.
Part I.C.7	Part I.C.7	Effluent Monitoring Frequencies	Language unchanged. Outfalls 107, 108, 114, 115,116, 117, 118, 119, 121, 122, and 002 removed because monitoring frequency reductions no longer apply to these outfalls and monitoring frequencies have been returned to baseline.
Part I.C.8	Part I.C.8	Oil Storage Ground Water Monitoring Reopener	Reference to "ODCP" regulation removed because ODCP's are required by the AST regulation. Language revised to account for how the AST regulation addresses both the Surry Power Station and Gravel Neck Station facilities with regard to groundwater monitoring. Unlike the Gravel Neck facility, the Surry Power Station is not specifically required by the AST regulation to conduct groundwater monitoring because it has an aggregated petroleum storage volume of less than 1 million gallons. However, they are required by the AST regulation to implement an early leak detection system, and one of the options for doing this is groundwater monitoring, which Virginia Power has elected to do.
Part I.C.9	Part I.C.9	Tank Bottom Waters Pump and Haul Activities	No Change
Part I.C.10	Part I.C.10	Intake Trash Racks	No Change
Part I.C.11	Part I.C.11	No Discharge of PCBs	No Change
Part I.C.12	Part I.C.12	Discharges of Uncontaminated Water	No Change
Part I.C.13	Part I.C.13	Discharge of Chlorine in Cooling Water	Revised language to match that used as the basis for this special condition (40 CFR 423.13(b)(2))
Part I.C.14	Part I.C.14	Radioactivity Regulated by NRC	No Change

Changes to Special Conditions and Other Changes			
From	**To**	**Special Condition Changed**	**Rationale**
Part I.C.15	Part I.C.15	No Discharge of Tank Bottom Waters	Removed "at the Gravel Neck Facility" because the prohibition on discharging tank bottom waters applies to both the Surry Power Plant and the Gravel Neck facilities.
Part I.C.16	Part I.C.16	Water Quality Criteria Reopener	No Change
Part I.C.17	Part I.C.17	316(b) Requirements	Revised to reflect language released by OWP&CA on 11/7/2011.
Part I.C.19	Part I.C.18	Treatment Works Closure Plan	Language revised in accordance with current agency guidance (GM10-2003, IN-3 , Pg. 19). Language further revised in accordance with Staff Decisions (8/7/2012)
Part I.C.20	Part I.C.19	95% Capacity Reopener	Language slightly revised for clarity.
Part I.C.21	Part I.C.20	CTC, CTO Requirement	Revised wording to reflect GM10-2003 (MN-3, Pg.4) and to be consistent with GM07-2008 Amendment 2.
Part I.C.22	Part I.C.21	Reliability Class	No Change
Part I.C.23	Part I.C.22	Sludge Reopener	No Change
Part I.C.24	Part I.C.23	Sludge Use and Disposal	Revised to remove reference to the Virginia Department of Health in accordance with GM10-2003 (MN-3, Pg.16)
--	Part I.C.24	Monitoring Frequencies Encompassing Multiple Months	New, added to clarify the expected monitoring schedule for monitoring periods spanning more than a single month.
--	Part I.C.25	Concept Engineering Report	New, added in accordance with 6/29/2010 regional staff, and 7/22/2010 water program manager decision to include this special condition in all industrial VPDES individual permits. Second paragraph added to be consistent with GM07-2008 Amendment 2.
--	Part I.C.26	Schedule of Compliance	New, added to provide the permittee with a schedule to attain compliance with the new 2013 permit limitations for Copper, Nickel, and Zinc.
Part I.C.25	Part I.C.27	WET Monitoring Program	Language revised in accordance with recommendations from OWP&CA.
--	Part I.D	Storm Water Management Conditions	New, added at the permittee's request. Storm water discharges from this site were previously covered under a No Exposure Certification issued in 2007. In January 2012 the permittee requested a meeting to discuss the fact that Dominion found it difficult to maintain a condition of No Exposure onsite during outages (about every 18 months) due to the influx of very large machinery and the need for storage of replaced turbines. The permittee submitted a Form 2F application to DEQ in May 2012, but did not include monitoring data at that time. Therefore, the boilerplate special condition language from GM10-2003 (IN-3, Pg. 16) was incorporated into Part I.D in order to allow the permittee to submit Part VII of Form 2F within one year of the effective date of the permit. Once testing results are received, the permit may be reopened to incorporate regular pollutant monitoring and WET monitoring.
--	Part II.A.4	VELAP Requirement	New, incorporated to reflect change in laboratory accreditation requirements and in accordance with GM10-2003

Changes to Special Conditions and Other Changes			
From	**To**	**Special Condition Changed**	**Rationale**
Items Removed from 2008 Permit Modification			
Part I.A.1.a Part I.A.2.a Part I.A.5.a Part I.A.7.a	Removed	Limitations & Monitoring Page Preamble	This subpart has been combined with the rest of the preamble to better match regional permit structural preferences
Part I.A.2.a(4)	Removed	Fecal coliform sampling	The footnote is redundant to the 2013 Part I.A.3 page and to Part I.B special condition
[Part I.A.3(1)] [Part I.A.4(1)] Part I.A.5(1) Part I.A.6(1) Part I.A.7.a(1)	Removed	Effluent Monitoring Frequencies Reference	Baseline monitoring frequencies have been applied for the 2013 permit, therefore, this footnote reference to the Effluent Monitoring Frequencies special condition is no longer applicable.
Part I.A.7.a(5)	Removed	PCB Sampling Instructions	PCB sampling is not required for the 2013 permit

21. Variances/Alternate Limits or Conditions: A §316(a) thermal variance is continued in the proposed permit. There have been no substantial changes in the conditions described in Virginia Power's initial request for a variance under §316(a) of the Clean Water Act.

22. Public Notice Information required by 9 VAC 25-31-280 B:
Comment period: Start Date: TBD End Date: TBD
Published Dates: TBD
Name of Newspaper: *Sussex-Surry Dispatch*

All pertinent information is on file and may be inspected or copied by contacting Jeremy Kazio at:

Virginia Department of Environmental Quality (DEQ)
Piedmont Regional Office
4949-A Cox Road
Glen Allen, Virginia 23060-6296

Telephone Number 804/527-5044
Facsimile Number 804/527-5106
Email Jeremy.Kazio@deq.virginia.gov

DEQ accepts comments and requests for public hearing by hand delivery, e-mail, fax or postal mail. All comments and requests must be in writing and be received by DEQ during the comment period. Submittals must include the names, mailing addresses and telephone numbers of the commenter/requester and of all persons represented by the commenter/requester. A request for public hearing must also include: 1) The reason why a public hearing is requested. 2) A brief, informal statement regarding the nature and extent of the interest of the requester or of those represented by the requester, including how and to what extent such interest would be directly and adversely affected by the permit. 3) Specific references, where possible, to terms and conditions of the permit with suggested revisions. A public hearing may be held, including another comment period, if public response is significant, based on individual requests for public hearing, and there are substantial, disputed issues relevant to the permit. The public may review the draft permit and application at the DEQ Piedmont Regional Office by appointment or may request copies of the documents from the contact person listed above.

23. Additional Comments:

Previous Board Action: None

Staff Comments:

a. *Watershed Nutrient General Permit:* This facility is authorized to discharge total nitrogen and total phosphorus in accordance with 9 VAC 25-820-70.A.2 of the *General VPDES Watershed Permit Regulation for Total Nitrogen and Total Phosphorus Discharges and Nutrient Trading in the Chesapeake Bay Watershed in Virginia*. During promulgation of Virginia's *Water Quality Management Plan Regulation* (9 VAC 25-720), this facility was identified as a non-significant discharger according to the definition in the regulation, and therefore the permittee did not receive site specific nutrient load allocations. Existing facilities that were not identified as significant dischargers may, nonetheless, be required to register under the Watershed Nutrient General Permit (and consequently receive individual nutrient load allocations) if the facility has undergone a design flow expansion (municipal dischargers), or has increased its delivered nutrient load to levels that are equivalent to a design flow expansion (industrial dischargers) as outlined in § 62.1-44.19:15 (*Code of Virginia*), and 9 VAC 25-40-70 (*Regulation for Nutrient Enriched Waters and Dischargers within the Chesapeake Bay Watershed*).

   For industrial dischargers, agency guidance (GM07-2008 Amd.2, Page 10) asserts that an increase in effluent flow volume should not be used to determine whether there has been an increase in delivered nutrient load from a facility unless the flow rate increase is directly associated with capital construction improvements requiring a Concept Engineering Report. Since Virginia Power has not undergone an expansion or upgrade, the permittee is not required to register under the Watershed Nutrient General Permit, and an evaluation of the facility's delivered nutrient load is not required.

b. *Monitoring Frequency Reduction:* The permittee has not received any Notices of Violation in the last three years. A reduction in monitoring frequency was granted for BOD_5 and TSS at Outfall 101, and for all pollutants that are limited or monitored at Outfalls 102, 103, 104, 109, 110, 111, 112, 113, & 120 in accordance with GM10-2003 (IN-2, Pgs.51-53) for the 2013 permit. Please note that the monitoring frequency reduction analysis for TSS at Outfall 113 resulted in an increased monitoring frequency of 1 per 3 Months (from 1 per 6 Months). This was due to a single data point of 28.2 mg/L, which is much higher than the overall 5 year average of 8.7 mg/L (6.2 mg/L without this data point). It is staff's judgment that this data point is an outlier and does not represent the typical effluent discharged from this outfall, and therefore, it is recommended that the monitoring frequency for this parameter remain at 1 per 6 months.

   Pollutants for which monitoring frequency reductions were previously granted at Outfalls 107, 108, 114, 115,116, 117, 118, 119, 121, 122, and 002 have been increased to baseline frequencies (1 per Month) because these outfalls discharge on an intermittent basis according to historic DMR data submittals and the 2011 permit application. Monitoring frequency reductions are not allowed for intermittent discharges according to GM10-2003 (IN-2, Pg. 53).

c. *Storm Water Requirements:* Storm water discharges from this site were previously covered under a No Exposure Certification accepted 9/28/2008. In January 2012 the permittee requested a meeting to discuss the fact that Dominion found it difficult to maintain a condition of No Exposure onsite during station outages (about every 18 months) due to the influx of very large machinery traffic and the need for storage of replaced turbines, and other large machinery, onsite. The permittee submitted a Form 2F application to DEQ in May 2012, but did not include monitoring data at that time. Therefore, the boilerplate special condition language from GM10-2003 (IN-3, Pg. 16) was incorporated into Part I.D of the 2013 permit in order to allow the permittee to submit Part VII of Form 2F within one year of the effective date of the permit. Once testing results are received, the permit may be reopened to incorporate regular pollutant monitoring and WET monitoring. In the interim, and during the rest of the permit cycle, the permittee is expected to develop and maintain a SWPPP and utitlize BMPs in accordance with Parts I.D.2, 3, and 4, as well as conduct benchmark monitoring in accordance with Part I.D.5, of the 2013 permit.

d. *Permit Expiration Prior to Reissuance:* This permit is being reissued subsequent to expiration due to administrative delays.

e. *VDH-Office of Drinking Water (ODW) and VDH-Division of Shellfish Sanitation (DSS):* The VDH-ODW indicated no objection to the existing discharge. Coordination with VDH-DSS indicated that the existing discharge would not change the current shellfish harvest designation (see **Attachment L**).

f. This permit reissuance is non-controversial. The staff believes that the attached effluent limitations will maintain the Water Quality Standards adopted by the Board.

g. *Planning Concurrence:* The discharge is not addressed in any planning document but will be included when the plan is updated.

h. *EPA Comments*: The draft permit was sent to EPA on --, 2013. EPA responded on --, 2013 stating that --. Please see **Attachment M** for EPA's full response.

i. *Permit Fees:* The permittee is considered to be current on their annual maintenance fee, last paid on August 22, 2012.

j. *VEEP Status:* The permittee is not a participant in the Virginia Environmental Excellence Program.

k. *E-DMR Status:* The permittee is an e-DMR participant beginning 4/19/2012.

l. *Local Government Notification of Public Notice:* A copy of the public notice for the 2013 permit reissuance was mailed to the Crater Planning District Commission, the Surry County Administrator, and the Chairman of the Surry County Board of Supervisors on , 2013, in accordance with the Code of Virginia, §62.1-44.15:01. No comments regarding the permit action were received.

m. *Coordination with DCR:* Coordination with DCR was initiated on 9/27/2012. DCR responded on 10/22/2012 stating that they do not anticipate that the permit reissuance will adversely impact natural heritage resources or state-listed threatened or endangered plant and insect species (see **Attachment L**)

n. *Application Waiver* The permittee submitted a request for, and was subsequently granted, a waiver from 24-hour composite sampling from Outfall 002. Please see **Attachment N** for Virginia Power's sampling plan as well as a copy of the application waiver granted by DEQ.

o. Special standards "z", and "ESW-11" do not apply to the segment of the river basin to which this facility discharges. Special standard "a" is addressed via a limitation for Fecal Coliform at Outfall 101(see Item 16 of this fact sheet for more information). See Item 25 of this fact sheet for further information regarding special standard "bb".

24. Public Comment: TBD

25. 303(d) Listed Segments and TMDLs:

Outfall 001 / Outfall 052:
During the 2010 305(b)/303(d) Integrated Water Quality Assessment, the James River was considered a Category 5A water ("A Water Quality Standard is not attained. The water is impaired or threatened for one or more designated uses by a pollutant(s) and requires a TMDL (303d list).") The Aquatic Life Use is impaired due to excessive chlorophyll *a*, inadequate benthic community, and past dissolved oxygen exceedances. The Fish Consumption Use is impaired due to a VDH advisory for PCBs; in addition, kepone is considered a non-impairing observed effect. The Recreation Use was fully supporting and the Wildlife Use was not assessed.

In the draft 2012 Water Quality Assessment, the river was assessed as Category 5D. The Aquatic Life Use is impaired due to excessive chlorophyll *a*, inadequate benthic community, and past dissolved oxygen exceedances. The Fish Consumption Use is impaired due to a VDH advisory for PCBs; in addition, kepone is considered a non-impairing observed effect. The Recreation Use was fully supporting and the Wildlife Use was not assessed.

Outfall 002 / Outfall 050:
During the 2010 305(b)/303(d) and draft 2012 Assessments, the unnamed tributary was not assessed for any Designated Use. It is therefore considered a Category 3A water.

Outfall 051:
The stream was not assessed in the 2010 or draft 2012 Water Quality Assessment (Category 3A).

Outfall 053:
Stormwater outfall 052 discharges to the mesohaline James River at rivermile 2-JMS029.27. The James River was considered Category 5A in the 2010 305(b) cycle and Category 5D in the draft 2012 report. The applicable fact sheets are attached. The Aquatic Life Use is impaired due to excessive chlorophyll *a* and dissolved oxygen exceedances during the summer period in segment JMSMH. The Fish Consumption Use is impaired due to a VDH advisory for PCBs; in addition, kepone is considered a non-impairing observed effect. The Recreation Use and Shellfish Uses were fully supporting and the Wildlife Use was not assessed.

All Outfall Locations:
The facility was addressed in the Chesapeake Bay TMDL, which was approved by the EPA on 12/29/2010. The TMDL allocates loads for total nitrogen, total phosphorus, and total suspended solids to protect the dissolved oxygen and submerged aquatic vegetation acreage criteria in the Chesapeake Bay and its tidal tributaries. The Surry Power Plant discharge was included in the aggregated loads for non-significant wastewater dischargers in the oligohaline James River estuary (JMSOH). The stormwater outfall discharge to the mesohaline James River estuary (JMSMH) was not addressed. The nutrient allocations are administered through the Watershed Nutrient General Permit; the TSS allocations are considered aggregated and facilities with technology-based TSS limits are considered to be in conformance with the TMDL.

a. *Chesapeake Bay TMDL, chlorophyll-a, benthic impairments, and dissolved oxygen impairment*:
This facility discharges directly to James River in the Chesapeake Bay watershed in segment JMSOH. The receiving stream has been addressed in the Chesapeake Bay TMDL, approved by EPA on December 29, 2010. The TMDL addresses dissolved oxygen (DO), chlorophyll a, and submerged aquatic vegetation (SAV) impairments in the main stem Chesapeake Bay and its tidal tributaries by establishing non-point source load allocations (LAs) and point-source waste load allocations (WLAs) for Total Nitrogen (TN), Total Phosphorus (TP) and Total Suspended Solids (TSS) to meet applicable Virginia Water Quality Standards contained in 9VAC25-260-185.

Implementation of the Chesapeake Bay TDML is currently accomplished in accordance with the Commonwealth of Virginia's Phase I Watershed Implementation Plan (WIP), approved by EPA on December 29, 2010. The approved WIP recognizes the "General VPDES Watershed Permit Regulation for Total Nitrogen and Total Phosphorus Discharges and Nutrient Trading in the Chesapeake Bay Watershed of Virginia" (9VAC25-820) as controlling the nutrient allocations for non-significant Chesapeake Bay dischargers. The approved WIP states that for non-significant Municipal and Industrial facilities, nutrient WLAs are to be consistent with Code of Virginia procedures, which set baseline WLAs to 2005 permitted design capacity nutrient load levels. In accordance with the WIP, TN and TP WLAs for non-significant facilities are considered aggregate allocations and will not be included in individual permits. The WIP also considers TSS WLAs for non-significant facilities to be aggregate allocations, but TSS limits are to be included in individual VPDES permits in conformance with the technology-based requirements of the Clean Water Act. However, the WIP recognizes that so long as the aggregated TSS permitted loads for all dischargers is less than the aggregated TSS load in the WIP, the individual permit will be consistent with the TMDL.

40 CFR 122.44(d)(1)(vii)(B) requires permits to be written with effluent limits necessary to meet water quality standards and to be consistent with the assumptions and requirements of applicable WLAs.

This facility is considered a Non-significant Chesapeake Bay discharger because it is an existing facility with a nutrient load equivalent to a permitted design capacity flow of less than 100,000 gallons per day into tidal waters. This facility has not made application for a new or expanded discharge since 2005. It is therefore covered by rule under the 9VAC25-820 regulation. In accordance with the WIP, TN and TP load limits are not included in this individual permit, but are consistent with the TMDL because the current nutrient loads are in conformance with the facility's 2005 permitted design capacity loads. This individual permit includes TSS limits of 30 mg/L that are in conformance with technology-based requirements and, in turn, are consistent with the Chesapeake Bay TMDL. Implementation of the full Chesapeake Bay WIP, including GP reductions combined with actions proposed in other source sectors, is expected to adequately address ambient conditions such that the proposed effluent limits of this individual permit are consistent with the Chesapeake Bay TMDL, and will not cause an impairment or observed violation of the standards for DO, chlorophyll a, or SAV as required by 9VAC25-260-185.

The Regulation for Nutrient Enriched Waters and Dischargers within the Chesapeake Bay Watershed, 9VAC25-40, does not regulate discharges of storm water; therefore, the permittee's storm water discharges are not subject to the General VPDES Watershed Permit Regulation for Total Nitrogen and Total Phosphorus Discharges and Nutrient Trading in the Chesapeake Bay Watershed in Virginia, 9VAC25-820. Although the storm water requirements of this permit do not include numeric limitations, it is consistent with the Chesapeake Bay TMDL through the SWPPP. The goal of the SWPPP is consistent with that of the TMDL, which is to minimize pollutants to the maximum extent possible.

b. *Polychlorinated Biphenyl's (PCB's)*: The permittee submitted effluent data for all seven PCB aroclors required by Attachment A using the proper test method (608). All PCB aroclors were reported less than the DEQ recommended QL (<1.0 µg/L). Therefore, this facility's discharge is not expected to cause or contribute to the PCB fish consumption impairment.

26. Fact Sheet Attachment Guide:

Attachment A	Flow Frequency Memo, VIMS Mixing Study
Attachment B	Flow Diagram, Outfall Location Map, Sewage Treatment Plant Diagram, Storm Water Outfall Location Map, Well Location Map and Sludge Hauling Route
Attachment C	Topographic Map and Aerial Photographs
Attachment D	Materials/Chemicals Used/Stored Onsite
Attachment E	Ambient Data from Monitoring Stations 2-JMS041.27 & 2-JMS050.57
Attachment F	Facility Site Inspection
Attachment G	Effluent Screening Data, Form 2C Data, and DMR Data
Attachment H	Effluent Limitation Analysis (MSTRANTI & STATS Printouts)
Attachment I	Federal Effluent Guidelines (Steam Electric Power Generating Cat.)
Attachment J	WET Evaluation and Associated OWP&CA Guidance
Attachment K	NPDES Permit Rating Worksheet
Attachment L	VDH and DCR Concurrence
Attachment M	EPA Review Response
Attachment N	5/27/2010 Application Waiver

SECTION 316(a) DEMONSTRATION
(Type I)

SURRY POWER STATION - UNITS 1 and 2

Submitted to

Virginia State Water Control Board

by

Virginia Electric and Power Company

August 31, 1977

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FIGURES

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I. INTRODUCTION

The Virginia Electric and Power Company (Vepco) announced plans in 1967 for the construction of a two unit nuclear powered electric generating station on Gravel Neck peninsula adjoining Hog Island in Surry County, Virginia (Fig. 1). Gravel Neck is located adjacent to the tidal oligohaline transition zone of the James River, a major tributary of Chesapeake Bay. This zone is centered around Hog Island and generally ranges from 46 to 63 km (25-34 nautical miles) upstream from the river mouth.

Unit 1 attained initial criticality on July 1, 1972, and Unit 2 attained initial criticality on March 7, 1973.

Vepco applied for a Section 316(a) demonstration on August 16, 1974, to be filed with the Virginia Water Control Board on September 1, 1977.

The following report constitutes a non-predictive demonstration (Type I, absence of prior appreciable harm), and is submitted in accordance with the provisions and regulations under Public Law 92-500 and Vepco's request of August 16, 1974. The data presented herein will demonstrate conclusively that the thermal effluent from Surry has not caused appreciable harm to the fish, shellfish, and wildlife in and on the waters of the James River. Such proof will constitute a successful Type I demonstration and render the Surry Power Station thermal discharge eligible for alternate thermal effluent limitations as provided in existing laws and regulations.

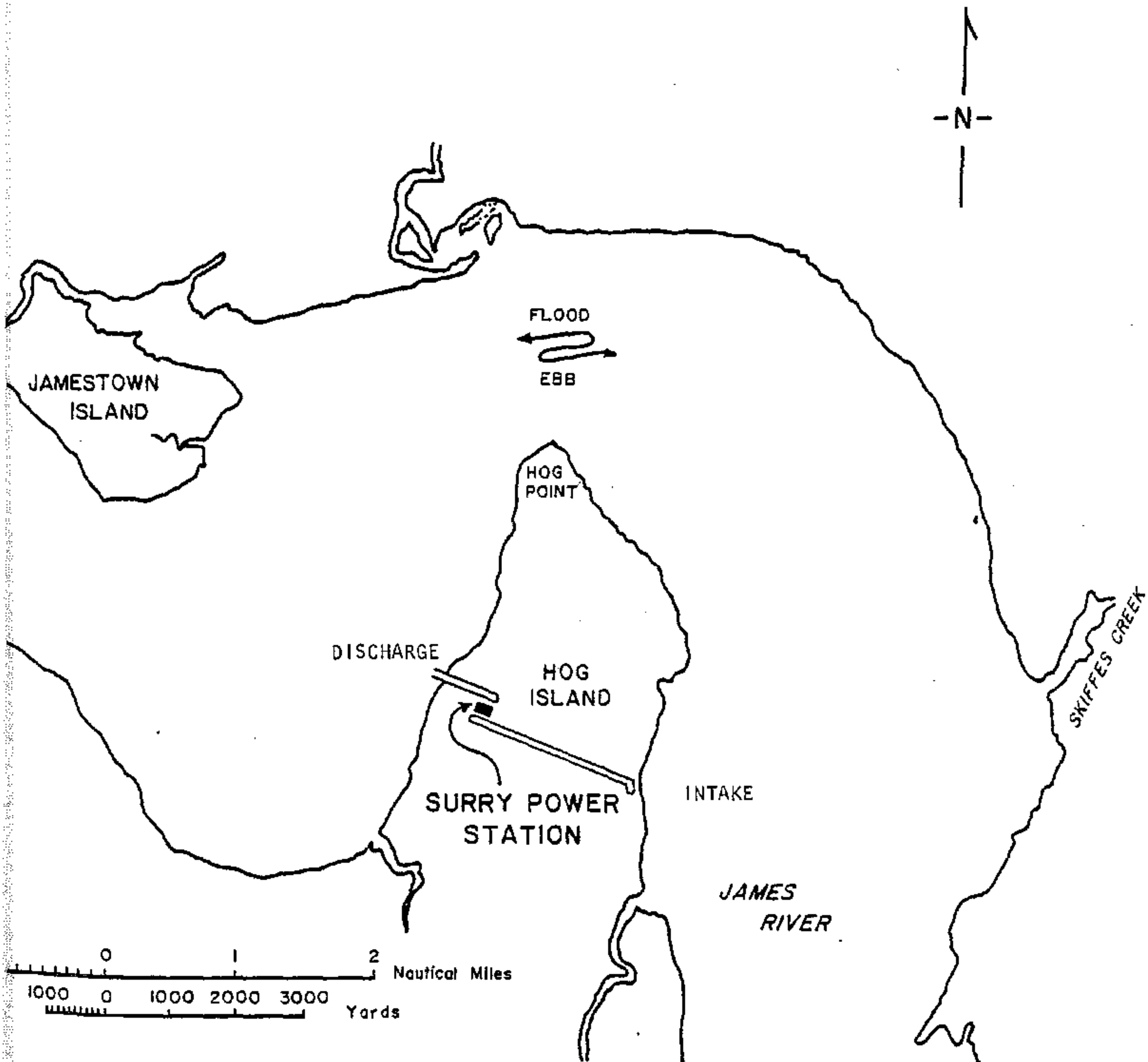


FIGURE 1: Location of Surry Power Station on the James River, Virginia.

II. MASTER RATIONALE FOR TYPE I DEMONSTRATION

Regulations of the Environmental Protection Agency (EPA) provide that a Type I demonstration (absence of prior appreciable harm) may permit the imposition of alternate effluent limitations where the applicant can demonstrate that "no appreciable harm has resulted from the thermal component of the discharge . . . to a balanced, indigenous community of shellfish, fish and wildlife in and on the body of water into which the discharge has been made . . ." 40 C.F.R. § 122.15(b)(1)(A) (1976). In order to conduct a Type I demonstration, Vepco has conducted and funded extensive physical and ecological studies in the vicinity of Surry Power Station. As discussed below and throughout this demonstration, data from these studies indicate that Vepco's Type I demonstration successfully meets the regulatory standard. The remainder of this master rationale discusses the requirements for conducting a Type I demonstration and the results of the physical and ecological studies.

The threshold question is whether an applicant may be permitted to conduct a Type I demonstration. Vepco submitted a Type I demonstration study plan to EPA with a copy to the State Water Control Board on October 14, 1974. This plan was approved on March 22, 1976. Also, Vepco satisfies the requirements for such a demonstration. According to EPA's regulations, a Type I demonstration may be conducted if it satisfies two requirements. First, an applicant must have been discharging heated effluent into a body of water for a sufficient period of time prior to its § 316(a) application to allow evaluation of the effects of the discharge. The preamble to EPA's regulations specifies that the minimum period between the commencement of thermal discharges and a § 316(a) demonstration should be one year. Vepco's Surry Power Station more than satisfies this requirement -- Unit 1 became critical on July 1, 1972 and Unit 2, on

March 7, 1973, and Vepco submitted its application on August 16, 1974. Moreover, Vepco has conducted or funded ongoing physical and ecological studies since the late 1960's including more than three years since its application for a § 316(a) demonstration. Thus, there is a substantial body of on-site thermal effects data with which to evaluate the influence, if any, of the discharge.

Second, the discharge must not have been into waters which are (or were) so despoiled as to preclude evaluation of the ecological effects of the thermal discharge. While the James River, at points upstream from Surry, might be considered despoiled, it is not despoiled in the vicinity of Surry because the station is located in the river's transition zone. As will be discussed later in this demonstration, this transition zone is one of relatively clean water since the pollution load in the river upstream is largely dissipated through natural processes before reaching Surry. Thus, the James River in the vicinity of Surry is not so despoiled as to preclude evaluation of the ecological effects of its thermal discharge.

Once it is established that a thermal effluent qualifies for a Type I demonstration, it is necessary to determine whether absence of prior appreciable harm can be demonstrated. To accomplish this entails comprehensive, long-term ecological studies in the area of concern; studies which involve communities from almost all trophic levels as well as selected species within communities. If the data from several years' duration indicate that the balanced, indigenous populations of fish, shellfish, and wildlife in and on the body of water under study are not being appreciably harmed by the thermal effluent, the demonstration should be found successful.

The circulating water system of Surry Power Station was designed to minimize the size of the thermal plume with the knowledge that such a design would minimize any possible impact on the aquatic ecosystem. During the design phase of Surry Power Station, Vepco contracted with Pritchard-Carpenter, Consultants, to utilize the hydraulic model of the James River estuary located at the U. S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi. The purpose of using the model was to develop an optimum discharge location, configuration, and exit velocity. The final design resulted in a relatively low delta-t effluent that mixes rapidly with ambient estuarine waters. This design minimizes any possible influence from the effluent on the environment by substantially reducing the area of excess temperature. Model tests also showed that by withdrawing water from the downstream side of Hog Point and discharging it into Cobham Bay upstream, any possible influence of the heated effluent on the downstream James River seed oyster beds would be eliminated.

The success of the design and the accuracy of the model have been verified by extensive field monitoring. The circulating cooling water system was designed, constructed, and operated according to hydraulic model parameters. Model verification field data were collected by VIMS from 1971 through 1975, and included several years of station operation. These field studies indicated that model projections were conservative in that areas of excess temperature were much smaller than predicted. Vepco concluded and the State Water Control Board has recently agreed that, under operating conditions, the thermal plume complies with Virginia water quality standards.

The most important component of this demonstration is Section X which describes the effects, if any, of Surry's thermal discharge upon various components of the aquatic ecosystem. In order to assess these thermal effects, Vepco has conducted and funded extensive studies on various trophic levels. Most of the proof of absence of prior appreciable harm is based upon these recent physical and ecological studies. In addition, the demonstration draws from studies of the James River ranging from water quality, to fishes, to power station effects which have been conducted by a myriad of sponsors for a multitude of reasons.

Field studies commenced in 1969, placing primary emphasis on fish populations and benthic communities. These studies also included fouling organisms, zooplankton and phytoplankton studies continued throughout several years of station operation. Depending on the trophic level under investigation, sample frequency ranged from daily to annually.

The sum total of these studies support two basic conclusions. First, the heated effluent from Surry Power Station has caused no appreciable harm to the aquatic ecosystem. Second, these studies confirm what is already well-known by estuarine ecologists. The oligohaline zone of an estuary is a highly variable, inhospitable environment characterized by its natural instability. Such instability dictates that only a few species from each trophic level are indigenous to this type zone. Other species that may be present in significant numbers, and there are many of these, are temporary inhabitants and are present when environmental conditions are suitable for their well being.

The highest trophic level, the finfish, have not been appreciably harmed by the thermal discharges from Surry Power Station. Communities have remained stable, within natural variability, as evidenced by diversity, evenness, and richness indices and confirmed by both parametric and non-parametric statistical tests. In addition, changes within dominant species, where changes were evident, were examined and determined to be the result of natural and man-made perturbations other than Surry. Also, the thermal plume from Surry was determined not to form a barrier to migratory fishes based on studies of various anadromous species such as blueback herring (*Alosa aestivalis*). During six years of study, fishes of the James River from egg stage through adult, were subjected to a wide variety of environmental insults. Hurricane Agnes flooded the lower estuary with freshwater runoff. Certain species were overfished. Mild as well as extremely cold winters were the rule rather than the exception. Chemicals such as chlorine from sewage treatment plants as well as Kepone resulted in unknown consequences.

As to ichthyoplankton, relatively few eggs and larvae were found because little spawning occurs in the vicinity of Surry. Centers of spawning abundance are known to be well upstream and downstream. VIMS determined that those eggs and larvae present in the area were not being entrained by the thermal plume.

Benthos (including shellfish) and fouling organisms have not been appreciably harmed by the thermal effluent. Rather, studies have served largely to confirm the well-known low diversity and high temporal variability in communities of an estuarine transition zone. Change has occurred, largely in community structure but has not been related to the thermal effluent. Change, however, appears related to natural events such as Hurricane Agnes, depressed salinity levels, elevated wintertime temperatures, and minimum wintertime temperatures. Natural, environmentally induced changes, have overshadowed any response of these communities that may have been due to the power station effluent.

Results of plankton studies by VIMS revealed no appreciable harm from the thermal plume to James River communities of phytoplankton and zooplankton (including egg and larval stages of benthic macroinvertebrates). Natural periodic seasonal shifts in species dominants related to normal reproductive cycles, not Surry produced temperature regimes, were found. A slight modification in community structure during the summer months was found within the discharge canal and in a small area immediately outside of the canal, but not in the balance of the river. It should be noted that, while this was the only seemingly negative effect found in any of the studies related to Surry operations, the effect was due to pumping operations across the peninsula, was not a thermal effect, and did not constitute an impact. In reality, plankton populations in the plume were sometimes diluted when the downstream water was poorer in plankton than the upstream receiving water, and were augmented when the downstream water was richer in plankton or when meroplankton were released into the cooling water canals by natural spawning activity. These were near-field, nonthermal effects that could not be detected in sampling at other stations in the river.

From these studies the following conclusions have been made:

1. These studies demonstrate that there has been, and is likely to be, no appreciable harm to the balanced, indigenous community of shellfish, fish, and wildlife in and on the James River resulting from the thermal discharge from Surry Power Station.

a. Finfish populations have shown natural variability within and between species, sample stations, months, seasons, and years. The increase or decline of any given species has not been the result of the thermal effluent from Surry. A zone of passage has not been impaired to the extent that fish and shellfish species are unable to pass upstream and downstream past the thermal discharge.

b. Benthic organisms, including shellfish, have not displayed a negative response to, or impact from, the Surry thermal effluent.

c. Fouling organisms exhibited seasonal variation patterns that changed from year-to-year in response to natural factors and indicated no appreciable harm from the Surry thermal effluent.

d. Zooplankton populations, while generally low in numbers, showed considerable variability in abundance within and between stations, months, and seasons, as well as depth, tide, and time of day. The zooplankton community in the transition zone was not appreciably affected by the thermal effluent.

e. Phytoplankton populations did not react to the thermal component of the Surry discharge. An infrequently observed pumping effect in the immediate discharge area consisted of augmentation (both species and individuals within species) or reduction depending on the comparative concentration of cells between the intake and discharge. Far-field populations showed no changes due to this non-thermal pumping effect.

f. There has been no harm to threatened or endangered species.

g. Vertebrates other than finfish have not been appreciably harmed by the Surry thermal effluent.

2. Receiving water temperatures, outside the State established mixing zone, comply with thermal water quality standards.

3. The receiving waters are not of such quality that in the presence or absence of the thermal discharge promote the growth of nuisance organisms.

III. DESCRIPTION OF SURRY POWER STATION

A. PHYSICAL LAYOUT

Units 1 and 2 were constructed on a peninsula of land known as Gravel Neck (Fig. 1). This peninsula, generally land of 20+ feet MSL, is adjacent to Hog Island Waterfowl Refuge on the north, and timber lands to the south. Prior to construction, the 840 acre site was used solely for timber operations.

The station, from intake point to discharge point, extends across the peninsula with the discharge situated upstream from the intake, about 6 miles away.

Cooling water is withdrawn from the James River through an eight-bay, reinforced-concrete intake structure (hereinafter called "low-level"). Housed within each of the intake bays is a 210,000 gpm circulating water pump which moves water through a 95-in. diameter line to an elevated intake canal. The canal, maintaining a minimum of 45,000,000 gallons of water, is concrete lined and about 1.7 miles in length.

Cooling water flows by gravity the entire length of the canal (hereinafter called "high-level") into two four-bay intake structures, each structure serving one 810 MWe nuclear unit. After passing through the condensers and station proper, the water from both units, warmed by about 15 F, flows into a common discharge canal, 20-65 feet wide and 2,900 feet long. The end of the canal at the point of exit to the James River is designed to maintain a 6 fps discharge velocity to aid in the rapid mixing of heated water with ambient river water.

B. PERTINENT ENVIRONMENTAL DESIGN CHARACTERISTICS

Certain features of environmental significance were incorporated into the design of the Surry Power Station. Because of the proximity of the station to historical Jamestown Island, the reactor containment foundations were constructed 50 feet below grade so as to lower the tops of the concrete domes and minimize their effect on the skyline as seen from across the river. A blue-green siding for the turbine building was chosen to help to blend the structure into the forest background. The discharge canal, lined with trees, was constructed with an offset angle to minimize the view of the station from the river.

No chlorine is used for condenser cleaning at Surry Power Station. Instead, an Amertap system was installed, utilizing abrasive sponge rubber balls.

A relatively low delta-t of 15 F was designed into the cooling system. This feature, coupled with the 6 fps jet discharge of heated water to the river, reduces the area of excess temperature in the James River proper.

Probably the feature of most significance to the aquatic environment of the James River was the design, construction, installation, and, above all, successful operation of a new concept in vertical travelling intake screens - the Ristroph travelling fish screen. These screens are discussed in detail in Appendix S; briefly, they permit 94% of all impinged fishes to return alive to the James River.

C. CIRCULATING WATER SYSTEM

Surry Power Station utilizes a once-through system to dissipate waste heat from the turbine condensers and plant service water system (Fig. 1). Water is withdrawn from the James River by eight 210,000 gpm pumps in an eight-bay shoreline structure. Ahead of each pump is a standard trash rack (4 inches on center, 1/2 inch thick, 3 1/2 inch clearance). Between each trash rack and pump is a Ristroph travelling fish screen which effectively removes fishes greater than 30 mm total length from the incoming water and safely transports about 94% of them back to the James River.

From the pumps, water travels upward through 95 inch diameter pipes to an elevated, 1.7 mile long canal, whereby it flows by gravity through a second intake structure. This high-level structure has a trash rack assembly similar to the one at the low-level structure, and conventional vertical travelling screens which operate on a pressure differential. Water passes through the 15 F condensers of each unit and into 12.5-ft. by 12.5-ft. rectangular tunnels and then into separate seal-pits in the discharge canal. The canal is 2900 feet in length; 1800 feet is concrete lined and extends from the unit discharges to the river shoreline, and 1100 feet extends out into the river in the form of a limestone rock enclosed groin (Fig. 1).

The velocity of the water flowing through the discharge canal is about 2 fps, however, the terminal discharge velocity is maintained at 6 fps by a control structure at the end of the canal. The time required for water to travel from the low-level shoreline intake structure to the discharge canal exit is about 61 minutes, of which the time of travel from the condenser inlet to the discharge canal exit is about 28 minutes.

In full-power operation, the Surry Power Station discharges 11.9×10^9 Btu/hr into the James River. Dissipation of the thermal plume is dependent on prevailing estuarine and meteorological conditions including, but not limited to: the flow regimes of the estuary, their associated densities and temperatures, wind velocities and direction, ambient air temperatures, and relative humidities.

River topography is also important in determining the manner of heat dissipation. The river in the vicinity is generally shallow with a maintained shipping channel. Directly across from the discharge toward Jamestown Island the river is about 2.6 miles wide. At its narrowest, opposite Hog Point, the river is 1.5 miles wide, and becomes about 3.75 miles wide opposite the low-level intakes.

IV. SURRY POWER STATION OPERATING HISTORY

Surry Unit 1 attained initial criticality July 1, 1972, and was declared commercial December 22, 1972. Unit 2 became critical March 7, 1973, and was declared commercial May 1, 1973. The following Tables (1-4) list net electrical output (MW-hrs) and plant capacities (%) from the time each unit became critical through June 1977.

Surry Power Station utilizes eight (8) circulating water pumps to supply cooling and service water from the James River for the condensers. When all eight (8) circulating water pumps are in operation, the combined flow is 1,680,000 gpm or 210,000 gpm per pump.

Figure 2 indicates current velocities at the low-level intakes. These data were determined utilizing a Bendix Savonius Rotor Current Speed Sensor Model B-1. Replicates were taken surface to bottom at one foot intervals outboard of three (3) intake bays.

The change in temperature (delta-t) of the cooling water when both units are operating at 100% capacity and all systems are functioning, varies between 14.0 and 14.8 F. If both units are operating and a malfunction in the system occurs, eg., loss of a circulating water pump, there may be a subsequent slight increase in the delta-t.

The groin discharge structure was designed to maintain an exit current velocity of approximately 6 fps. This design was established from model studies so that the velocity of the discharge water would permit maximum heat transfer efficiency with ambient river water.

TABLE 1: SURRY POWER STATION - UNIT ONE - NET ELECTRICAL OUTPUT IN MEGAWATT-HOURS

	1972	1973	1974	1975	1976	1977
January		76,582	-0-	-0-	561,212	139,519
February		351,949	-0-	412,497	517,366	456,863
March		345,220	251,119	431,941	376,648	568,732
April		313,633	503,663	462,515	426,326	195,185
May		337,327	478,272	530,894	465,205	308,286
June		266,603	498,838	477,277	527,763	551,480
July	30,252	445,294	326,556	407,891	395,817	
August	-0-	409,375	548,037	487,651	416,802	
September	78,764	284,190	468,107	429,467	422,821	
October	31	159,011	243,481	-0-	286,925	
November	-0-	490,569	-0-	-0-	-0-	
December	206,937	-0-	-0-	276,394	-0-	

TABLE 2: SURRY POWER STATION - UNIT TWO -
NET ELECTRICAL OUTPUT IN MEGAWATT-HOURS

	1972	1973	1974	1975	1976	1977
January			493,276	424,102	387,305	547,338
February			427,329	480,554	371,511	174,425
March		57,436	526,222	514,153	449,305	-0-
April		255,450	229,597	427,911	358,361	349,246
May		147,294	-0-	-0-	-0-	564,584
June		466,755	51,204	216,234	355,272	543,470
July		410,548	401,279	458,372	527,570	
August		450,028	400,622	513,134	505,862	
September		481,628	104,944	497,651	258,516	
October		409,633	-0-	424,714	-0-	
November		223,365	-0-	542,529	-0-	
December		475,475	-0-	553,728	129,619	

TABLE 3: SURRY POWER STATION - UNIT ONE - PLANT CAPACITY %

	1972	1973	1974	1975	1976	1977
January		13.1	-0-	-0-	95.7	23.8
February		66.6	-0-	78.0	94.3	87.7
March		58.9	42.1	73.7	64.2	98.6
April		55.4	88.8	81.5	75.1	35.0
May		57.5	78.2	90.6	79.3	53.5
June		47.0	84.3	84.1	93.0	98.8
July	5.1	76.0	53.4	69.5	67.5	
August	-0-	69.8	93.4	83.2	71.1	
September	13.9	50.1	82.5	75.7	74.5	
October	0.005	27.1	41.5	63.3	48.9	
November	-0-	86.5	52.5	57.6	-0-	
December	44.5	-0-	32.7	47.1	-0-	

$$\text{Plant Capacity} = \frac{\text{Net Elec. Power Generated}}{\text{Cur. Lic. Power Level (788)} \times \text{Gross Hours in Reporting Period}} \times 100$$

TABLE 4: SURRY POWER STATION - UNIT TWO - PLANT CAPACITY %

	1972	1973	1974	1975	1976	1977
January			87.7	72.3	66.0	93.4
February			78.9	90.7	67.7	33.5
March		9.8	87.8	87.7	76.6	0
April		45.1	38.8	75.4	63.2	62.7
May		25.1	56.2	64.7	0	97.9
June		82.2	8.6	38.1	62.6	97.4
July		70.0	65.6	78.2	90.0	
August		76.8	68.3	87.5	86.3	
September		84.9	18.5	87.7	45.6	
October		69.8	45.8	72.4	0	
November		39.3	41.7	95.6	0	
December		81.1	38.2	94.4	22.1	

$$\text{Plant Capacity} = \frac{\text{Net Electric Power Generated}}{\text{Cur. Lic. Power Level (788)} \times \text{Gross Hours in Reporting Period}} \times 100$$

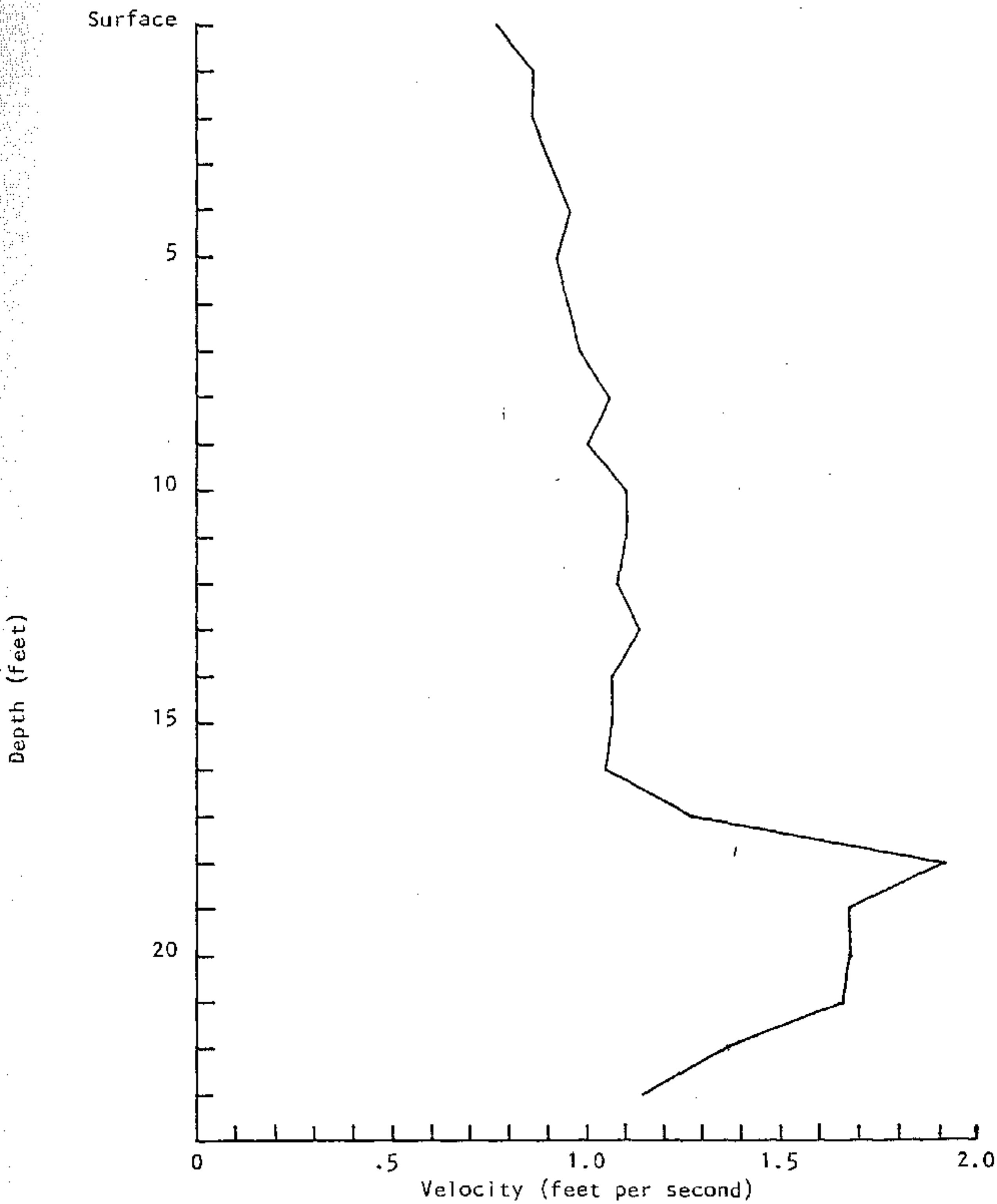


FIGURE 2: Typical Intake Current Velocity

V. DESCRIPTION OF THE TIDAL JAMES RIVER AND TRANSITION ZONE

A. HYDROLOGY

The James River is tidal from its mouth at Fort Wool to its fall line at Richmond. Upstream from the site at Surry, the James is fed by a drainage area of 9517 square miles. Freshwater inflow from this watershed is highly variable, ranging from a mean monthly average low of 350 cfs in October, 1930, to a mean monthly average high of 36,185 cfs in January, 1937. Hurricane Agnes in June, 1972 caused the flood of record in the James River with a flow of 313,000 cfs.

The tidal James River is classified as a partially mixed estuary where salinity decreases in a more or less regular manner from the mouth toward the transition zone, and also increases with depth at any location.

The less saline upper part of the water column has a net non-tidal motion directed toward the mouth of the James, while the more saline deeper part has a net non-tidal motion directed upstream. The boundary between the layers is generally sloped across the estuary so that the downstream moving surface layer extends to greater depths on the right side (looking downstream) than on the left. Conditions can exist whereby a net downstream flow on the right side of the estuary coexists with a net upstream flow on the left side.

Basically this means that the net non-tidal flow involves volumes of water that are large when compared to river flow, but small compared to oscillatory tidal flow. For example, in July, 1950, the fresh water discharge at Hog Point was about 6,000 cfs, the downstream directed flow in the surface layers was 18,000 cfs, and a counter-flow upstream in the deeper layers was about 12,000 cfs. By comparison, the average volume rate of flow (upriver during flood tide, downriver during ebb tide) was about 130,000 cfs during this time.

Flow records for the James River have been maintained for many years at the farthest downstream gaging station on the main stem at Richmond (Fig. 3). Using these records and records from major tributary streams downstream from Richmond, fresh water inflows at Hog Point have been calculated. It should be noted that the mean travel time for a flow of 14,000 cfs from Richmond to Hog Point is in excess of 20 days. This results in a relatively slow reaction time of the estuary at Hog Point to rapid fluctuations in flow at Richmond. The effects of rapid changes at Richmond are dampened considerably by the time the water reaches Hog Point.

The astronomical tide in the James River estuary, as along the Atlantic coastline of the United States, is primarily semi-diurnal with two high and two low waters each lunar day of 24.84 hours. Mean tide level at Hog Point (based on a datum plane of mean low water) is +1.0 foot. Mean tidal range is 2.1 feet and the mean spring tidal range is 2.5 feet.

At Hog Point the ebb current is longer and stronger than the flood current. The average maximum ebb current is 2.2 ft. sec^{-1} (1.3 knots) while the average maximum flood current is 1.9 ft. sec^{-1} (1.1 knots). Spring tides have maximum ebb currents of 3.2 ft. sec^{-1} (1.9 knots) and maximum flood currents of 2.8 ft. sec^{-1} (1.6 knots). Current ebbs for 7 hours 5 minutes and floods for 5 hours 20 minutes during a typical tidal period of 12 hours 25 minutes. Since these figures are based on near surface observations, it should be noted that the predominance of ebb over flood decreases with decreasing river discharge and often depth.

The salinity structure in the James River has been studied almost every year since 1942. Hog Point has been established to be in the transition region between the tidal river and the estuary proper. Areas upstream and

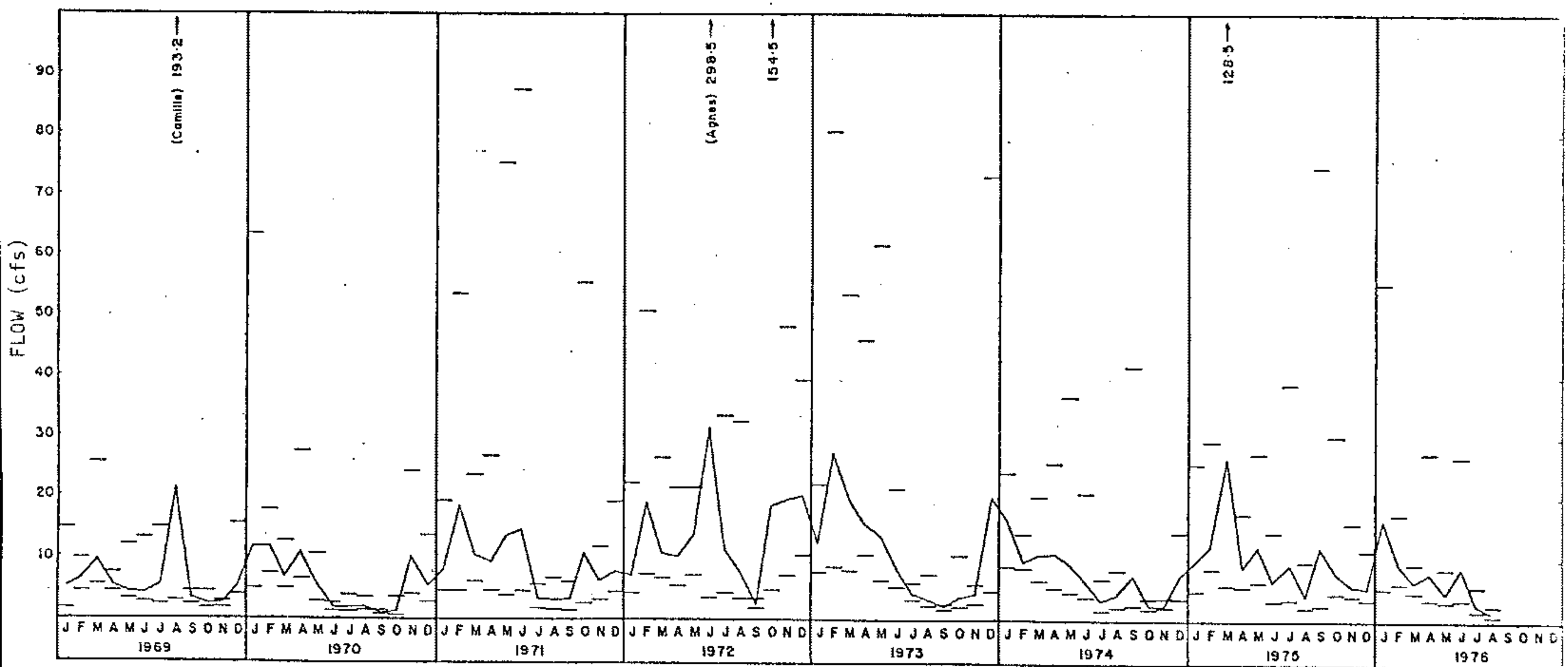


FIGURE 3: Flow records of the James River at Richmond (1970-1976) showing monthly maxima, minima, and averages.

downstream from Hog Point are subject to a wide range of salt concentrations, primarily depending on freshwater river flow. Above 10,000 cfs, the freshwater/saltwater interface moves downstream of Hog Point. At median river flows of about 7,500 to 8,000 cfs, salinity readings off Hog Point are about 2 ppt.

High discharge rates in the James River occur generally in the colder months with low flows occurring generally in late summer and early fall.

For a more detailed description of the hydrology of the James River estuary see Appendix C from which much of the foregoing summary has been drawn.

B. METEOROLOGY

The Surry Power Station is located in a humid subtropical climate which has warm humid summers and mild winters. Tropical maritime air dominates the area during the summer months while the winter season is dominated by a transition zone separating polar continental and tropical maritime air masses. The site's close proximity to the Atlantic Ocean, Chesapeake Bay, and the Appalachian Mountains results in these geographic features influencing the local climate in the Surry area. The Atlantic Ocean and the Chesapeake Bay have a moderating effect on the ambient temperature at Surry. The Appalachian Mountains either deflect or modify winter storms approaching from the West and Northwest and, thereby, decrease the storms' severity for the Piedmont and Tidewater areas of Virginia.

The onsite meteorology has been monitored since March, 1974 by a mini-computer based system which satisfies the requirements of Regulatory Guide 1.23. The meteorological monitoring site is located 1494 meters to the southeast of Unit 1. The system includes a 45.7 meter tower. Dry bulb temperature, dew point temperature, wind speed, and wind direction are measured at the 10 meter level. Wind speed and wind direction are measured at the 45.7 meter level. Differential dry bulb temperature is measured between the 10 meter level and the 45.7 meter level. Precipitation is measured at the surface. The data are processed into one hour averages for historical storage.

Joint frequency distributions of wind speed and wind direction for the wind sensors at the 10 m and the 45.7 m levels for the period March, 1974 through February, 1977 are presented in Appendix B. A summary of the maximum one hour averaged wind speeds and their associated wind directions for the 10 m and the 45.7 m wind sensors for the period March, 1974 through February, 1977 is also presented in Appendix B. The data show that the prevailing wind direction is from the S through SW with a secondary maximum from the NW through N. This is in good agreement with climatological wind direction data for eastern Virginia.

Dry bulb temperature, dew point temperature, and differential dry bulb temperature data are presented in Appendix B for the period March, 1974 through February, 1977. The average daily value, maximum one hour value, and minimum one hour value are given for each parameter. Additionally, an hourly profile of the average parameter day for each summary period is presented. The Surry dry bulb temperature data indicate an annual average of 59.9 F and 57.8 F for 1975 and 1976 which agrees very well with the average annual temperatures for Richmond (58.5 F and 57.7 F) and Norfolk (60.8 F and 59.7 F) for the same periods.

The Surry average annual dew point temperatures of 50.6 F and 45.1 F for 1975 and 1976 compare favorably with estimated average annual dew point temperatures for Richmond (50 F and 47 F) and Norfolk (52 F and 48 F). The one hour averaged dew point temperature extremes are 78.9 F (August, 1975) and -4.5 F (January, 1977).

The onsite precipitation data are also given in Appendix B. The maximum 1, 6, 12, 18, and 24 hour precipitation amounts and the total precipitation are given for each month during the period March, 1974 through February, 1977. The monthly total precipitation data for Surry are also given. The Surry annual precipitation amounts for 1975 and 1976 are 59.07 in. and 32.66 in. These amounts compare very well with the precipitation totals for Richmond (61.31 in. and 34.76 in.) and Norfolk (50.53 in. and 32.36 in.) for the same periods.

Based upon the onsite wind speed, wind direction, dry bulb temperature, and dew point temperature data observed at Surry for the period March, 1974 through February, 1977, there are no significant deviations in the onsite meteorology from the general meteorological conditions experienced by eastern Virginia for the same period.

C. WATER QUALITY

1. Chemistry

The James River is the most heavily industrialized and urbanized of Virginia's major tributaries to Chesapeake Bay. In addition to receiving substantial artificial enrichment from forest and agricultural sources, the tidal river receives heavy organic and inorganic loadings from both the metropolitan Richmond and the industrialized Hopewell areas.

Levels of dissolved oxygen in the James River estuary, as in other estuarine systems, are determined largely by temperature and salinity influenced solubility coefficients. In addition, man-made or natural organic loadings which create an oxygen demand exceeding reaeration rates also influence this coefficient. Lower portions of estuaries generally range between 90 and 100 percent saturation, while upper reaches frequently fall below 90 percent due to marsh drainage and industrial wastes. In the James River, reaeration generally occurs between the transition zone and the 5 ppt isohaline and "critical" levels have not been measured around Hog Point.

Values for pH levels show that the James River estuarine and tidal fresh water is slightly alkaline with mean values of 7.4-8.0 (Appendix D). An occasional value as low as 6.8 has been recorded in the freshwater reach which has been attributed to marsh drainage water. Biological activity or minor influences by man seldom cause significant changes in pH levels. In general, mean pH values tend to decrease from the mouth upstream to the fall line although the range of values becomes wider upstream with decreasing salinity.

Alkalinity values tend to show differences with decreasing salinity in the James River because the freshwater discharge in this system is poorly buffered. Mean values range from 1.50 $meq \cdot l^{-1}$ (1.26-1.71) at the 20 ppt isohaline to 0.69 $meq \cdot l^{-1}$ (0.41-1.18) at the 0 ppt isohaline.

Phytoplankton productivity in natural waters depends largely on the primary nutrients nitrogen and phosphorus. Added to trace substances these elements are discharged in large amounts into estuarine waters through runoff from farmland, sewage treatment facilities, detergents, and certain industrial activities.

Total nitrogen levels in the tidal James River are generally indicative of upstream loadings. While nitrate plus nitrite values tend to remain constant within the system at any given time, soluble organic nitrogen and particulate organic nitrogen levels varied with freshwater discharge.

Phosphorus levels are generally related to loadings from artificial sources, especially sources in Richmond and Hopewell. During the summer and fall months, the highest soluble phosphorus levels tend to be found near the mouth of the James River indicating that this form is coming from lower Chesapeake Bay or the Atlantic Ocean. Wintertime and springtime values show that total particulate phosphorus was the dominant form and these levels were generally related to high freshwater discharges during these seasons.

2. Salinity

The James River is tidally influenced from its mouth at Ft. Wool in Hampton Roads upstream to the fall line at Richmond, about 90 nautical miles. In times of low freshwater inflow, measurable ocean-derived salt water can be found as far upstream as Hopewell, although the upstream limit at median river flows is generally between Jamestown Island and the Chickahominy River. When river discharges are greater than 14,000 cfs, the boundary between the fresh water tidal river and the estuary proper is downstream from Deep Water Shoals. Thus, salinities exceeding 0.5 ppt occur off the downstream intakes about 75% of the time while the upriver limit of salt intrusion extends above the upstream discharge point more than 50% of the time.

According to data appearing in Appendix C , the following salinity ranges have been observed in the vicinity of Surry Power Station:

Off intakes: Surface - 0.0 to 16.95 ppt.
at 25 ft. - 0.0 to 21.13 ppt.

Off Hog Point: Surface - 0.0 to 12.20 ppt.
at 20 ft. - 0.0 to 14.20 ppt.

Off discharge: Surface - 0.0 to 9.19 ppt.
at 20 ft. - 0.0 to 11.16 ppt.

While these ranges were observed from 1942 through 1965, the upper limits recorded have not been measured from 1969 through 1976, the time period for Surry preoperational and operational studies (Fig. 4).

For a more detailed description of the salinity structure of the James River estuary, see Appendices C and D.

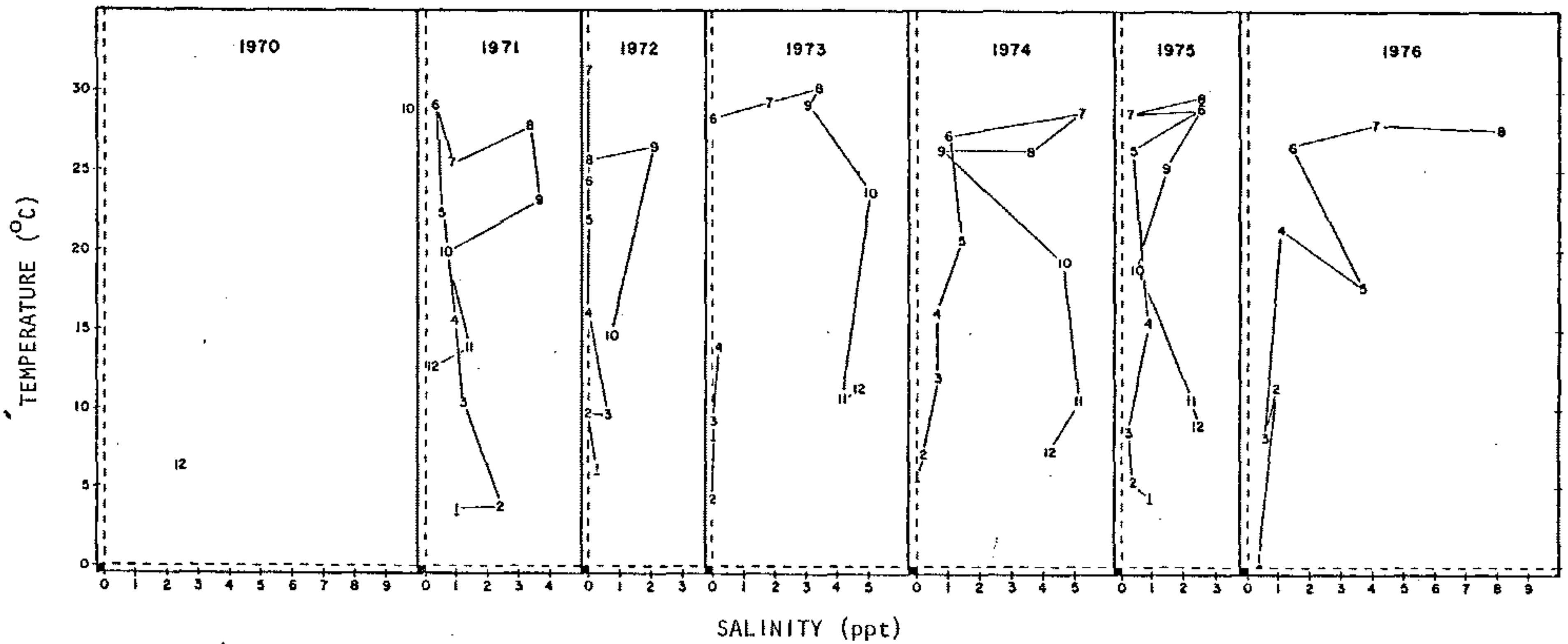


FIGURE 4: Temperature-salinity hydroclimographs showing average conditions for seven seine stations around Hog Point, James River, Virginia by month by year, 1970-1976.

3. Temperature

As with salinity, the temperature structure of the James River has been studied in detail since 1942. Surface water temperatures historically have closely followed the mean daily air temperature, except for a slight lag in the spring when air temperatures rise rapidly, and in the fall when they cool rapidly. Temperature-salinity hydroclimographs are presented in Figure 4.

Prior to station operation, the maximum surface water temperature measured in the area was 33.8C (92.8F) while the minimum was 0.0C (32F) when this stretch of the river iced over in 1969. While the majority of summer surface water temperatures fall in the range of 26-28C (78.8-82.4F), temperatures exceeding 30C (86F) are commonly found.

During the spring and summer water temperatures generally decrease with depth. A vertical gradient of about 4C is present over 20 feet of depth in the spring while the gradient is about 1-2C in the summer. In the fall, the temperature is approximately isothermal with wintertime temperatures increasing slightly with depth.

It should be noted that because surface water temperatures closely track air temperatures, differences in surface water temperature patterns between years and between months of successive years can be considerable. A prolonged season such as winter can result in an "out-of-phase" spring or even an abbreviated spring if summer air temperatures occur on schedule. A prolonged winter can, for example, result in an increasing day-length occurring with cool water whereby water temperatures would "normally" be increasing along with day-length. These situations can adversely influence the normal biological processes of many species.

Minimum water temperatures can occur in December, January, February, or March while maxima can occur in July, August, or September.

More detail on the temperature structure of the James River before Surry Power Station operation can be found in Appendices C and D.

VI. HISTORICAL ECOLOGY OF THE TIDAL JAMES RIVER AND TRANSITION ZONE

Aquatic populations of the James River have been studied for many years and a bibliography of these studies has been compiled by Virginia Institute of Marine Science (Appendix A). Generally, many of the investigations have examined the tidal James from its mouth at Fort Wool to the fall line at Richmond. Reference to the oligohaline or transition zone, where Surry Power Station is situated, is contained in these publications.

The following brief synopsis is a general characterization of the tidal James River taken from these many publications, with emphasis on the transition zone at Surry.

A. FINFISH

The tidal James River supports a wide diversity of finfish species ranging from exclusively marine forms near the mouth to exclusively freshwater riverine forms at the fall line in Richmond. Also present at various life stages, depending on the season, are both anadromous and catadromous species. Extensive commercial and sport fisheries exist within the tidal James although the activities of both have been severely curtailed in recent years due to chemical contamination of the basin waters.

Limited localized surveys of the James River fish fauna have been conducted for many years. However, no systematic survey of the entire basin has ever been attempted. The Virginia Institute of Marine Science (VIMS), through its anadromous fish program and winter trawl survey, has probably been the most instrumental in characterizing the fishes of the tidal James River. Vepco has characterized the faunas of the upper tidal James and the transition zone. About 80 species have been taken in the transition zone and 40 in the upper tidal river.

Population densities for any given species will vary by several orders of magnitude depending on the season of the year and the location within the basin where such a determination was made. Variation of a similar magnitude also occurs between years. Long-term studies have shown that probably the most numerous estuarine species on an annual basis tend to be the indigenous forage forms such as the bay anchovy, Anchoa mitchilli, and silverside, Menidia spp., as well as nondescript forms such as the hogchoker, Trinectes maculatus.

The tidal James River contains meroplanktonic forms from marine, estuarine, freshwater, anadromous, and catadromous fish species that spend all or part of their life cycles in these waters. Few fish eggs, however, are found in the vicinity of Surry Power Station because the true estuarine species generally spawn at salinities higher than 5 ppt, while the freshwater and anadromous forms spawn upriver from the 0.5 ppt isohaline. Salinities in the vicinity of Surry are usually between these values but can vary between 0 ppt and about 15 ppt.

Larval stages of several species, transported largely by tidal action, are found in the transition zone. Some species, especially marine and estuarine, use this zone as a nursery. Among the more notable are postlarvae of the Atlantic croaker, Micropogon undulatus and the Atlantic menhaden, Brevoortia tyrannus.

The tidal James River has been the site of several large fish kills over the last several decades. Despite these kills, the resiliency of the system has been shown as affected populations have tended to recover, some more quickly than others. Fish diversity in the tidal basin has remained relatively stable.

More detailed analyses of historical fish populations in the tidal James River appear in Appendices A and E.

B. BENTHOS

Bottom dwelling species are found in the James River estuary from the mouth to the fall line. Variation is considerable, changes occurring not only with longitudinal distance upstream (Fig. 5), but with sediment type and depth within an area as well.

Shellfish, from the transition zone downstream form the bulk of the benthic biomass encountered in the James River estuary. The brackish water clam, *Rangia cuneata*, dominates from fresh water to about 5 ppt salinity. The American oyster, *Crassostrea virginica*, occurs from about 5 ppt to about 20 ppt, while the hard clam, *Mercenaria mercenaria*, occurs extensively in higher saline parts of the lower estuary. In relatively recent times the Asiatic clam, *Corbicula* sp., has been found in the freshwater James in ever increasing numbers. The blue crab, *Callinectes sapidus*, occurs sporadically in the transition zone, with population concentrations downstream in more saline waters. Commercial quantities of penaeid shrimp are not present within Chesapeake Bay.

The diversity of benthic taxa is minimal in the transition zone, increasing maximally toward seawater and moderately upriver to freshwater. This distribution is not the result of a single environmental variable such as the oft-studied parameter salinity, but results from a combination of physical, chemical, and biological gradients which influence the genotypic physiological behavior and tolerance of all species from all sources. These variables collectively may limit the distribution of a species to a much greater extent than could be determined through laboratory experimentation on single factors. The ionic composition of the water *per se*, however, probably exerts the greatest influence on the distribution of benthic organisms.

More specific details on estuarine benthos in general and James River benthos in particular may be found in Appendices F and G.

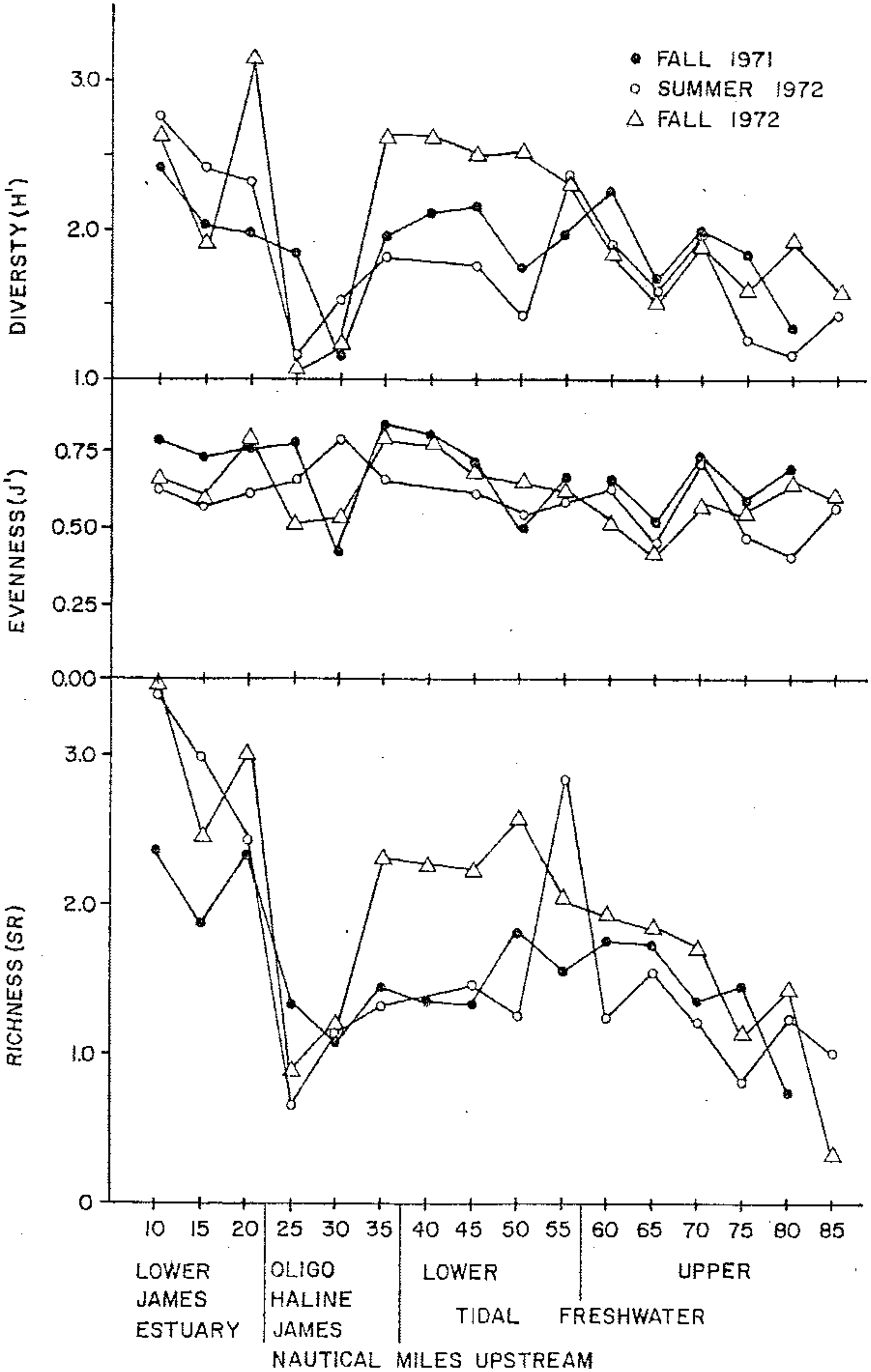


FIGURE 5: Mean benthic community structure measurements by transect. (from Appendix G)

C. FOULING ORGANISMS

One component of the infauna of benthic organisms that is usually highly visible but often little studied are the fouling organisms. These organisms in estuaries are commonly composed of barnacles (Balanus spp.), hydroids, tube-secreting worms, and sea squirts.

Diversity in the transition zone is generally low due to the salinity gradient experienced over time while numbers within a given species may be relatively high (Appendices G and H).

D. ZOOPLANKTON

Historically, zooplankton abundance and composition in the James River has been closely related to phytoplankton abundance and turbidity levels. The fresh water component of the James River estuary supports relatively large populations of cyclopoid and calanoid copepods, however, the heavy organic load results in cladocerans being a common part of the zooplankton community. The estuarine component is volumetrically abundant but relatively limited as to the number of species. Reasons for this phenomena include a salinity gradient compartmentilization of species.

Whether the salinity is reduced going upstream or the salinity manifests itself going downstream from fresh water, there is an area where the most tolerant species of both environments coexist, the transition zone. At Surry, seasonal pulses are evident in both forms dependent, in part, on the salinity regime present at the time, as well as the prevailing temperature and turbidity levels. In addition to salinity zonation, temperature zonation is also known to occur.

Meroplankton includes those forms having a temporary planktonic stage (eggs, larvae, etc.) in their life cycle. Included are temporary planktonic stages of true benthic organisms and other invertebrates such as the blue crab, Callinectes sapidus, as well as fish eggs and larvae discussed previously.

Few egg stages are found in the vicinity of Surry Power Station. Such a phenomenon occurs because the true estuarine forms generally spawn at salinities higher than 5 ppt, while the freshwater and anadromous forms spawn upriver from the 0.5 ppt isohaline. Freshwater inflow and tidal action, however, result in limited numbers of both forms present in the transition zone.

Larval stages of several species, transported by tidal action, are found in the transition zone. Other species, such as the indigenous brackish water clam, *Rangia cuneata,* spawn in the transition zone with egg and larval stages tending to cluster within the zone of salinity tolerance.

The zooplankton fauna in the transition zone is usually dominated by copepod nauplii with occasional pulses of other forms. More detailed species information may be found in Appendices A and I.

E. PHYTOPLANKTON

The James River estuary, while probably the most highly enriched of Virginia's estuaries, is also one of the most turbid. High turbidity levels tend to reduce light penetration and hence phytoplankton populations; a condition usually found in the James.

The James contains both downriver saline and upriver freshwater species of phytoplankton with the transition zone around Hog Point having a mixture of the two. Standing crop, as determined by chlorophyll "a" determinations, will vary significantly at any given point in the estuary both within and between seasons, within and between years, and within and between stations. In the oligohaline zone it is not uncommon to find the fauna dominated by one or two species particularly well suited to existing environmental conditions.

The study area of the James is usually dominated by diatoms and cryptophytes with representatives from both freshwater and estuarine environments present. Primary productivity values, whether by $mgC/hr/m^3$ or by $\mu g^{-1} l^{-1}$, are extremely low in this zone.

Species lists appear in Appendices A and I. Individual species will be discussed in more detail in Section X-E of this demonstration.

F. THREATENED AND ENDANGERED SPECIES

The following species are listed as endangered (E) or threatened (T) by the U. S. Fish and Wildlife Service* as possibly occurring on or near the Surry Nuclear Power Station site.

Fish

Acipenser brevirostrum	shortnose sturgeon	(E)

Birds

Haliaectus l. leucocephalus	southern bald eagle	(E)
Falco peregrinus anatum	American peregrine falcon	(E)
Falco peregrinus tundris	Arctic peregrine falcon	(E)
Pelecanus occidentalis	brown pelican	(E)
Dondrocopus borealis	red-cockaded woodpecker	(E)
Dendroica kirtlandi	Kirtlands warbler	(E)

Only the southern bald eagle and American peregrine falcon are likely to have resident individuals during any given season of the year. All others would probably occur, if at all, only as migrants through the area.

* Federal Register, Wednesday, October 27, 1976, Vol. 41, No. 208, pp. 47181-47197.

G. VERTEBRATES OTHER THAN FINFISH

The only category of vertebrates coming under the jurisdiction of this classification that would be reasonably close to the thermal discharge at Surry would be waterfowl. Eastern Virginia lies within a major duck and goose migration route. Consequently, directly to the north of Surry Power Station, on Hog Island, the Commonwealth of Virginia owns and operates a waterfowl refuge that is annually visited by thousands of ducks and Canada geese. The refuge consists of many freshwater ponds as well as fields that are planted each year with waterfowl food.

VII. HISTORY OF THERMAL AND ECOLOGICAL STUDIES AROUND SURRY POWER STATION

Historically, the James River and its ecology have been under investigation for many years and a list of these studies has been compiled in an inclusive bibliography by VIMS (Appendix A). Although the majority of these studies were conducted under Federal, State or University sponsorship, private industry such as Vepco has also contributed extensively to knowledge concerning the James River (Appendices J and K).

Studies conducted and/or funded by Vepco with the Virginia Institute of Marine Science (VIMS) were initiated in 1969. These studies, designed to assess ecological consequences of operation of a nuclear generating facility on the oligohaline zone of the James River, include the following trophic levels or areas of interest: finfish, benthos, primary productivity, zooplankton, phytoplankton, and fouling plate communities. In addition, extensive model and field studies on thermal plume configuration have been conducted.

Studies related to an assessment of the aquatic ecosystem as influenced by the thermal plume were divided into three categories -- thermal plume model studies, field studies and laboratory investigations.

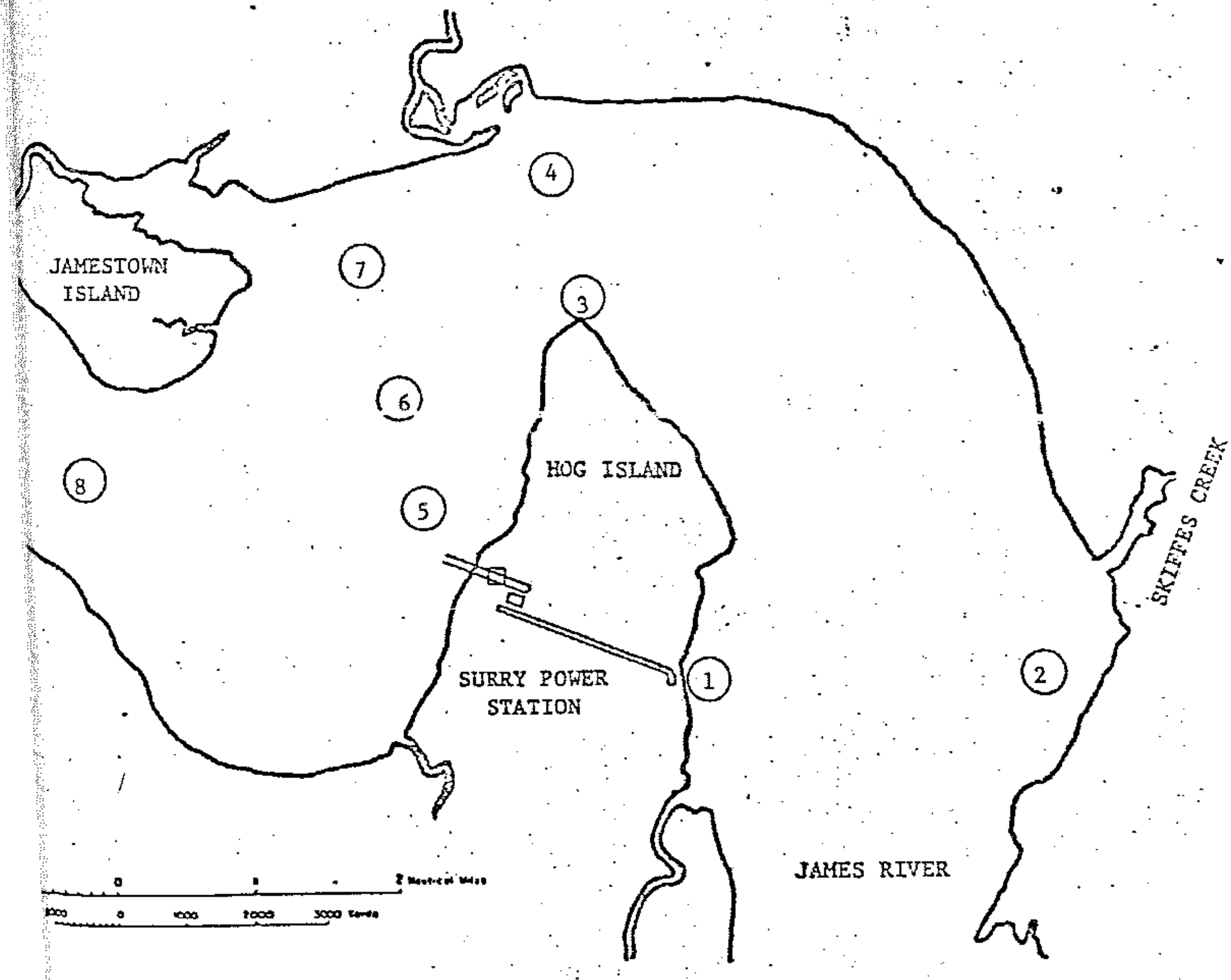
A. THERMAL MODEL STUDIES AND FIELD VERIFICATION

During the design phase of Surry Power Station, Vepco and its consultant (Pritchard-Carpenter, Consultants) employed the hydraulic model of the James River estuary at the U. S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi, to determine the best design features and location of the circulating water system (Appendix L). The results were incorporated into the design of the station and later checked by field studies when the station became operational.

A thermal monitoring system was designed and employed by VIMS and Vepco in order to better determine the region of the James River estuary which would be affected by the discharge of the Surry Power Station as well as to better determine the temperature distribution within that area. Three different measurement systems were utilized: (1) multi-sensor system located on a small boat serving as a mobile measurement platform, (2) multi-sensor system located on towers in the James River which served as fixed instrument platforms (Fig. 6), and (3) infra-red sensor scanning system located in a plane.

Two years of background data were obtained prior to Units 1 and 2 becoming operational. These data and the subsequent three years of data collected after the plant went operational are described in detail in Appendix M.

FIGURE 6: TEMPERATURE MONITORING RECORDERS - JAMES RIVER IN VICINITY OF HOG POINT



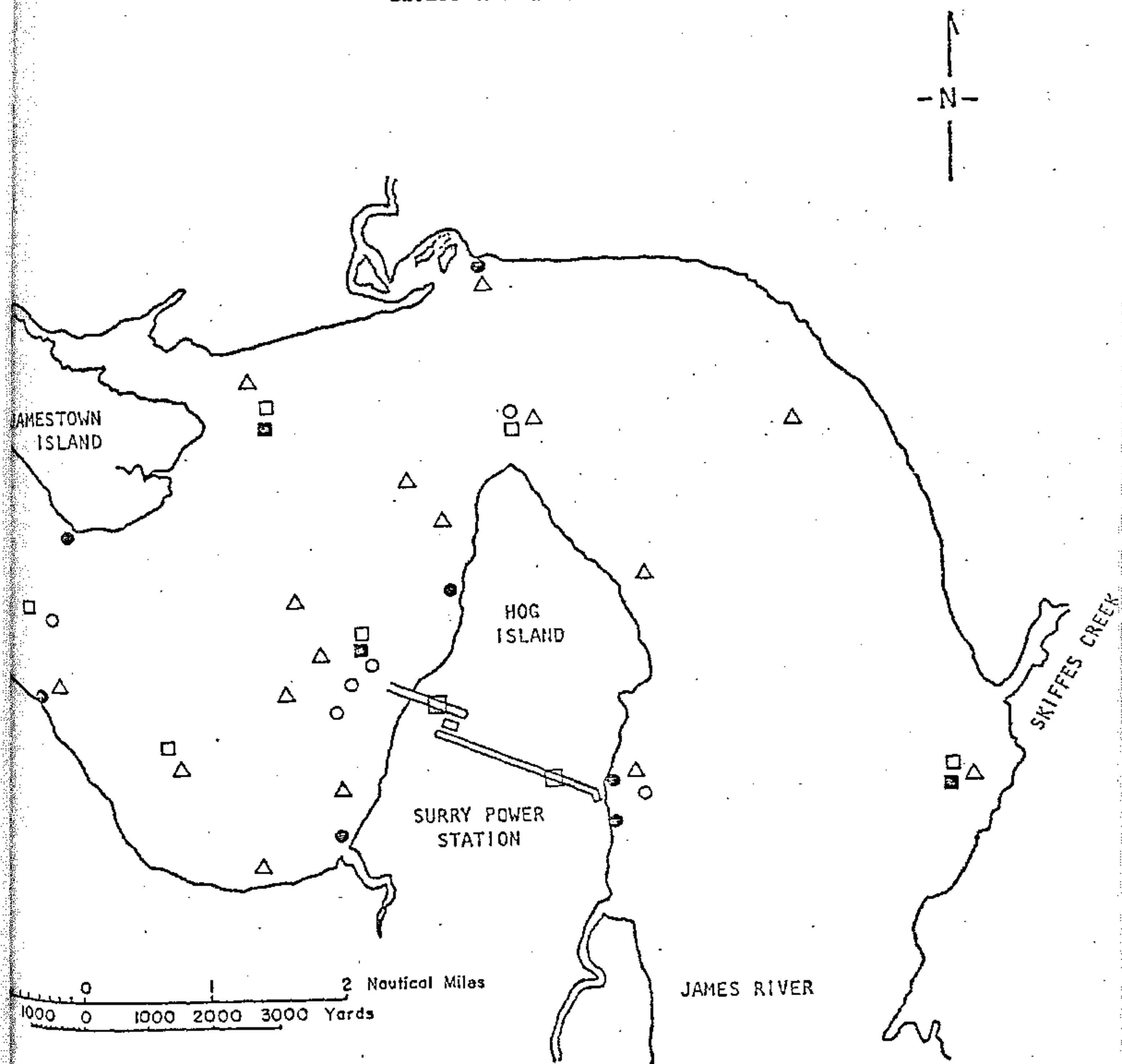
Legend

1. Station Intakes
2. Deepwater Shoals
3. Hog Point South
4. Hog Point North
5. Cobham Bay South
6. Cobham Bay Middle
7. Cobham Bay North
8. Jamestown Island

B. ECOLOGICAL FIELD STUDIES

Field studies designed specifically to characterize the biota in the Hog Point region of the James River were originated in May, 1969 by VIMS and by Vepco in 1970. The field work placed primary emphasis on fish populations and benthic communities but also included studies on phytoplankton, zooplankton, and fouling organisms. Figure 7 locates the sampling stations for various components of the Surry Power Station ecological studies.

BIOLOGICAL SAMPLE STATIONS



○ Trawl (Nekton)
● Seine (Nekton)
□ Plankton
▣ Fouling Plates
△ Benthos

FIGURE 7: Sample station locations for various components of the Surry Power Station ecological studies.

1. Finfish

A program by Vepco personnel was begun in May, 1970, to identify finfish populations in the shallow water oligohaline zone of the James River near the Surry Power Station. The program's purpose was to obtain baseline data prior to the facility becoming operational. Collections were taken monthly by beach seine and by otter trawl at thirteen locations. In addition, fish populations have been sampled by VIMS Ichthyological Department on a monthly basis at four locations in the James River near Surry since 1964. These data collectively provided a sound data base to which similar post-operative study results could be compared (Appendices N, O, and E).

The postoperative studies were intensified to have a better understanding of the composition and changes of the fish populations at Surry. In addition to the haul seine and otter trawl samples, the circulating water intake screens were employed as a biological sampling gear type during this study. The circulating water intake screen system was sampled, usually five days per week, from July, 1972 through August, 1976 (Appendix O).

2. Benthos

Studies began in May, 1969, to quantitatively and qualitatively describe the benthic organisms found in the James River adjacent to the Surry Power Station. Samples were gathered quarterly with the exception of the summer months when samples were collected monthly. Two replicates were collected with a 0.07 m^2 Van Veen grab, washed through a 1 mm screen and preserved. Selection of the sixteen stations generally was based on the sediment type found at each station as well as on the areas most likely to be influenced by the thermal discharge. A large number of these stations were, therefore, concentrated in Cobham Bay, however, some were selected in areas not likely to be affected by the effluent (Appendices H and P).

3. Fouling Organisms

Fouling organism studies have been conducted at three river towers, Cobham Bay North, Cobham Bay South and Deep Water Shoals (Fig. 6), since 1971. The studies involved suspending two pairs of 125 x 75 mm asbestos plates one meter above the bottom at each of the towers, one pair being replaced monthly and the other on a yearly schedule. Scheduled plate removal and replacement have yielded data on the fouling community in this area (Appendix H).

4. Zooplankton

Surface zooplankton samples have been taken with a No. 20 mesh Clarke-Bumpass plankton sampler on a monthly schedule since November, 1972. Tow duration ranged from one minute to five minutes, depending on the turbidity conditions encountered. Samples were preserved and counts and identifications made using a dissecting microscope. Seven river stations were sampled in 1972-1974, increasing to twelve stations in 1975, while ten stations were sampled in 1976 (Appendices H and P).

5. Phytoplankton

Phytoplankton samples were taken monthly at seven river stations and in the intake and discharge canals in 1973 and 1974, and continued at six stations in 1975 and ten stations in 1976. A non-metallic 2-liter Van Dorn bottle was used for the collection. These samples were preserved with Lugols' iodine solution, and total cell counts and identification of dominant organisms were made using the inverted microscope method. These stations were also sampled and analyzed qualitatively in the second half of 1972. Monthly phytoplankton studies are continuing at ten stations. Chlorophyll $\overline{a}$ measurements were taken from July, 1972 through December, 1973 and again in 1975 and 1976. Primary productivity measurements have been taken at three stations monthly between May, 1971 and April, 1972. This program was continued in 1975. A modified C-14 procedure was utilized at river towers Cobham Bay North (CBN), Cobham Bay South (CBS) and at the intake canal (Fig. 6), (Appendices H and P).

C. ECOLOGICAL LABORATORY INVESTIGATIONS

Diaz (1972) studied the effects of thermal shock on growth, mortality and setting success of oyster larvae, Crassostrea virginica. Another study researched the reproductive cycle and larval tolerance of the brackish water clam, Rangia cuneata in the James River (Cain, 1972). Dressel (1971) examined the effects of thermal shock and chlorine exposure on the estuarine copepod, Acartia tonsa. Details of these studies are presented in Appendix I.

VIII. ANALYSIS OF SURRY STUDIES BY OAK RIDGE NATIONAL LABORATORY

The Oak Ridge National Laboratory, acting under contract with the Nuclear Regulatory Commission, reviewed the physical and biological data collected under the NRC Technical Specification requirements and published two reports authored by Adams, et al. on its evaluation of the non-radiological environmental technical specifications. The first, ORNL/NUREG/TM-69, Vol. 1, compared the quality of the studies conducted at eight nuclear powered generating facilities. The Surry studies received an overall ranking of 2, only behind Peach Bottom, a station located on a riverine impoundment. The authors acknowledged the quality of study data despite the complexity and dynamics of the tidal system at Surry.

A second report, ORNL/NUREG/TM-70, (Vol. 2 of ORNL/NUREG/TM-69), covered only the studies conducted over a three-year period at Surry.

The authors concluded that the data indicated that the thermal discharges were enhancing the nektonic (fish) and benthic populations in the discharge area, but were having a negative effect on the phytoplankton and zooplankton in the discharge area. However, they did not address the materiality of their interpretation of negative effects on phytoplankton and zooplankton, except insofar as their conclusions implicitly recognized that any such effects have not adversely affected nektonic or benthic populations.

The conclusions relating to adverse impacts were strongly challenged by aquatic scientists of the Virginia Institute of Marine Science and the Virginia Electric and Power Company. The Institute and the Company immediately requested the Oak Ridge National Laboratory to recall the publication and correct the erroneous data analyses that led to the conclusions. The Oak Ridge National Laboratory has not responded to the request.

The fish and benthic data reviewed by the authors were very straight-forward, and persons with minimal knowledge and experience in estuarine systems could only conclude that the thermal discharges were not adversely affecting the populations. The oligohaline-freshwater reach of an estuary is a very complex environment for phytoplankton and zooplankton, however, and the authors completely misinterpreted the data in arriving at their conclusions.

The authors major interpretive error resulted from their complete disregard for salinity differences that occur in an oligohaline reach of an estuary both within and between years. Salinity changes may also be associated with turbidity levels in this reach because high freshwater runoff which depresses salinity also carries high levels of suspended solids. Nektonic and benthic populations that are found in the area are much better adapted to cope with fluctuations in salinity and turbidity than are phyto- and zooplankton populations.

Dr. Robert A. Jordan, Associate Marine Scientist, Virginia Institute of Marine Science, was the scientist in charge of the phytoplankton and zooplankton studies. Dr. Jordan reviewed the Oak Ridge National Laboratory Report and submitted a critical review to the authors in support of the request to recall the publication.

Dr. Jordan pointed out that, "most of the data analyses performed by Adams, et al. in the sections listed above failed to support their conclusions, because the analyses either were fundamentally improper or were inaccurately done."

Dr. Jordan went on to say, "Consequently the statements made by Adams, et al. concerning the ecological impact of the Surry Power Plant are unjustified."

Adams, et al. concluded that the 1974 data suggested inhibition of phytoplankton production in the discharge area. Dr. Jordan replied, " . . . the 1974 control means lie within the discharge confidence limits for eleven of the twelve sampling dates. The control values and the discharge means were very close for the warm summer months of July, August, and September. There is certainly no statistical evidence for inhibition of phytoplankton production."

Adams, et al. contended that zooplankton densities at the control station were generally higher than those in the discharge area. Dr. Jordan's statistical analysis of the data for 1975 indicated that only two t values were significant, the value for May when the discharge mean was significantly higher than the mean for the control station and the value for July when the control mean was higher. He concluded, "These test results certainly do not support the author's statement."

The Conclusion section of Dr. Jordan's critical review follows:

> "The deficiencies present in the data evaluations performed by Adams et al. are serious. The authors committed many errors attributable to carelessness: improper application of the log transformation; inaccurate construction of graphs; inaccurate interpretation of graphs. Other errors may be attributable to ignorance: failure to select benthos stations with the same substrate type to use in their data comparisons; selection of a study conducted in the polyhaline York River to provide the basis for predicting plankton responses to a thermal effluent in the oligohaline James River. Their most serious technical error, however, which renders all of their conclusions invalid, is their complete failure to invoke the concept of statistical significance in making the comparisons upon which their conclusions are based. Professional scientists cannot be forgiven for such a failure. As I mentioned in the section on models,

I suspect that the preoccupation of Adams et al. with performing a modeling exercise can explain, to a large degree, their approach to the data evaluation and their zeal to demonstrate power plant effects that, upon proper scrutiny, prove to be imaginary."

Staff members of the Virginia Institute of Marine Science have presented numerous papers at professional meetings (Atlantic Estuarine Research Society, National Benthological Society, etc.) which described the flora and fauna of the James River in the vicinity of Hog Point before and/or after the operation of Surry Units 1 and 2. Without exception, these papers reached the same conclusion as that contained in this demonstration - that the operation of the Surry Power Station was not adversely affecting the balanced, indigenous aquatic populations of the James River.

In summary, while the Oak Ridge review of existing data concluded that the data indicated a reduction in planktonic populations in the immediate discharge area but enhancement of benthic and nektonic populations, intensive and extensive studies conducted by the Virginia Institute of Marine Science and Vepco discussed in this demonstration, indicate that the thermal effluent from the Surry Power Station is not adversely affecting any trophic level including the balanced, indigenous population of fish, shellfish, or wildlife in the James River.

IX. THERMAL PLUME ANALYSIS

A. PHYSICAL MODEL PREDICTIONS

The distribution of excess temperature that would result from the discharge of waste heat from the Surry Power Station was determined from studies conducted on the hydraulic model of the James River estuary located at the U. S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi. This physical model covers the entire tidal waterway from Richmond to the mouth, and part of the lower Chesapeake Bay. Studies were conducted for Vepco by Pritchard-Carpenter, Consultants and are appended as Appendix L. The model has a horizontal scale of 1:1000, and a vertical scale of 1:100. The approximately 90 nautical miles of the estuary are therefore represented by a model about 550 feet long. The time scale of this model is 1:100; therefore one day in the prototype occurs in about 14 1/2 minutes in the model.

All pertinent features of tide, current, river inflow, and mixing of seawater and freshwater are properly scaled in the model. Density, temperature, and salinity are all scaled 1:1 in this model, and previous studies have shown that for models of this relative size, the thermal exchange processes at the water surface are also properly scaled.

A model heat source was constructed at the site of the Surry Power Station on the James River estuary. The heat source was designed to maintain a constant temperature rise of 15 F between the intake and discharge.

Tests were conducted during two different periods. The first set of tests were made between 29 July - 1 August 1966, and the second series during the period 19 October - 23 October 1966. The freshwater inflow at Richmond was maintained throughout the first series at a simulated 2000 cfs. The results of the first series of tests determined that the ideal discharge of the heated effluent back to the James River could be accomplished through a six foot per second discharge velocity.

For the second series improvements were made in the temperature measuring system so that 2 thermister bead sensors were towed across the model on each run. In the October series the model was run for a total of 784 tidal cycles, corresponding to about 379 days of prototype time.

In addition to the simulated flow of 2000 cfs from Richmond into the model, tests were also run simulating a river flow of 6000 cfs. Results showed that there was very little difference in the distribution of excess temperature under these two different river flows. This lack of difference is largely attributable to the initial mechanical mixing produced by the jet discharge, which provides for a rapid decrease in the maximum excess temperatures. In addition, mixing provided by the oscillatory ebb and flood of the tide, which on a single flood tide passes an average of 190,000 cfs pass the plant site, is not significantly influenced by river discharge except during very high river flows.

The results of the thermal studies in the James River estuarine model show that only a small portion of the estuarine water in the tidal segment adjacent to the plant site would be subject to excess temperatures which might have biological significance, assuming that the plant were designed, built and operated according to the parameters tested in the model. Averaged over a tidal cycle the area having excess temperatures exceeding 5 C would occupy less than 7 percent of the width of the estuary. Over 2/3 of the width of the estuary in the tidal segment adjacent to the discharge would have excess temperatures less than 2 C. The highest excess temperature which completely encloses cross-section of the river would be 0.80 C which occurs at only 1 of the eight distributions over the tidal cycle. The average closing excess temperature over the tidal period would be 0.66 C.

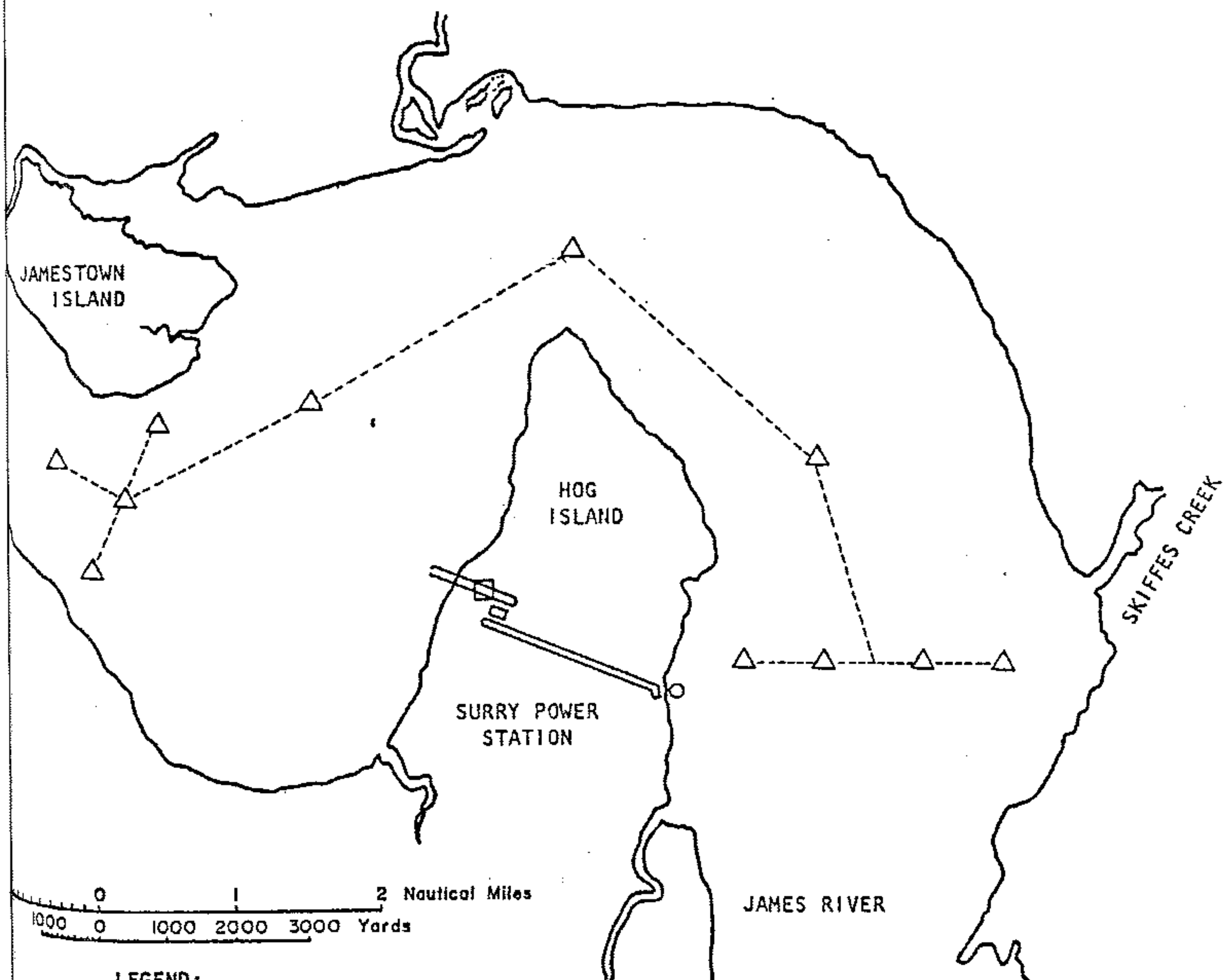
Other results of the model study indicated parameters that might be useful in the design and construction of the Surry Power Station. For example, it was found that the condenser cooling water circulating system with an intake on the downstream side of the site and the discharge on the upstream side would be more desirable from the standpoint of the estuarine environment than the opposite arrangement. In addition, the mechanical mixing produced by a jet discharge, and the turbulent mixing resulting from the tidal currents, should contribute significantly to reducing the area occupied by the warmest water. Subsequently, these two parameters in particular were incorporated into the design of Surry Power Station.

For a more detailed study of the results of the model test, the reader is referred to Appendix L.

B. FIELD MEASUREMENTS

Temperature distribution in the James River in the vicinity of Surry Power Station is measured by two methods: stationary recorders affixed to towers or buoys within the river (Fig. 6), and a monthly boat survey that starts downstream near the intake at low slack water and proceeds upstream to the vicinity of Jamestown Island (Fig. 8). In addition, the Virginia Institute of Marine Science, under a grant from the Nuclear Regulatory Commission, conducted a multitude of near-field measurements during several years of station operation (Appendix M).

Results generally show that the thermal plume dissipates rapidly due to the proper functioning of the jet discharge at the end of the discharge groin. Rapid mixing occurs between the heated effluent and ambient river water causing the area of excess temperature to be kept at a minimum.



LEGEND:

△ Monthly Salinity - Temperature Profile Station

○ Continuous Salinity - Temperature Monitoring Station

□ Near Surface Temperature Monitoring Station

---- Boat Cruise

FIGURE 8: Boat cruise temperature and salinity monitoring stations.

C. COMPARISON OF FIELD DATA WITH MODEL PREDICTIONS

Although Vepco has been collecting monthly temperature and salinity data as well as continuous temperature and salinity data from the James River estuary in the vicinity of the Surry Power Station, probably the most intensive survey in the area has been conducted by Dr. C. S. Fang, Virginia Institute of Marine Science, under ERDA project AT-(40-1)-4067. Results of Dr. Fang's study may be found as Appendix M.

Comparison of actual field studies with model studies indicates that model results tend to be about an order of magnitude higher in their predictions than actual field measurements. The main reason for this discrepancy lies in the fact that the scale of the model is distorted and does not appear to accurately predict water entrainment and near field excess temperatures. Because actual field data show that the areas of excess temperature are much less than the model predicted, and therefore much of the James River in the area is not affected by the thermal plume from Surry Power Station, the reader is referred to Appendix M showing six parts of the study by Dr. Fang on "The Thermal Effects of the Surry Nuclear Power on the James River, Virginia."

D. COMPLIANCE WITH WATER QUALITY STANDARDS

The Commonwealth of Virginia has determined that the thermal discharge from Surry Power Station is in compliance with state water quality standards. This determination will be reflected in the amended NPDES permit.

X. THERMAL EFFECTS

The following section contains information from studies conducted over the past seven years (1970-1976) which show, in keeping with the purpose of the Type I demonstration (absence of prior appreciable harm), that the Surry Power Station has been operated for five years with no appreciable harm occurring in the balanced indigenous populations of fish, shellfish, and wildlife in the James River estuary surrounding the Surry Power Station. Sample station locations for various components of the study are shown on Figure 7.

A. FINFISH

Vepco has elected to examine fish populations in the Surry area through the study of juvenile fishes. This stage in the life cycle is usually beyond the stages of highest natural mortality and can be used to reflect the general success and "health" of the current year-class of any given species as well as to make implications concerning past and future adult populations. In addition, juvenile fishes are more susceptible to capture by present-day biological sampling gear than are larvae or adults. Fishes less than 30 mm TL and greater than 200 mm TL usually display gear avoidance behavior patterns not so commonly found in fishes within this size range. Finfish in the oligohaline zone of the James River have been examined with probably more intensity and repetitiveness than lower organisms since the ecological "health" of this trophic level generally reflects the "health" of the ecosystem as a whole. The breakdown of, or damage to, a lesser trophic level should manifest itself in this higher level once or twice removed from the affected component.

The studies of fish populations influenced by Surry Power Station operations commenced in May, 1970, and have concentrated on a 10-mile stretch of the James River centered on Hog Island (Appendices N and O). This geographical limit allowed for a characterization of populations found about 5 miles upstream and downstream from Hog Point and encompassed both the intake and discharge areas as well as the primary study area and a reasonable far-field study area. In addition to the study of juvenile fishes by Vepco, fish eggs and larvae of the area have been sampled by VIMS through a thermal plume entrainment study (Appendices H and P).

Although estuaries are generally regarded as intricate environments their transition zones display an even greater complexity with wide variability being characteristically normal. Physico-chemical parameters such as temperature and salinity exhibit wide annual ranges and are subject to rapid changes within each range. Variations in freshwater input from the basin watershed, in addition to tidal fluctuations, have a pronounced influence on these parameters. Natural events such as floods, hurricanes, and droughts are added variables. These changes continually influence freshwater, estuarine, and marine fishes which perpetually immigrate and emigrate through the area at different life stages. In addition, natural or man-made occurrences may be causative factors of periodic fish kills which, in turn, influence the relative abundance and/or behavior of certain species.

In an effort to assess the composition and fluctuations of the fish populations as influenced by thermal and other factors, haul seines, trawls, and circulating water system intake screen were used during this study. While each gear type has its own limitations, their uses in a repetitive sampling program have collectively provided the best available insight into the composition, habits, and movements of young fishes in the area.

The overall program was divided into three parts. Seines at seven stations and trawls at six stations (Fig. 9) were used in a monthly preoperational and postoperational survey (May, 1970 - August, 1976) (Appendix O) and are continuing. A haul seine was used to study shore zone populations at three stations (Fig. 10) between the power station intake and discharge points (hereinafter called the special seine program). These three stations were sampled from May, 1973 through August, 1976. The circulating water system intake screens were sampled for impinged fish, usually five days a week, from July, 1972 through August, 1976.

Results from these three studies covering the period from May, 1970 through August, 1976 have been presented in an inclusive report (Appendix O).

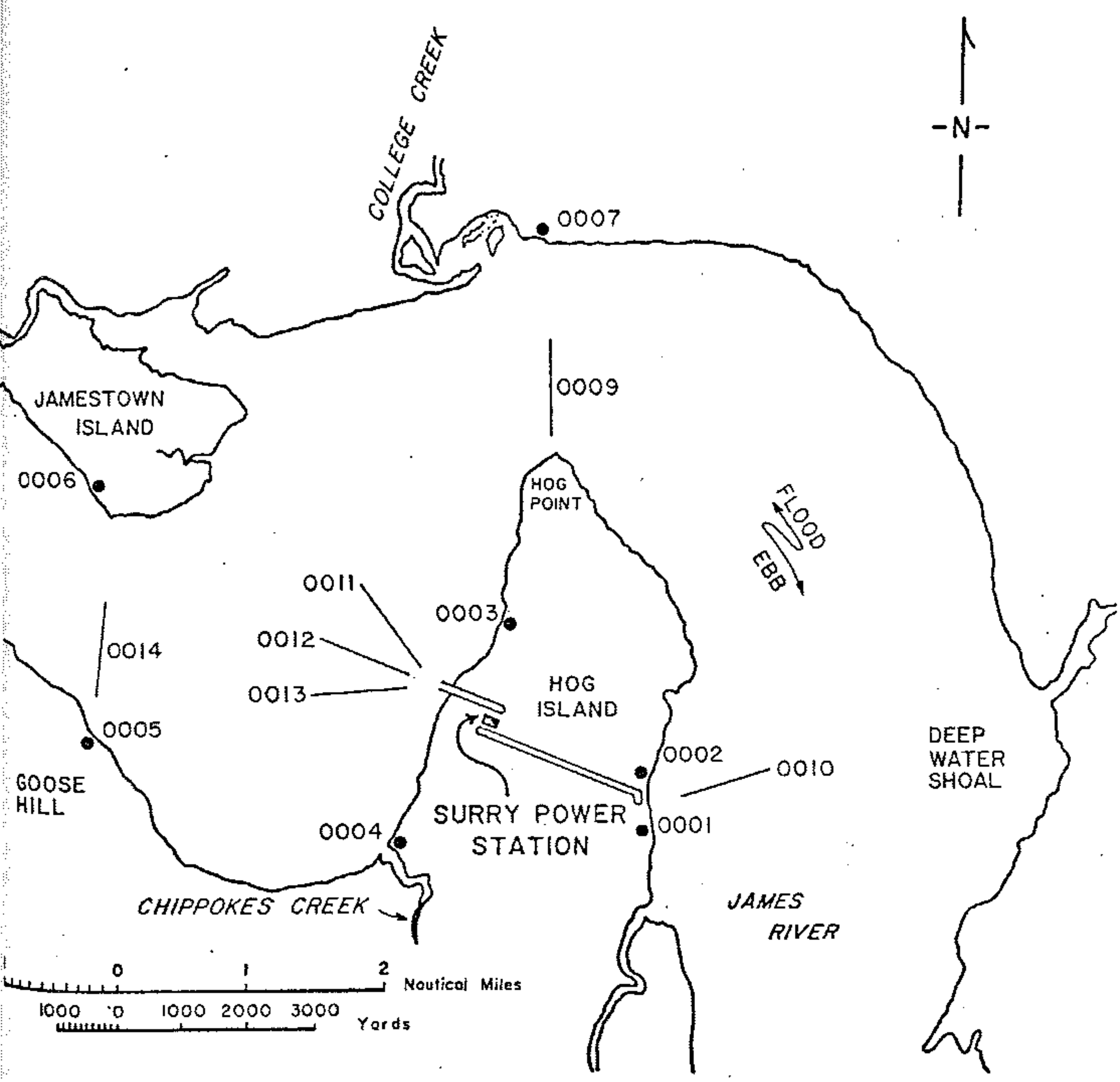
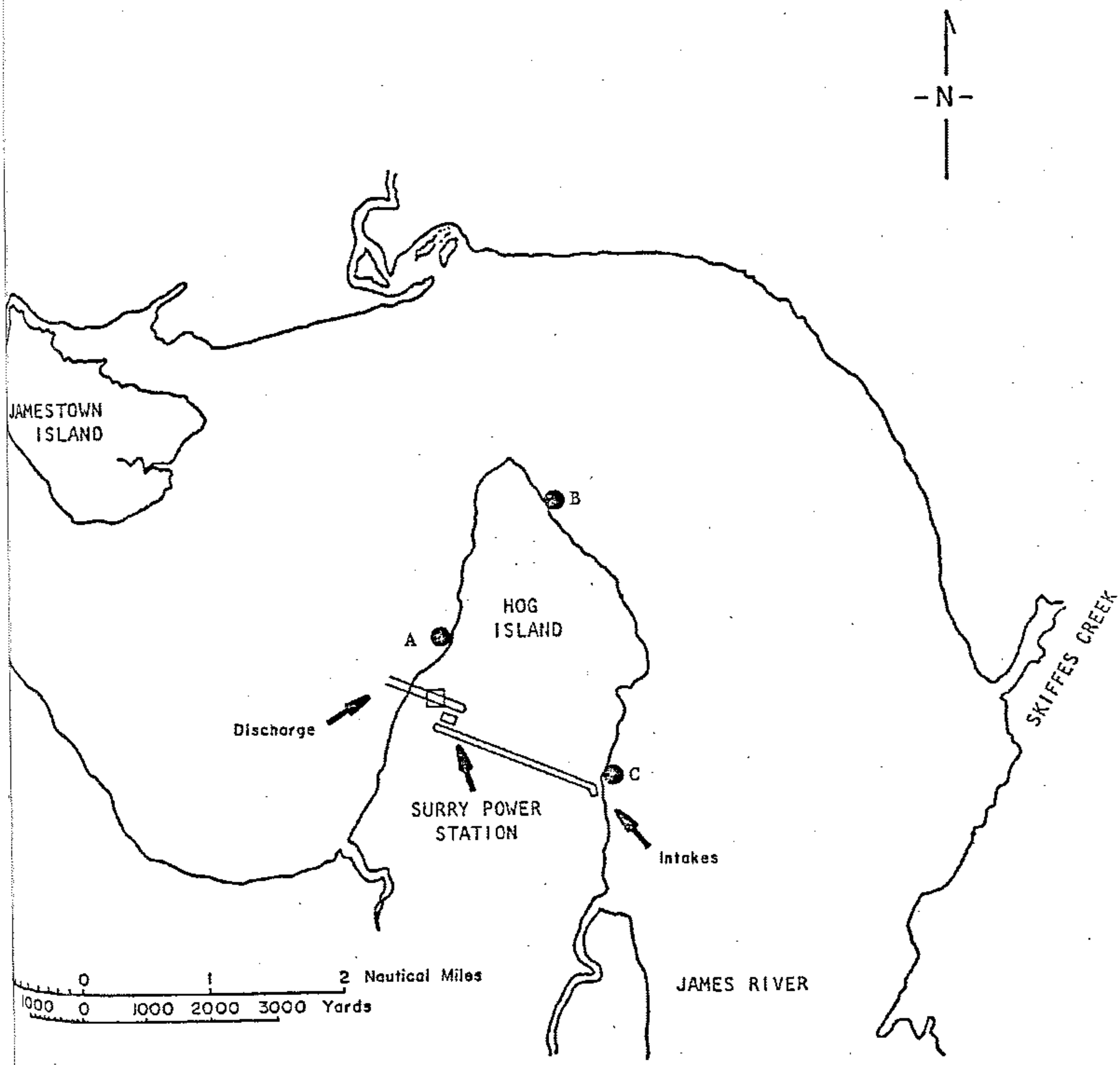


FIGURE 9: Sample stations for haul seine and otter trawl.
Haul seine - 0001 to 0007; otter trawl - 0009 to 0014.



A--Hog Point-West
B--Hog Point-North
C--Hog Point-East

FIGURE 10: Sample stations for special seine study.

Using three gear types during the six years of the study, 84 species and five genera of fishes were collected. This diverse population included 32 freshwater species, 32 species living in both the Atlantic Ocean and freshwater, and 20 species normally inhabiting only the Atlantic Ocean. The following are the major conclusions resulting from this comprehensive examination of young fishes residing in that section of the James River most likely to be influenced by operation of the Surry Power Station.

This series of studies has shown that the nektonic community around Surry is very diverse and dynamic, changing monthly and seasonally between species and sizes of individuals within species (Fig. 11). Diversity, evenness, and richness indices are useful analyses for determining long-term community trends and comparing pre- and postoperational communities. Since wide variability exists within and between samples, fish communities were analyzed by season, e.g., a given diversity for a given seine or trawl gear type for a given season is representative of samples from seven collection sites taken once each month for three months. Data pooled in this manner provide a more realistic look at fish community changes and provide a damping effect on the within and between station variability.

The diversity, evenness, and richness trends are amenable to a parametric test such as regression analysis. Using least squares regression, analyses show that the young fish populations around Surry have remained relatively stable for the past six years (including two years preoperational and four years postoperational data). Regression slopes have either: (1) not changed significantly, or (2) increased slightly ($p < 0.05$) over time indicating improvement.

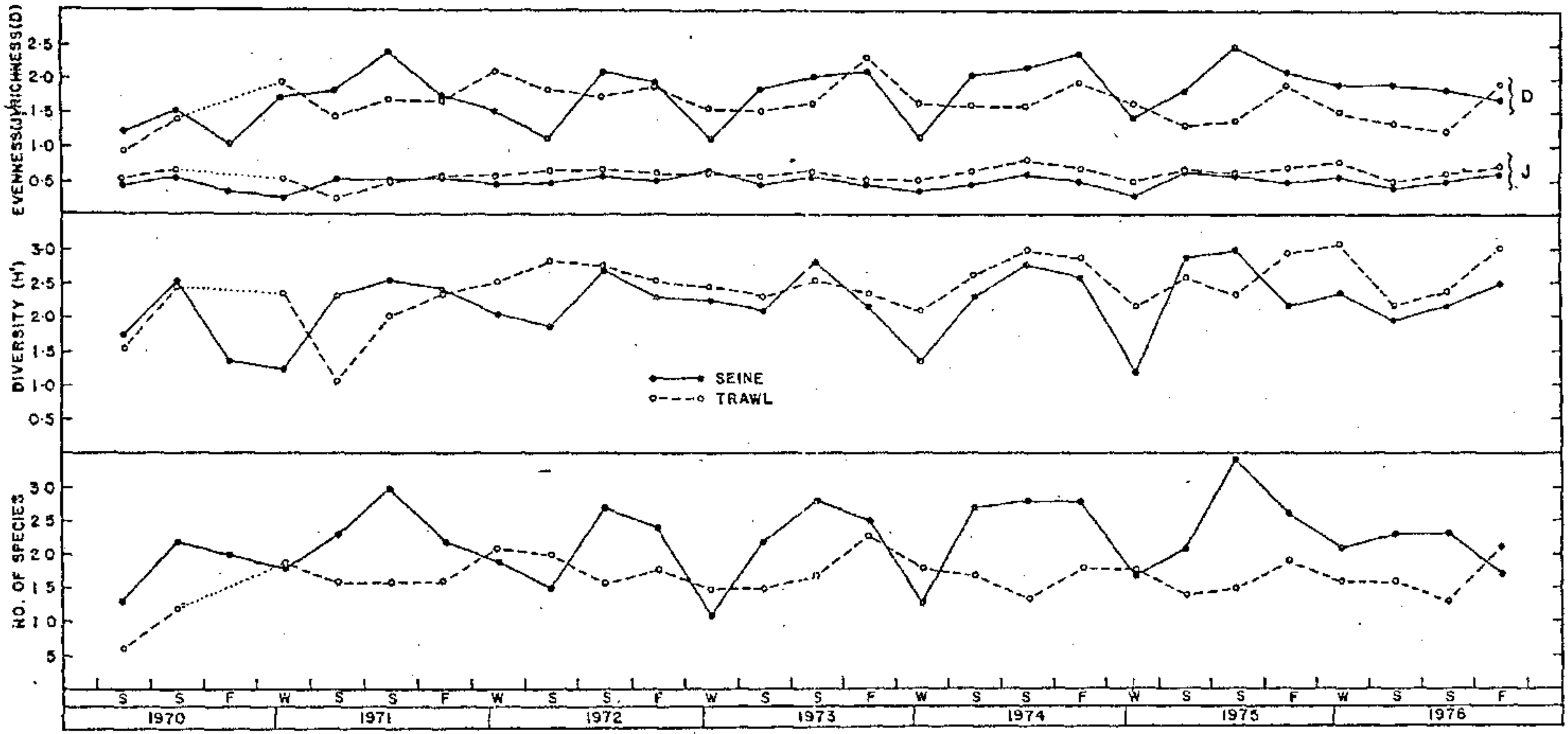


FIGURE 11: Number of species, diversity (H'), evenness (J), and richness (D) by season for seine and trawl caught fishes, 1970-1976.

A non-parametric comparison between preoperational and postoperational diversity indices indicated either no significant difference in the means or that preoperational means were significantly ($p < 0.05$) less than postoperational means. The null hypothesis was that the preoperational mean and postoperational mean were equal.

It was therefore concluded not only but from both parametric and non-parametric analyses of the data in Figure 11, that operation of the Surry Power Station has caused no appreciable harm to the fish community in the area. A negative response, if any, of the young fish community has not been evident as community diversity, evenness, and richness indicators have remained relatively stable or increased slightly during the six years of the study (Fig. 11).

At the species level, the following discussion focuses on the dominants, as well as certain non-dominant commercially and recreationally important species. Changes have taken place at the species level within the community that are a direct response to other environmental perturbations that have occurred in the James River. During the study period from May, 1970 through August, 1976, a major hurricane (Agnes) resulted in the flood of record and corresponding salinity depression; several other floods occurred; droughts and attendant salinity elevations were frequent; rainfall patterns within any given year did not appear to follow expected "norms"; winters were relatively mild, on the average, except for an occasional cold snap, similar to that in January, 1976, that caused water temperatures to drop sharply in a relatively short period of time.

Between 1962 and 1971, there were 17 documented fish kills in the James River between Hopewell and Jamestown (Appendix O). The Virginia Water Control Board lists 24 kills in the lower James River alone from 1962 to 1973

(Appendix Q). The kill of 1971, prior to Surry operations, was one of the worst on record and possibly contributed to the precipitous population decline experienced by white perch, Morone americana. Other species possibly affected included striped bass (Morone saxatilis) and hogchoker (Trinectes maculatus). Another kill was recorded in 1973, and another in 1974. No kills, however, were associated with the operation of the Surry Power Station.

These events have undoubtedly influenced specific fish populations in the James River. The response of the individual species, however, has not always been one of population decline (Tables 5, 6 , 7). Marine spawners whose larvae and young use the river as a nursery have generally shown increases in relative abundance. Atlantic menhaden (Brevoortia tyrannus), spot (Leiostomus xanthurus), and Atlantic croaker (Micropogon undulatus) are three of the dominants at Surry that were spawned in the marine environment. Using a combination of seine and trawl catches, these three species have shown increases over preoperational times in relative percent of the total number of fishes taken during operational times. Declines in relative abundance of some anadromous species such as alewife (A. pseudoharengus) and blueback herring (A. aestivalis) have been attributed by VIMS to natural fluctuations in year-class strength and offshore catches by foreign fishing fleets (Appendix E). Estuarine species such as the indigenous bay anchovy (Anchoa mitchilli) and silversides (Menidia spp.) have shown no change at all or have increased. Upper estuarine species such as channel catfish (Ictalurus punctatus) and spottail shiner (Notropis hudsonius) have experienced significant population increases.

The results of all of these studies only serve to emphasize what is already known about young fish populations in the transition zone of an estuarine environment. While this zone serves as a nursery for some species, there is

TABLE 5 -PREOPERATIONAL AND POSTOPERATIONAL HAUL SEINE DATA

Pre - 149 hauls
Post - 357 hauls

Frequency of Occurrence (%)

	Pre	Post
verside sp.	95	99
tail Shiner	57	77
Anchovy	56	53
te Perch	41	10
back Herring	39	39
ichog	28	17
t	28	30
iped Bass	24	2
rican Shad	22	8
ntic Menhaden	22	21
ard Shad	20	23
den Shiner	18	37
kinseed	13	13
ife	11	7
hoker	11	4
kory Shad	10	≤1
ntic Needlefish	9	1
rican Eel	7	4
low Perch	7	4
nel Catfish	6	15
ped Killifish	5	≤1
n Bullhead	5	6
ded Killifish	5	27
ntic Croaker	4	13
lle Shiner	3	1
fish	3	0
alle Jack	2	0
d Goby	2	1
ish sp.	2	≤1
emouth Bass	2	0
er sp.	≤1	2
tern Mudminnow	≤1	0

	Pre	Post
Carp	≤1	3
Summer Flounder	≤1	4
Mosquitofish	≤1	2
Tessellated Darter	≤1	1
White Catfish	≤1	2
Silver Perch	≤1	0
Bluefish	≤1	1
Harvestfish	≤1	0
Bluegill	≤1	1
Common Shiner	0	6
Threadfin Shad	0	7
Satinfin Shiner	0	13
Silvery Minnow	0	8
Johnny Darter	0	2
Shiner sp.	0	1
Striped Mullet	0	5
Rough Silverside	0	3
Chain Pickerel	0	≤1
Ladyfish	0	2
Bonefish	0	≤1
Sheepshead Minnow	0	≤1
Bluespotted Sunfish	0	≤1
Redfin Pickerel	0	≤1
Smallmouth Bass	0	≤1
White Mullet	0	1
Spotfin Killifish	0	≤1
Longnose Gar	0	≤1
Redbreast Sunfish	0	≤1
Shorthead Redhorse	0	≤1
Ironcolor Shiner	0	≤1

TABLE 6 -- PREOPERATIONAL AND POSTOPERATIONAL HAUL SEINE DATA

Pre - 149 hauls
Post - 357 hauls

Total Number (%)

	Pre	Post		Pre	Post
Blueback Herring	18.6	15.5	Naked Goby	≤0.1	≤0.1
Silverside sp.	18.0	24.5	Bluegill	≤0.1	≤0.1
Atlantic Menhaden	16.3	21.2	Bluefish	≤0.1	≤0.1
Bay Anchovy	14.8	9.9	Silver Perch	≤0.1	0
Alewife	8.5	0.4	Largemouth Bass	≤0.1	0
Spot	6.6	2.2	Weakfish	≤0.1	0
White Perch	4.2	0.5	Harvestfish	≤0.1	0
American Shad	4.2	1.3	Eastern Mudminnow	≤0.1	0
Spottail Shiner	3.8	15.1	Crevalle Jack	≤0.1	0
Striped Bass	1.6	0.1	Striped Mullet	0	≤0.1
Mummichog	0.9	1.1	Common Shiner	0	0.2
Atlantic Needlefish	0.8	≤0.1	Rough Silverside	0	≤0.1
Golden Shiner	0.5	1.9	Threadfin Shad	0	0.2
Hickory Shad	0.3	≤0.1	Satinfin Shiner	0	0.2
Hogchoker	0.2	≤0.1	Silvery Minnow	0	0.3
Gizzard Shad	≤0.1	0.4	Johnny Darter	0	≤0.1
Brown Bullhead	≤0.1	≤0.1	Chain Pickerel	0	≤0.1
Pumpkinseed	≤0.1	0.2	Ladyfish	0	≤0.1
Sunfish sp.	≤0.1	≤0.1	Shiner sp.	0	≤0.1
Channel Catfish	≤0.1	0.5	Spotfin Killifish	0	≤0.1
Yellow Perch	≤0.1	≤0.1	White Mullet	0	≤0.1
Striped Killifish	≤0.1	≤0.1	Smallmouth Bass	0	≤0.1
American Eel	≤0.1	≤0.1	Redfin Pickerel	0	≤0.1
Atlantic Croaker	≤0.1	0.7	Bluespotted Sunfish	0	≤0.1
Banded Killifish	≤0.1	3.1	Sheepshead Minnow	0	≤0.1
Darter sp.	≤0.1	≤0.1	Bonefish	0	≤0.1
Carp	≤0.1	≤0.1	Redbreast Sunfish	0	≤0.1
Summer Flounder	≤0.1	≤0.1	Ironcolor Shiner	0	≤0.1
Bridle Shiner	≤0.1	≤0.1	Shorthead Redhorse	0	≤0.1
White Catfish	≤0.1	≤0.1	Longnose Gar	0	≤0.1
Mosquitofish	≤0.1	≤0.1			
Tessellated Darter	≤0.1	≤0.1			

TABLE 7 -- PREOPERATIONAL AND POSTOPERATIONAL TRAWL DATA

Pre - 90 trawls
Post - 300 trawls

Frequency of Occurrence (%)

	Pre	Post
Hogchoker	84	50
White Perch	56	25
Channel Catfish	53	74
White Catfish	46	55
Bay Anchovy	39	48
Spot	34	40
Atlantic Croaker	34	44
Spottail Shiner	29	39
Brown Bullhead	26	4
American Eel	22	22
American Shad	18	8
Alewife	17	16
Carp	16	14
Weakfish	16	4
Striped Bass	16	2
Blueback Herring	12	9
Gizzard Shad	8	11
Silver Perch	6	1
Darter sp.	6	1
Pumpkinseed	6	5
Hickory Shad	4	0
Tessellated Darter	3	4
Crevalle Jack	3	1
Yellow Perch	3	1
Atlantic Sturgeon	2	0
Silverside sp.	2	1
Harvestfish	≤1	0
Seaboard Goby	≤1	1
Bluespotted Sunfish	≤1	0
Atlantic Menhaden	≤1	9
Summer Flounder	0	5
Threadfin Shad	0	12
Redbreast Sunfish	0	≤1
Longnose Gar	0	≤1
Ladyfish	0	≤1
Catfish sp.	0	≤1
Naked Goby	0	2
Spotfin Mojarra	0	≤1
Silvery Minnow	0	≤1
Spotted Hake	0	≤1
Bluefish	0	≤1

Total Number (%)

	Pre	Post
Hogchoker	46.1	11.7
Channel Catfish	8.8	22.9
Spot	8.4	18.1
White Perch	8.2	1.3
Atlantic Croaker	7.9	15.5
Bay Anchovy	5.0	9.5
White Catfish	3.1	4.9
Alewife	2.6	0.6
Spottail Shiner	2.6	5.3
American Shad	1.3	0.3
Brown Bullhead	1.1	≤0.1
Weakfish	0.8	0.2
Striped Bass	0.7	≤0.1
American Eel	0.7	1.0
Carp	0.5	0.4
Blueback Herring	0.4	0.5
Silver Perch	0.3	≤0.1
Gizzard Shad	0.3	0.7
Hickory Shad	0.2	0
Pumpkinseed	0.2	0.3
Crevalle Jack	≤0.1	≤0.1
Darter sp.	≤0.1	≤0.1
Tessellated Darter	≤0.1	0.2
Atlantic Sturgeon	≤0.1	0
Silverside sp.	≤0.1	≤0.1
Yellow Perch	≤0.1	≤0.1
Harvestfish	≤0.1	0
Seaboard Goby	≤0.1	≤0.1
Bluespotted Sunfish	≤0.1	0
Atlantic Menhaden	≤0.1	0.4
Summer Flounder	0	0.2
Threadfin Shad	0	5.4
Redbreast Sunfish	0	≤0.1
Longnose Gar	0	≤0.1
Ladyfish	0	≤0.1
Catfish sp.	0	≤0.1
Naked Goby	0	≤0.1
Spotfin Mojarra	0	≤0.1
Silvery Minnow	0	≤0.1
Spotted Hake	0	≤0.1
Bluefish	0	≤0.1

considerable immigration and emigration through the zone as well as constant changes taking place within the zone as well as without. Interspecific and intraspecific competition for food and space are commonplace. Over an extended time period, natural and man-made insults generally appear to result only in relatively short-term changes, and fishes within the zone apparently thrive.

These results also show that, despite numerous environmental perturbations occurring in almost every year of the studies, the young fish population in the transition zone of the James River has remained relatively diverse and stable.

Turning to ichthyoplankton, the transition zone supports little spawning activity although its nursery function has been established previously. Relatively few fish eggs and larvae are found in the area of Surry Power Station (Appendices H and P). Of those found, numbers of individuals and numbers of species are generally at their highest in early summer, declining during late summer and early fall. Although the number of species continues to decrease in late fall, total numbers of larvae increase. Wintertime sees fluctuating levels of, and early springtime shows increases in, both species and individuals within species.

Analysis of total catch data showed little or no entrainment of fish larvae or fish eggs by the thermal plume. VIMS concluded that effects on ichthyoplankters caused by Surry, if any, were within natural variability. Thus, the thermal effluent is resulting in no appreciable harm to the ichthyoplankton component of the nekton community of the James River. Naked goby, Gobiosoma bosci, and bay anchovy, Anchoa mitchilli, are the dominant species whose eggs (anchovy only) and larvae are found in the area. These two estuarine species have centers of abundance downstream from Surry Power

Station and those in the oligohaline zone are representative of the upstream edge of the population. Postlarvae and/or juveniles of some commercially important species such as Atlantic croaker, Micropogon undulatus, and spot, Leiostomus xanthurus, were captured seasonally in relatively low numbers; however, these are ubiquitous species, being widespread along the Atlantic and Gulf of Mexico coasts.

Species occurrences by temperature and salinity give some indication of the environmental limits within which these species were found during the course of the study (Tables 8, 9). It is interesting to note that both marine and freshwater species apparently tolerate lower and higher salinity levels, respectively, than is popularly believed.

An additional area of concern in more northern latitudes is one of "cold shock" whereby fish kills can occur upon rapid temperature decrease during winter months. No "cold shock" caused fish kills or other effects have been observed during Surry operations.

The thermal plume was not found to form a barrier to migratory fishes. This finding was confirmed by catches of several comparatively strong year-classes of juvenile blueback herring (Alosa aestivalis), the most numerically dominant of the James River anadromous fishes. These fishes had migrated as adults upstream past Surry to spawning grounds near Hopewell and Richmond and the young were sampled as they migrated downstream past Surry to Chesapeake Bay.

Several important conclusions can be drawn from the results of the finfish study:

1. Surry Power Station operations have had no significant effect on the young fish community of the James River.

2. From May, 1970 through August, 1976, several major environmental disturbances (Surry was not one) have occurred.

Table 8 Spp Occurance by Temperature

SP	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	COUNT
ACIPENSER OXYRHYNCHUS								X																	X											2
ALBULA VULPES																																			X	1
ALOSA AESTIVALIS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			33
ALOSA MEDIOCRIS					X			X	X						X	X	X	X			X		X	X	X	X	X	X	X							15
ALOSA PSEUDOHARENGUS	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			32
ALOSA SAPIDISSIMA	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					31
AMIA CALVA						X	X	X		X	X	X	X	X	X					X																10
ANCHOA HEPSETUS																									X				X		X					3
ANCHOA MITCHILLI			X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			30
ANGUILLA ROSTRATA	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			33
BAIRDIELLA CHRYSURA									X			X		X	X		X	X	X		X	X		X	X	X			X	X						14
BREVOORTIA TYRANNUS		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	34
CARANX HIPPOS											X					X		X	X	X	X		X	X	X	X	X	X	X				X			14
CENTRARCHUS MACROPTERUS													X																X							2
CITHARICHTHYS SPILOPTERUS																													X							1
CYNOSCION NEBULOSUS																X									X		X									3
CYNOSCION REGALIS						X	X			X	X				X	X		X	X	X	X	X	X	X	X	X	X	X	X	X		X				20
CYPRINIDAE					X					X																										2
CYPRINODON VARIEGATUS								X		X	X	X	X		X	X	X	X		X	X	X			X	X	X	X	X							17
CYPRINUS CARPIO		X	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			30
DOROSOMA CEPEDIANUM	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	35
DOROSOMA PETENENSE	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	34
ELOPS SAURUS								X		X			X	X		X			X	X	X	X				X	X	X	X	X	X	X	X			17
ENNEACANTHUS GLORIOSUS																		X		X					X	X	X	X	X							7
ERIMYZON SP.														X																						1
ESOX NIGER		X																									X									2
ETHEOSTOMA NIGRUM																									X	X			X	X	X		X			6
ETHEOSTOMA OLMSTEDI		X			X	X	X	X	X	X	X	X	X	X				X			X								X	X	X					16
ETHEOSTOMA SP.									X		X	X			X	X		X				X	X			X				X		X				11
EUCINOSTOMUS ARGENTEUS												X																								1
FUNDULUS CONFLUENTUS																										X										1
FUNDULUS DIAPHANUS		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	33
FUNDULUS HETEROCLITUS			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	32
FUNDULUS LUCIAE															X																					1
FUNDULUS MAJALIS				X				X			X		X		X										X		X		X	X	X					10
GAMBUSIA AFFINIS						X		X				X					X												X		X					6
GASTEROSTEUS ACULEATUS					X			X																												2
GOBIESOX STRUMOSUS																					X				X											2
GOBIOSOMA BOSCI					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				28
GOBIOSOMA GINSBURGI								X																												1
HYBOGNATHUS NUCHALIS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X		30
HYPORHAMPHUS UNIFASCIATUS																									X											1
ICTALURUS CATUS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				X	32
ICTALURUS NEBULOSUS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	34
ICTALURUS PUNCTATUS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	35
ICTALURUS SP.																													X	X						2
LEIOSTOMUS XANTHURUS			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	33
LEPISOSTEUS OSSEUS			X			X		X			X	X			X																X					7
LEPOMIS AURITUS														X	X					X		X				X		X		X						7
LEPOMIS GIBBOSUS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	34

Table 8 cont'd

SP	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	COUNT
LEPOMIS GULOSUS													X																							1
LEPOMIS MACROCHIRUS								X		X	X		X	X	X		X		X	X	X		X	X		X	X	X								15
LEPOMIS SP.								X	X																		X	X	X	X						6
LUTJANUS GRISEUS																	X	X		X	X															4
MEMBRAS MARTINICA						X		X		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					23
MENIDIA BERYLLINA	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	35
MENIDIA MENIDIA	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	35
MENIDIA SP.				X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	30
MICROPOGON UNDULATUS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			33
MICROPTERUS DOLOMIEUI																X														X						2
MICROPTERUS SALMOIDES									X				X		X	X				X								X		X						7
MORONE AMERICANA	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			33
MORONE SAXATILIS				X	X	X	X	X	X	X	X	X	X	X	X	X		X				X		X	X	X	X	X	X	X	X	X	X			25
MOXOSTOMA MACROLEPIDOTUM																															X					1
MUGIL CEPHALUS	X	X	X	X	X	X	X	X	X		X	X					X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	28
MUGIL CUREMA		X		X	X					X			X										X			X							X			8
NOTEMIGONUS CRYSOLEUCAS			X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	32
NOTROPIS ANALOSTANUS								X	X	X	X	X	X		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X						21
NOTROPIS BIFRENATUS							X					X								X		X				X	X	X	X	X		X				10
NOTROPIS CHALYBAEUS																														X						1
NOTROPIS CORNUTUS								X		X	X		X			X				X	X	X	X			X	X		X	X		X	X			15
NOTROPIS HUDSONIUS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	35
NOTROPIS PROCNE																													X							1
NOTROPIS SP.												X				X													X	X						4
PARALICHTHYS DENTATUS							X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				24
PEPRILUS ALEPIDOTUS																			X	X		X	X	X	X	X	X	X	X							10
PEPRILUS TRIACNATHUS																									X											1
PERCA FLAVESCENS			X		X					X	X	X	X		X	X		X		X	X		X	X	X	X	X		X	X	X					19
PETROMYZON MARINUS											X		X	X	X	X	X				X	X														8
POMATOMUS SALTATRIX													X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X					18
POMOXIS NIGROMACULATUS														X	X				X							X										4
PRIONOTUS CAROLINUS																			X					X	X		X									4
PRIONOTUS TRIBULUS																												X								1
SCOMBEROMORUS MACULATUS																									X	X	X	X	X	X						6
SELENE VOMER																									X			X		X	X					4
SEMOTILUS ATROMACULATUS																											X									1
STRONGYLURA MARINA																		X	X						X	X	X	X	X	X	X	X				10
SYGNATHUS FLORIDAE															X																					1
SYMPHURUS PLAGIUSA						X		X		X					X		X	X	X																	7
TRICHIURUS LEPTURUS																								X			X									2
TRINECTES MACULATUS		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				X	31
UMBRA PYGMAEA				X																																1
UROPHYCIS REGIUS											X		X																							2

SP	0	PT5	1	2	3	4	5	6	7	8	9	10	11	12	COUNT
ACIPENSER OXYRHYNCHUS	X												X		2
ALOSA AESTIVALIS	X	X	X	X	X	X	X	X	X	X	X				11
ALOSA MEDIOCRIS	X	X	X	X	X	X	X		X	X					9
ALOSA PSEUDOHARENGUS	X	X	X	X	X	X	X	X	X	X	X	X			12
ALOSA SAPIDISSIMA	X	X	X	X	X	X	X	X	X	X	X				11
AMIA CALVA	X		X			X									3
ANCHOA HEPSETUS							X			X			X		3
ANCHOA MITCHILLI	X	X	X	X	X	X	X	X	X	X	X	X	X	X	14
ANGUILLA ROSTRATA	X	X	X	X	X	X	X	X	X	X	X	X	X	X	14
BAIRDIELLA CHRYSURA			X	X	X	X	X		X	X	X	X		X	10
BREVOORTIA TYRANNUS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	14
CARANX HIPPOS	X	X	X	X	X	X	X	X		X	X	X	X	X	13
CENTRARCHUS MACROPTERUS	X														1
CITHARICHTHYS SPILOPTERUS								X							1
CYNOSCION NEBULOSUS					X				X		X				3
CYNOSCION REGALIS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	14
CYPRINIDAE	X				X										2
CYPRINODON VARIEGATUS	X	X	X	X	X	X	X	X	X	X					10
CYPRINUS CARPIO	X	X	X	X	X	X	X	X	X	X	X	X			12
DOROSOMA CEPEDIANUM	X	X	X	X	X	X	X	X	X	X	X	X	X	X	14
DOROSOMA PETENENSE	X	X	X	X	X	X	X	X	X	X	X	X	X	X	14
ELOPS SAURUS	X		X	X	X	X	X	X	X	X	X	X	X	X	13
ENNEACANTHUS GLORIOSUS	X	X	X	X	X	X									6
ERIMYZON SP.	X														1
ESOX NIGER	X						X								2
ETHEOSTOMA NIGRUM			X	X		X	X	X							5
ETHEOSTOMA OLMSTEDI	X	X	X	X			X								5
ETHEOSTOMA SP.	X		X		X										3
EUCINOSTOMUS ARGENTEUS					X										1
FUNDULUS CONFLUENTUS		X													1
FUNDULUS DIAPHANUS	X	X	X	X	X	X	X	X	X	X					10
FUNDULUS HETEROCLITUS	X	X	X	X	X	X	X	X	X	X	X	X	X		13
FUNDULUS LUCIAE				X											1
FUNDULUS MAJALIS	X		X	X	X	X	X	X	X						8
GAMBUSIA AFFINIS	X		X		X	X									4
GASTEROSTEUS ACULEATUS			X												1
GOBIESOX STRUMOSUS												X			1
GOBIOSOMA BOSCI	X	X	X	X	X	X	X	X	X	X	X	X	X	X	14
GOBIOSOMA GINSBURGI				X											1
HYBOGNATHUS NUCHALIS	X	X	X	X	X	X	X	X	X	X					10
HYPORHAMPHUS UNIFASCIATUS													X		1
ICTALURUS CATUS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	14
ICTALURUS NEBULOSUS	X	X	X	X	X	X	X	X	X	X	X	X	X		13
ICTALURUS PUNCTATUS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	14
ICTALURUS SP.	X														1
LEIOSTOMUS XANTHURUS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	14
LEPISOSTEUS OSSEUS	X	X	X	X	X	X	X								7
LEPOMIS AURITUS	X	X	X	X	X				X						6
LEPOMIS GIBBOSUS	X	X	X	X	X	X	X	X	X	X	X	X	X		13
LEPOMIS GULOSUS	X														1
LEPOMIS MACROCHIRUS	X		X	X	X	X	X								6
LEPOMIS SP.	X		X	X	X		X								5
LUTJANUS GRISEUS	X	X	X	X	X										5
MEMBRAS MARTINICA	X	X	X	X	X	X	X	X	X	X	X	X	X	X	14

SP	0	PT5	1	2	3	4	5	6	7	8	9	10	11	12	COUNT
MENIDIA BERYLLINA	X	X	X	X	X	X	X	X	X	X	X	X	X		13
MENIDIA MENIDIA	X	X	X	X	X	X	X	X	X	X	X	X	X	X	14
MENIDIA SP.	X	X	X	X	X	X	X	X	X	X	X				11
MICROPOGON UNDULATUS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	14
MICROPTERUS DOLOMIEUI	X														1
MICROPTERUS SALMOIDES	X		X	X			X								4
MORONE AMERICANA	X	X	X	X	X	X	X	X	X	X	X	X	X		13
MORONE SAXATILIS	X	X	X	X	X	X	X	X	X		X		X	X	12
MOXOSTOMA MACROLEPIDOTUM	X														1
MUGIL CEPHALUS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	14
MUGIL CUREMA	X				X	X		X							4
NOTEMIGONUS CRYSOLEUCAS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	14
NOTROPIS ANALOSTANUS	X		X	X	X	X	X	X							7
NOTROPIS BIFRENATUS	X		X	X		X	X								5
NOTROPIS CHALYBAEUS	X														1
NOTROPIS CORNUTUS	X	X	X	X	X		X								6
NOTROPIS HUDSONIUS	X	X	X	X	X	X	X	X	X	X	X	X		X	13
NOTROPIS PROCNE				X											1
NOTROPIS SP.	X		X												2
PARALICHTHYS DENTATUS	X	X	X	X	X	X	X	X	X	X	X	X	X		13
PEPRILUS ALEPIDOTUS	X							X		X	X	X	X	X	7
PEPRILUS TRIACNATHUS										X					1
PERCA FLAVESCENS	X	X	X	X	X	X	X	X							8
PETROMYZON MARINUS	X	X	X	X											4
POMATOMUS SALTATRIX		X	X	X	X	X	X	X	X	X	X	X	X	X	13
POMOXIS NIGROMACULATUS	X		X	X											3
PRIONOTUS CAROLINUS					X								X	X	3
PRIONOTUS TRIBULUS							X								1
SCOMBEROMORUS MACULATUS					X	X	X	X	X			X	X	X	8
SELENE VOMER					X					X	X				3
SEMOTILUS ATROMACULATUS						X									1
STRONGYLURA MARINA	X		X	X	X	X	X	X	X	X	X	X	X		12
SYGNATHUS FLORIDAE			X												1
SYMPHURUS PLAGIUSA			X	X	X	X	X								5
TRICHIURUS LEPTURUS						X		X							2
TRINECTES MACULATUS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	14
UMBRA PYGMAEA								X							1
UROPHYCIS REGIUS						X					X				2

3. There have been increases in the relative abundance of some species, decreases in others, while still other species such as the indigenous bay anchovy have shown no change at all. None of these changes could be correlated with Surry operations.

4. No "cold shock" fish kills have occurred.

5. No thermal barrier to migratory fishes was found to be present.

6. These studies show that, despite both natural and man-made perturbations, the young fish community of the transition zone of the James River is viable and stable and, above all, exhibits no appreciable response to Surry Power Station operation.

B. BENTHOS

Benthic macroinvertebrate studies have been conducted in the transition zone of the James River since 1969. Because this zone is of low but highly variable salinity (Fig. 12) and is characterized by high turbidities and sedimentation rates, it presents an inhospitable environment for all but a few of the most tolerant of benthic species (Appendix G). Those surviving either maintain viable, reproducing resident populations, or are temporary invaders when suitable environmental conditions permit. Consequently, the benthos of the area are characterized by low species diversity values (0-3.04 bits per individual), values that have been found throughout the study period. Diversity values have remained within natural limits of level and variability before and during Surry Power Station operations which have had no detectable influence on the components of this trophic level (preoperational, 0-2.8; postoperational, 0-3.04).

As is typical of most zones of this type, a few species are overwhelmingly dominant. In the James River at Surry, the non-commercial brackish water clam, Rangia cuneata is found in abundance, and comprises more than 90% of the total invertebrate biomass. The American oyster (Crassostrea virginica) is not found in the oligohaline zone of the James River, this species being more mesohaline in habitat while the blue crab (Callinectes sapidus) is only a sporadic visitor to the Surry area. VIMS concluded that Rangia cuneata showed no obvious preference or avoidance regarding the thermal plume as increases and declines occurred at both plume and non-plume sampling stations. Rather, Rangia cuneata revealed an apparent preference for silty-clay substrates whether this substrate type was within the thermal plume area or not (Appendices H and P).

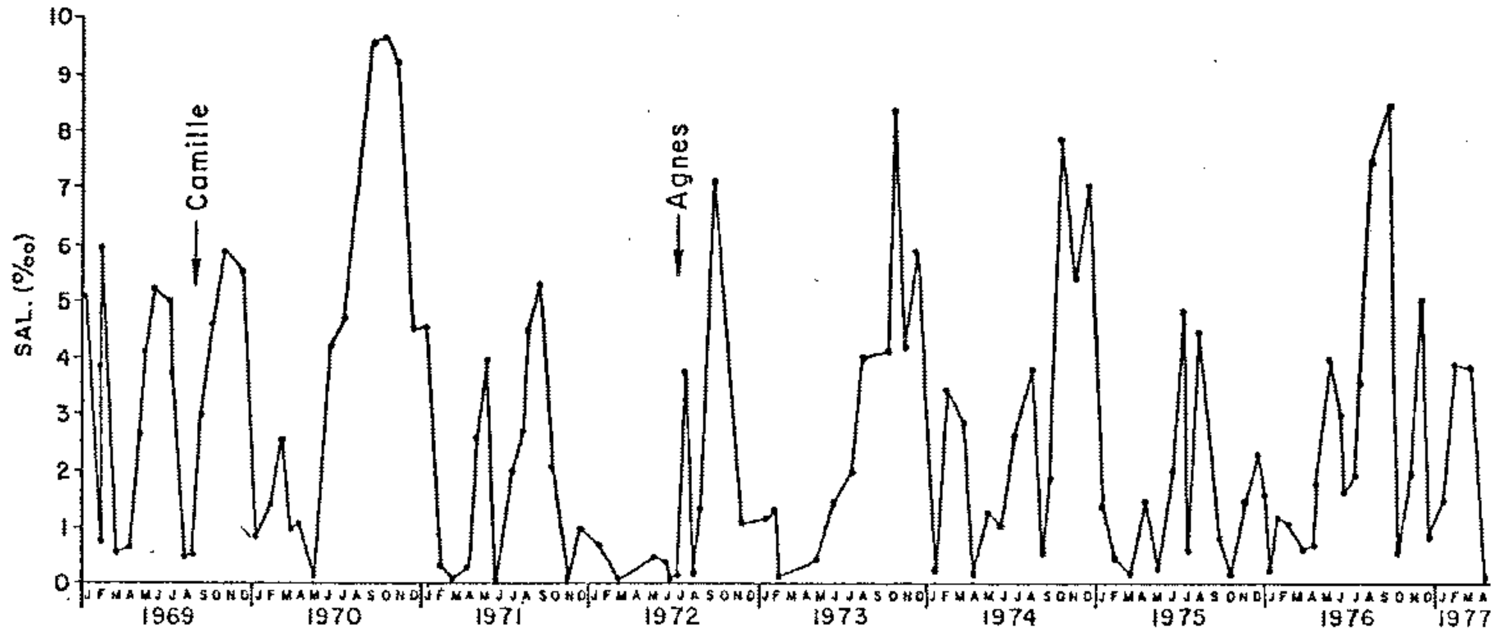


Figure 12: Temporal distribution of surface salinity at benthos Station 11 . (from Appendix P)

Other benthic species have shown changes during operational times with some decreasing in abundance while others increased. These changes occurred at both plume and non-plume stations and appeared to be related to natural perturbations such as Hurricane Agnes and its attendant low salinity levels. These changes are reflected in species diversity levels as well as temporal distribution patterns (Appendices H and P).

Benthic macroinvertebrates represent an excellent example of the natural variability encountered in nature, the subtle as well as obvious changes that take place over time, and, above all, the resiliency of the ecosystem to recover from insults such as Hurricane Agnes. Diversity and species richness levels were reduced in the summer of 1972 following Agnes. While diversity recovered rather quickly, richness depression continued into 1973. Diversity and richness values had recovered in 1974, 1975, and 1976 and were not significantly different from one of the two preoperational periods used for comparison (Appendices H and P).

The majority of the benthic macroinvertebrate species collected during this study are classed as "estuarine endemic" and are characteristic of the meso- and oligohaline zones of the estuarine system of Chesapeake Bay (Table 10). As such, they are well adapted to the varying environmental conditions found around Surry Power Station. Since the transition zone is what it is, other species from both the upstream freshwater zone and downstream saline zone are found when suitable conditions exist.

Results of this study show that the benthic macroinvertebrate community, including shellfish, is not being appreciably harmed by the thermal effluent from Surry Power Station. Changes within the community have been correlated with natural changes as well as sediment type.

TABLE 10: ECOLOGICAL CLASSIFICATION OF BENTHIC MACROINVERTEBRATES FOUND IN THE OLIGOHALINE JAMES RIVER*

Estuarine Endemic	Other
Scolecolepides viridis	*Tubulanus pellucidus* (polyhaline)
Laeonereis culveri	*Nereis succinea* (euryhaline)
Oligochaeta	Dipteran larvae (freshwater to oligohaline)
Hydrobia sp.	*Lepidactylus dytiscus* (euryhaline)
Congeria leucophaeta	*Corbicula manilensis* (freshwater to oligohaline)
Rangia cuneata	*Brachidontes recurvus* (meso- to euhaline)
Macoma balthica	*Polydora ligni* (oligo- to euhaline)
Macoma mitchelli	*Edotea triloba* (euryhaline)
Cyathura polita	*Monoculodes edwardsi* (euryhaline)
Chiridotea almyra	
Gammarus spp.	
Leptocheirus plumulosus	
Corophium lacustre	
Rhithropanopeus harrisii	

* Adapted from Appendix G.

C. FOULING ORGANISMS

A series of fouling plate stations was established in the James River around Surry Power Station in January, 1971. Studies on the organisms colonizing the plates have continued since that time. This community has shown no effect from the thermal effluent from Surry Power Station (Appendices H and P).

Throughout the six years that this trophic level has been under study the fouling plates have been colonized mainly by barnacles, ectoprocts, hydroids, and one species of amphipod of the genus Corophium. Other forms have been found in reduced numbers. With the exception of 1972 following Hurricane Agnes, the largest numbers of species and individuals within species have been collected in August and October of each year. Temporal distribution patterns related to normal seasonal cycles of temperature and salinity have been displayed.

Two species were dominant during the entire study period and these have shown no changes in population density or structure attributable to the thermal effluent from Surry Power Station. Barnacles of the genus Balanus exhibited similar temporal patterns in all years of the study except 1972 when Hurricane Agnes resulted in reduced salinity levels in the area (Fig. 13). Comparison of fouling plate data with plankton data (which sample barnacle nauplii) and benthic data (which sample adults on a monthly or quarterly basis) shows the superiority of fouling plates for sampling organisms of this genus (Fig. 14). While plates yield samples integrated over time, plankton sampling can miss periods of nauplier abundance and benthic sampling for adult barnacles is dependent on a suitable substrate. All three methods, however, gave results showing no influence from the thermal effluent.

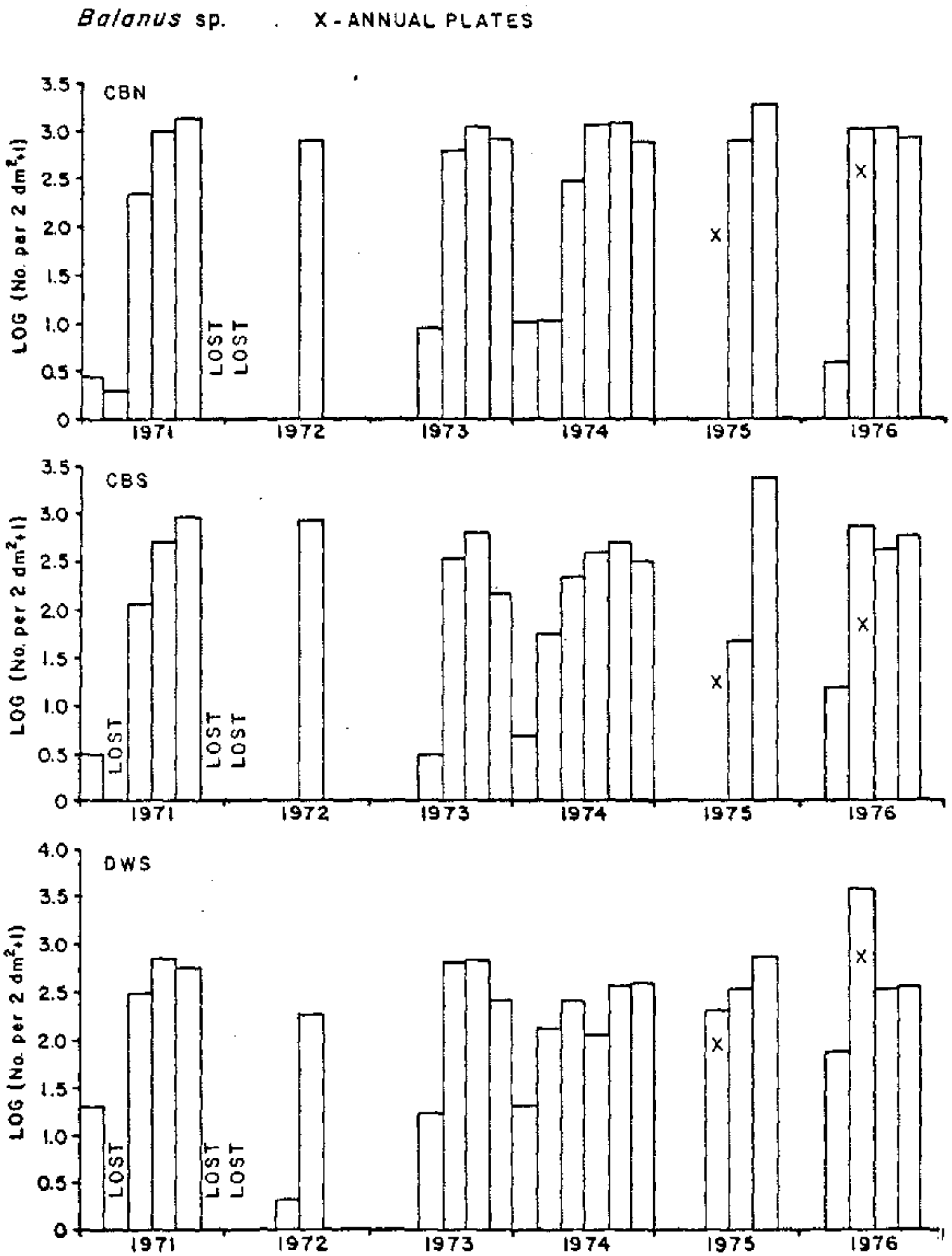


Figure 13: Temporal distributions of <u>Balanus</u> sp. population densities at the three fouling plate stations, 1971-76. (from Appendix P)

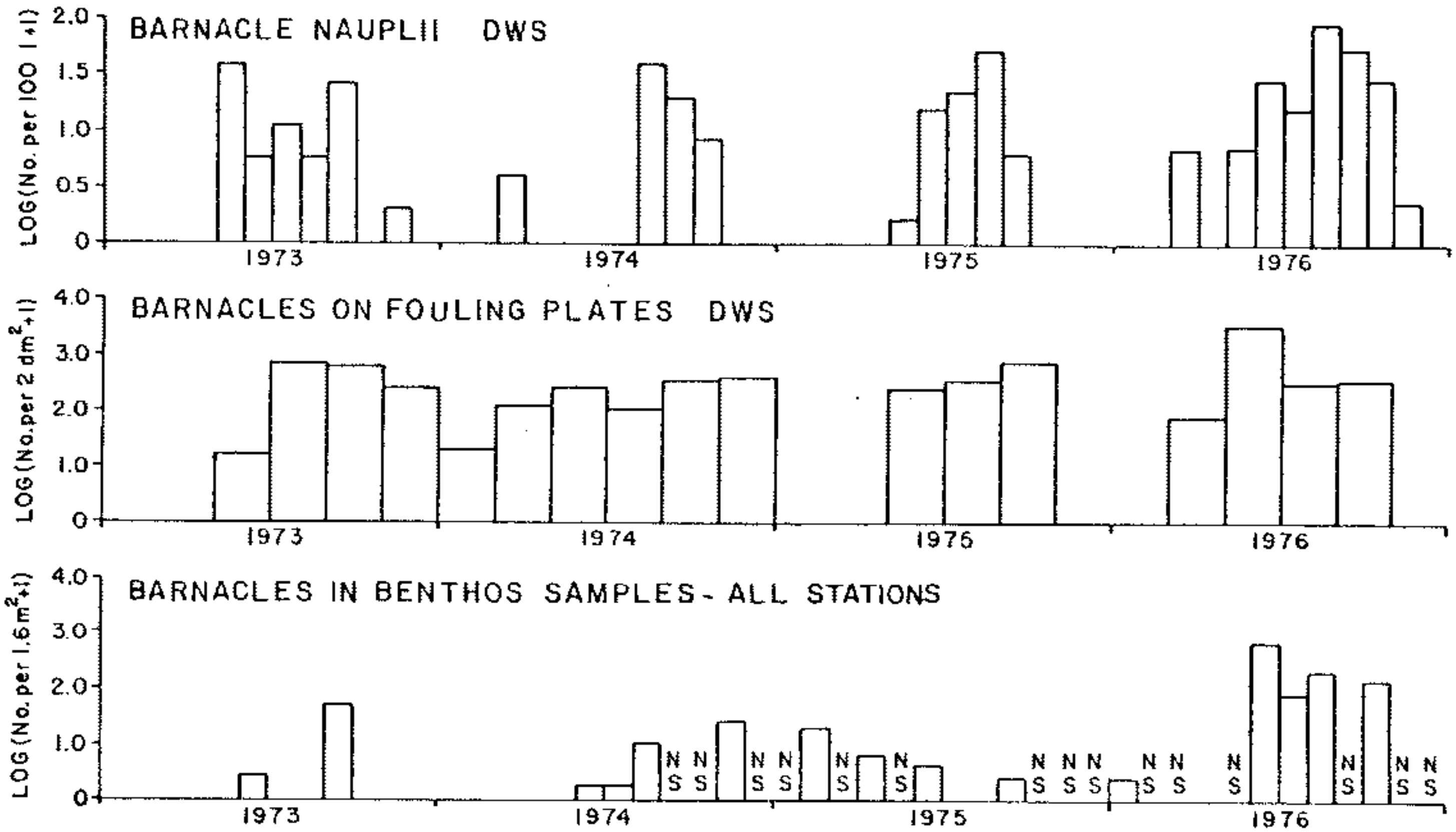


Figure 14: Temporal distributions of barnacle nauplii and Balanus sp. adults at fouling plate station DWS, and of Balanus sp. adults at all benthos stations combined; 1973-76. (NS = not sampled) (from Appendix P)

Amphipods (Corophium lacustre), while not considered a fouling organism, were opportunistic in seeking suitable habitat and consequently comprised the other dominant species collected during this study. Population densities for this species were highest in late summer or early fall at all stations in the six study years (Fig. 15). Specimens were collected in June of each year except 1971 and 1974 when they appeared on the fouling plates in February. The winters of 1970-1971 and 1973-1974 were relatively mild throughout the Chesapeake Bay system and resulted in the early collections.

Fouling organism populations, on the whole, exhibited seasonal variation patterns that changed from year-to-year in response to natural factors. No evidence has been found of any appreciable adverse effects from the thermal effluent from Surry Power Station (Appendices H and P).

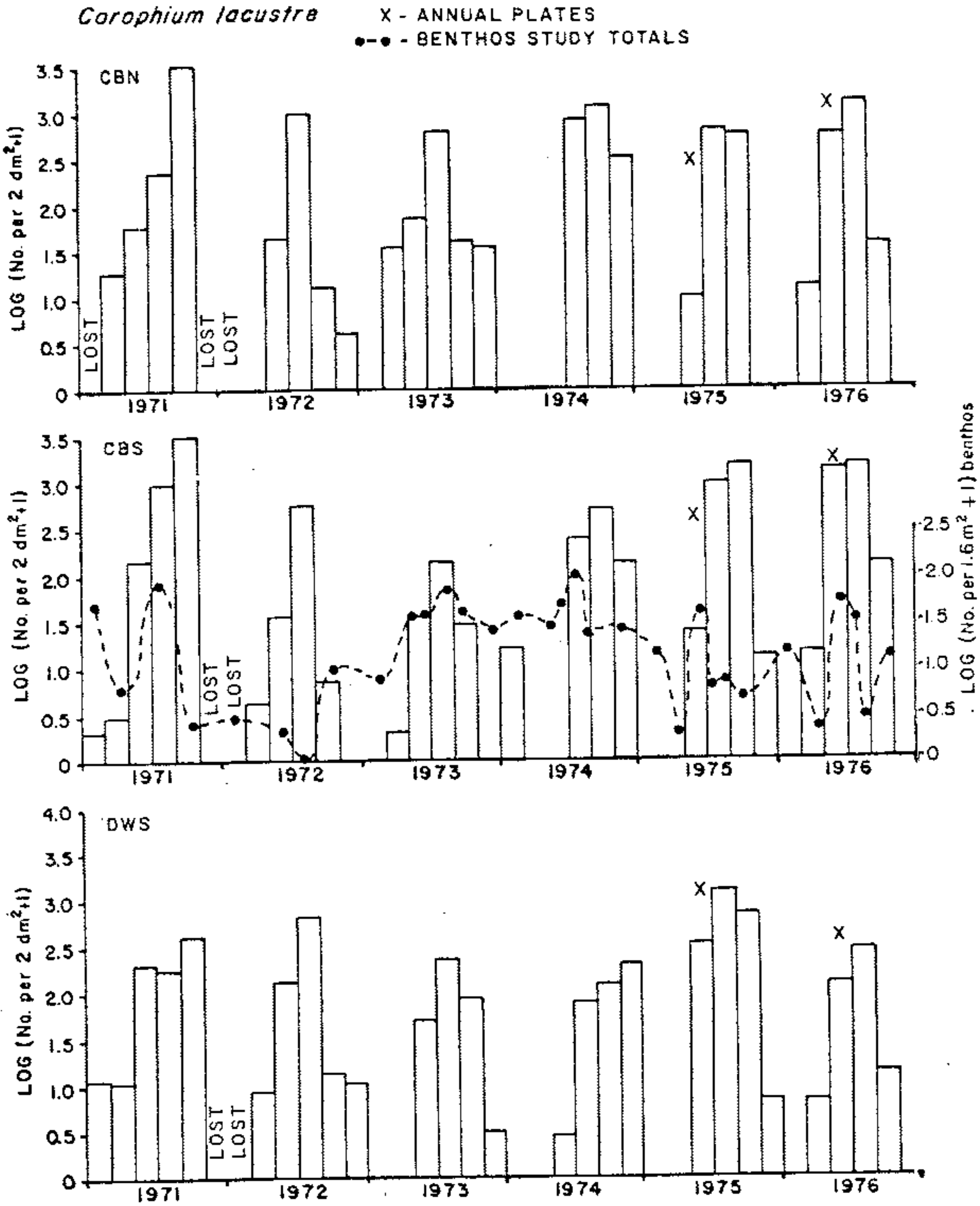


Figure 15: Temporal distributions of Corphium lacustre population densities at the three fouling plate stations and at all benthos stations combined, 1971-76. (from Appendix P)

D. ZOOPLANKTON

The James River zooplankton community is composed of two groups: the true zooplankton (holoplankton), and the meroplankton. The true zooplankters are generally present in varying numbers all year while the meroplankters are seasonal additions to the community, present only during times of reproduction. Those meroplankton discussed in this section include only the larval forms of benthic and fouling organisms. Ichthyoplankton, the other component of the meroplankton, are discussed in the finfish section.

Zooplankton studies have been conducted on a monthly schedule since November, 1972 by personnel of VIMS (Appendices H and P). Seven river stations were sampled in 1972-1974, twelve stations in 1975 and ten in 1976. These samples are taken with a 12.5 cm diameter Clarke-Bumpass quantitative sampler equipped with a No. 20 net. In addition to these river surveys, studies were designed and data taken to determine the effects of plume entrainment. Vertical distribution, vertical migration and the ranges of abundance of major zooplankton groups during a twenty-four hour period were also determined.

Throughout the study there has been a relative paucity of zooplankton in the area. This finding was not unexpected since it is typical of most turbid estuarine transition zones. As with preoperational sampling, copepod nauplii are the dominant forms in postoperational times (Fig. 16). Rotifers, likewise, are a dominant (Fig. 17) and both show, along with most other species, considerable variation due to tidal, diel, salinity, and seasonal influences (e.g., Fig. 18 showing variability of Bosmina sp.). Normally freshwater species such as Bosmina are most abundant when salinity levels fall below one ppt.

Figure 16: Population densities of copepod nauplii in the study area, 1975-76; means over nine stations. (from Appendix P)

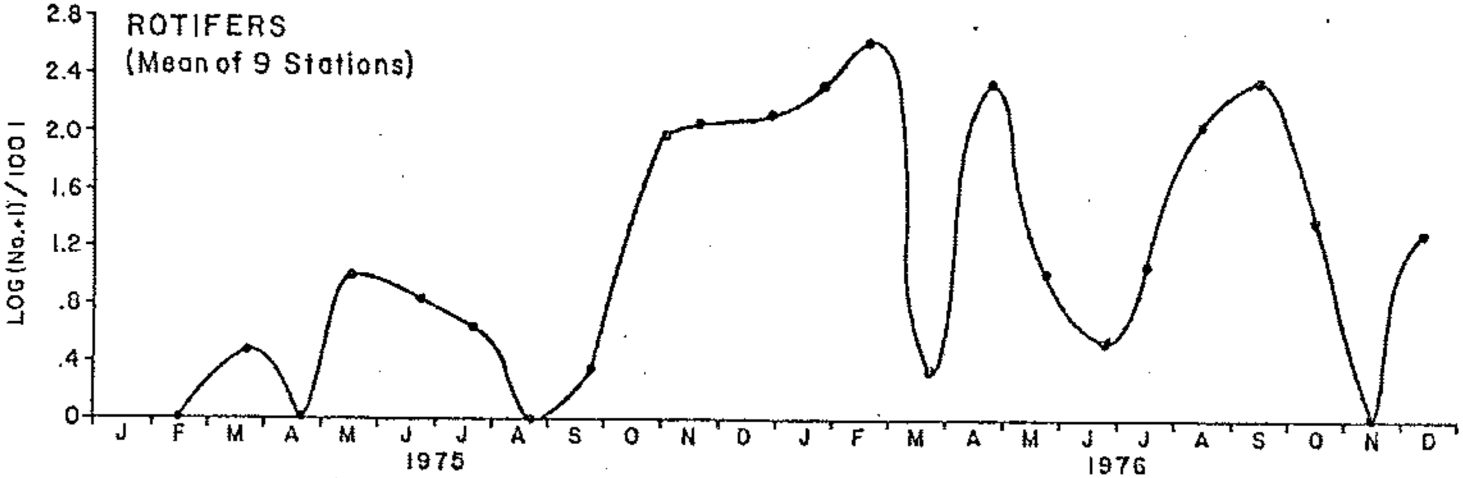


Figure 17: Population densities of rotifers in the study area, 1975-76; means over nine stations. (from Appendix P)

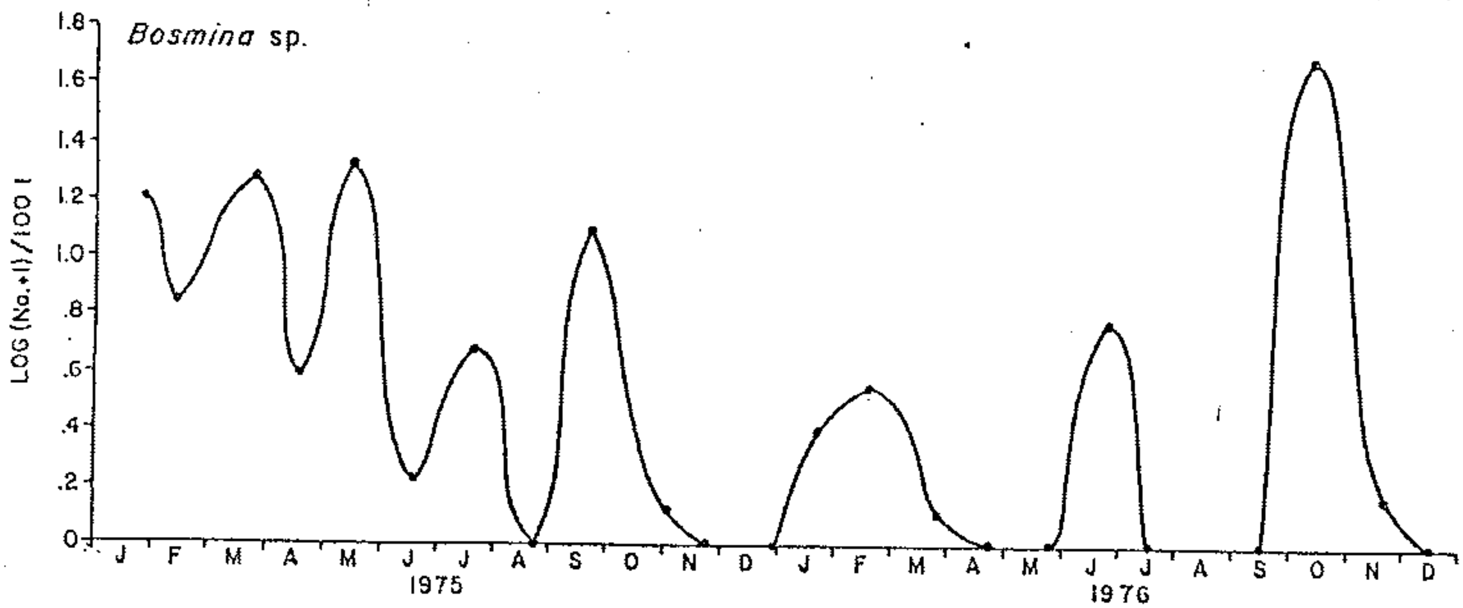


Figure 18: Population densities of Bosmina sp. in the study area, 1975-76; means over nine stations. (from Appendix P)

As to true zooplankters, the oligohaline zone of the James River was usually dominated by two genera of copepods: Acartia and Eurytemora. These dominants were joined by rotifers and cladocerans during low salinity conditions and by larvae of gastropods, polychaetes, and pelecypods during normal reproductive seasons.

Meroplankton larval forms of benthic and fouling organisms were sampled as an inseparable component of the holoplankton. Normal seasonal patterns of abundance were observed with additions to the community by barnacle nauplii from June to September (Fig. 19), polychaete larvae from June to December (Fig. 20), gastropod larvae from June to September, and pelecypod larvae from June to September. The only apparent effect of the Surry discharge was an addition of barnacle nauplii to the river in August and September. However, these are not considered to be a nuisance species.

Analyses were designed to determine significant differences in plume and non-plume areas of the river. Analyses were conducted on all parameters using a variety of approaches, including analysis of variance. Considerable variability in abundance was found within and between stations in and out of the thermal plume, as well as months and seasons. Variation also occurred over depth, tide, and time of day. VIMS concluded from such analyses that the heated effluent from Surry Power Station was not affecting the zooplankton community in the oligohaline zone of the James River.

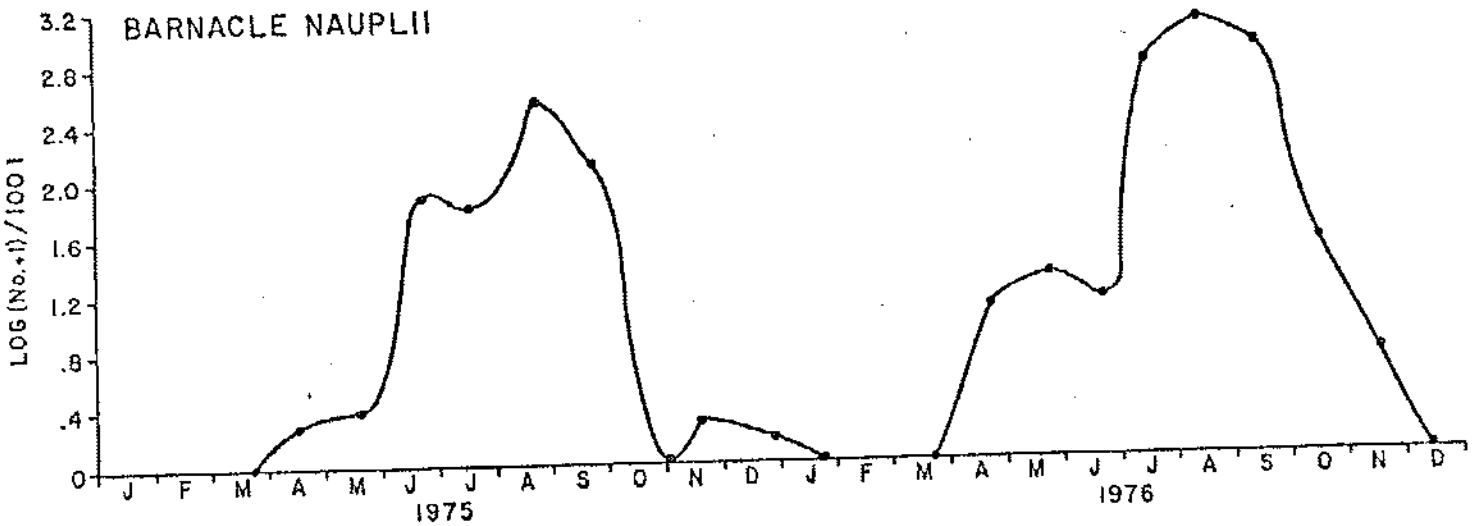


Figure 19:. Population densities of barnacle nauplii at the Surry Power Station discharge, 1975-76. (from Appendix P)

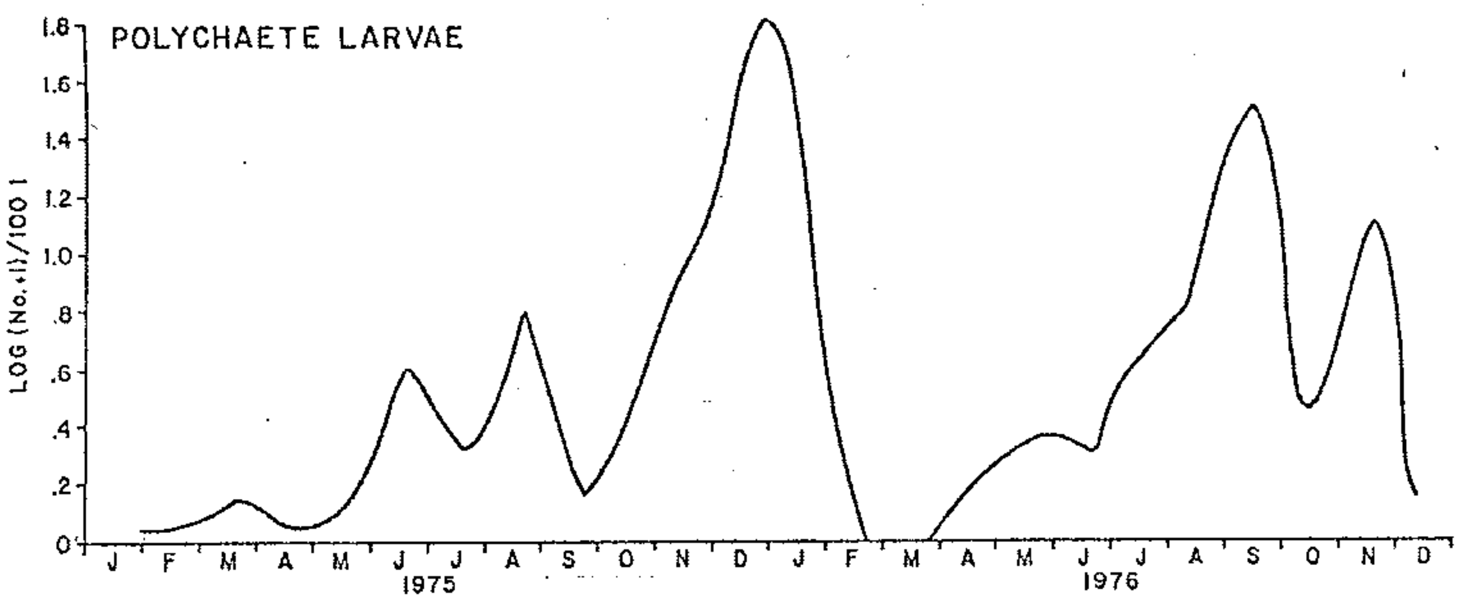


Figure 20: Population densities of polychaete larvae in the study area, 1975-76; means over nine stations. (from Appendix P)

E. PHYTOPLANKTON

Phytoplankton populations in the oligohaline zone of the James River have been under study since the late 1960's, largely by personnel of the Virginia Institute of Marine Science (Appendices H and P). Populations were characterized, and the effects of Surry Power Station thermal discharge determined, by at least four methods commonly utilized in such studies: primary production, chlorophyll $\bar{a}$, total cell counts and identification, and community structure (See VII for details). The major conclusion reached by VIMS during preoperational studies was that the oligohaline zone of the James River is one of low productivity (Appendix I), a conclusion affirmed during operational studies. Subsequently, through operational studies, VIMS concluded that the thermal effluent of Surry Power Station was not appreciably harming the diatom-dominated phytoplankton community of the river (Appendices H and P). There were two main reasons for the findings of low productivity. Populations are naturally low in the transition zone because it is the interface zone between fresh and salt water, a relatively hostile environment for all but the hardiest of species. Also, the zone is an area of high turbidity which reduces light penetration levels which in turn reduce plankton levels.

As stated previously, oligohaline or transition zones, such as the one near Surry Power Station, usually have low levels of phytoplankton because of fluctuating levels of salinity and because this zone is one of high turbidity resulting in reduced levels of light penetration. Employing several of the accepted methods for the characterization and evaluation of estuarine phytoplankton communities, it has been determined that although transition zone phytoplankton populations at times are diverse assemblages of flora, the thermal effluent from Surry Power Station is not causing appreciable harm to them. Dominance shifts and total density fluctuate seasonally in response to natural temperature conditions and the number of species (or community structure) varies in response to salinity (Appendices H and P).

Primary production in the James River transition zone has been determined to be generally very low. Primary production is basically the production of organic matter from inorganic materials per unit of time by autotrophic organisms (e.g., phytoplankton) with the aid of radient energy and is measured in terms of milligrams of carbon. Preoperational studies have shown most wintertime levels to be below 0.1 $mgC \cdot m^{-3} \cdot hr^{-1}$ with 87% of the annual measurements below 5 $mgC \cdot m^{-3} \cdot hr^{-1}$ (Appendices D and I). These low levels were due in part to extreme tidal variations in temperature and salinity and to high turbidities (e.g., Secchi disk readings ranged from 0.1 m to 1.0 m). Postoperational studies by VIMS tended to confirm those levels found prior to station operation in that 85% of the values obtained were below 5 $mgC \cdot m^{-3} \cdot hr^{-1}$ (Appendices H and P) indicating that the thermal effluent from Surry Power Station is not harming productivity in the phytoplankton community.

Chlorophyll a determinations, as measured in micrograms or milligrams per liter, provide a relative measure of the standing crop of phytoplankton, and were made during both preoperational and operational times (Appendices I, H and P). Variability was the rule within and between seasons and within and between stations. Generally, those measurements from July, 1972 through December, 1973 showed values ranging from 1.8 $\mu g \cdot l^{-1}$ in November, 1973 to 5.0 $\mu g \cdot l^{-1}$ in June, 1973. Studies in 1975 revealed ranges from 1.5 $\mu g \cdot l^{-1}$ in December to 5.3 $\mu g \cdot l^{-1}$ in July (Appendix H). Additional studies conducted in 1976 showed mean surface values ranging from 1.6 $\mu g \cdot l^{-1}$ in November to 6.7 $\mu g \cdot l^{-1}$ in April (Appendix P).

Investigations of tidal James River phytoplankton populations in 1968 and 1969 showed similar values with few measurements exceeding 10 $\mu g \cdot l^{-1}$ (Appendix D). Levels exceeding 50 $\mu g \cdot l^{-1}$ are considered indicative of overenrichment. The results by VIMS show that the thermal effluent is not influencing the standing crop of phytoplankton in the river.

Finally, phytoplankton populations have been studied through total cell counts and identification (Appendices H and P) with 1973 through 1976 samples having been analyzed quantitatively. In 1973 and 1974, VIMS found that the lowest counts were obtained in January which had ranges of 50-400 $cells \cdot ml^{-1}$ (1973), and 30-150 $cells \cdot ml^{-1}$ (1974). Yearly maxima occurred in the summer with ranges of 3,000-7,500 $cells \cdot ml^{-1}$ in June, 1973 and 1,550-5,200 $cells \cdot ml^{-1}$ in August, 1974. Similar results were obtained by VIMS in 1975 and 1976 (Fig.21), who concluded that there were no harmful effects from the thermal plume on cell counts.

Community structure in the James River was also similar in all of the years studied (Appendices H and P) although structure changes due to pumping were infrequently noted in the discharge canal. Dominant genera included four diatoms (*Nitzschia*, *Melosira*, *Cyclotella*, *Skeletonema*) and one cryptophyte (*Chroomonas*). As might be expected, periodic within-community dominance shifts occurred which were related to salinity fluctuations in the transition zone. Extreme, but natural, variability within species was the rule rather than the exception (Fig. 22). No effect on community structure could be related to the thermal effluent by VIMS.

During 1975, intensified studies were conducted to determine diel and vertical distributions of phytoplankton populations (Appendix H). These intensified studies were conducted in addition to the regular monthly samples

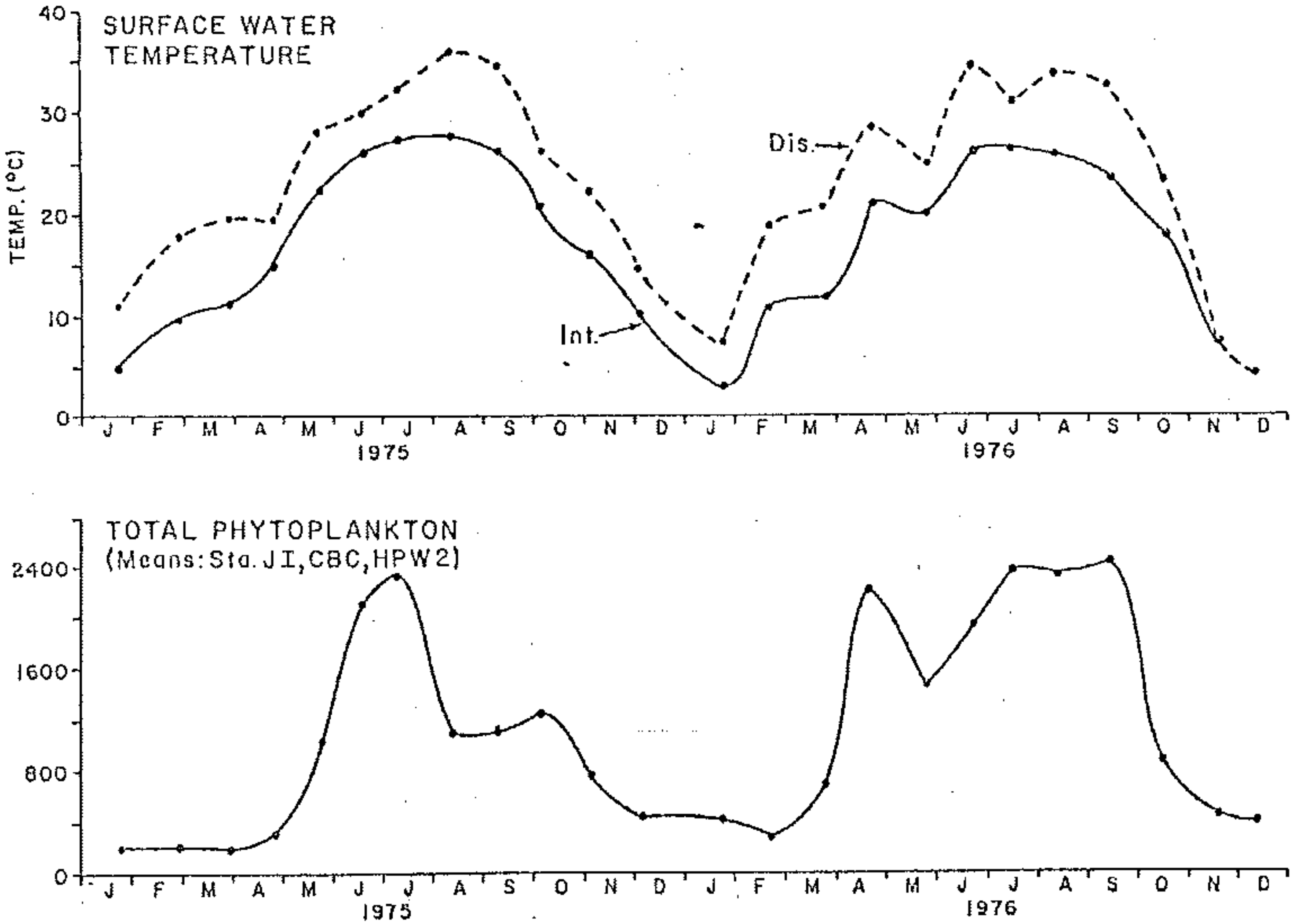


Figure 21: Surface water temperature and total phytoplankton abundance in the study area, 1975-76.
(from Appendix P)

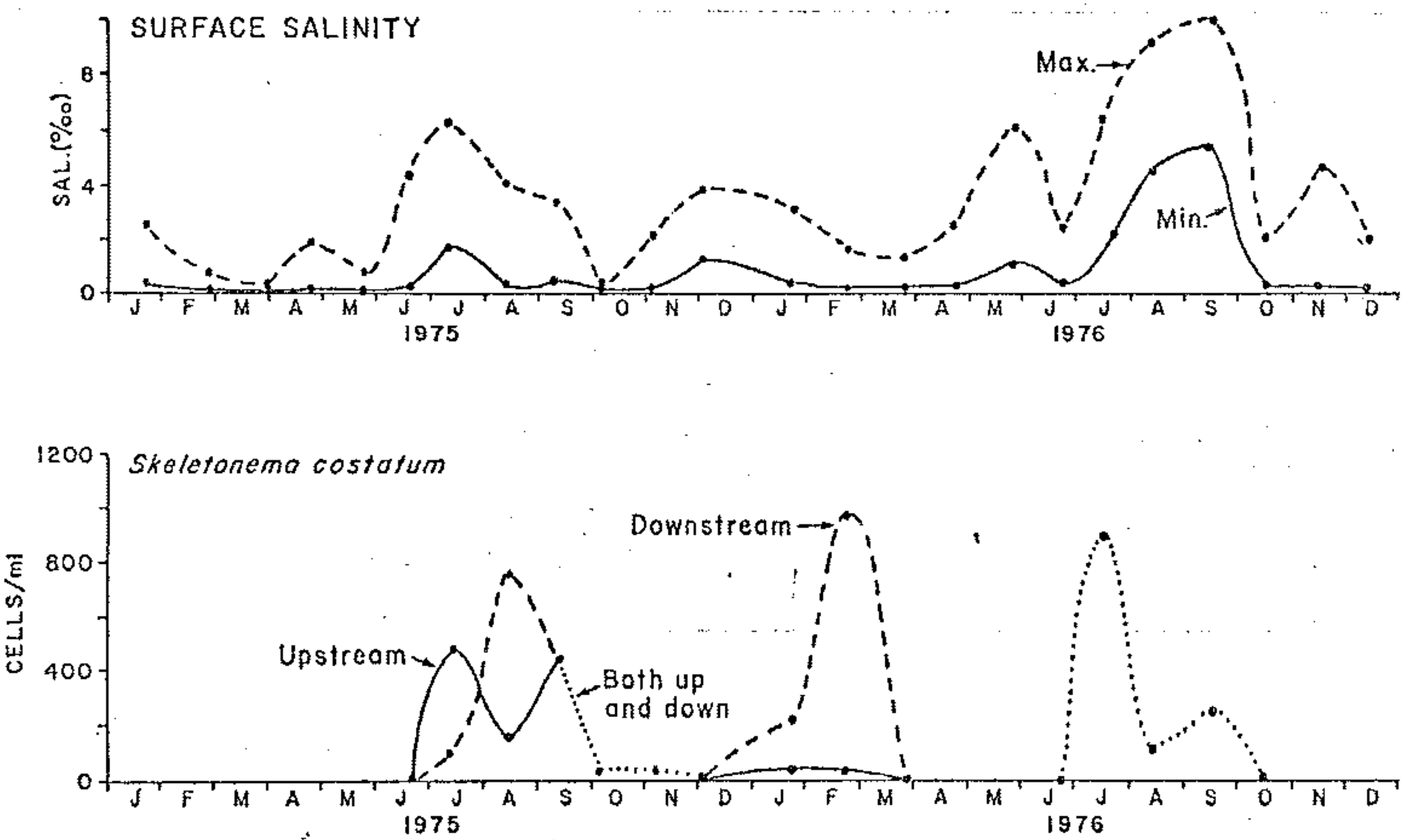


Figure 22: Surface salinity and Skeletonema costatum abundance in the study area, 1975-76. (from Appendix P)

taken at 12 river stations. Vertical distribution samples were taken at each of the 12 stations three times during the year. Diel distributions were determined by sampling at a single station for three 24-hour periods during the year.

Basically, the data indicate that the maximum abundance of phytoplankton occurs during daylight hours (justifying the validity of daytime sampling), and that abundance is relatively uniform over depth (justifying the validity of replicate surface samples). Similar studies in 1976 tended to confirm these results (Appendix P).

The one influence of power station operations that was observed by VIMS occurred in the warmer months of some, but not all, years and appeared to have been limited to the discharge canal system and to a very small area of the river immediately outside of the discharge canal mouth. The effect consisted of slightly reduced or increased numbers of cells in the discharge area which is well within the prescribed mixing zone for Surry Power Station. It should be pointed out that this effect was measured within the discharge canal and immediate vicinity and that there has been no detectable impact on the phytoplankton population in the James River. VIMS found that the effect was due largely to pumping operations and the resultant transport of organisms based on their comparative upstream/downstream densities. Discharge canal decreases occurred when downstream intake waters were poorer in plankton than upstream waters. The reverse was true at times when downstream areas were richer in plankton, and slight increases outside the discharge canal would occur from pumping augmentation. Once again, this increase or decrease could not be detected in the zone of the river beyond the immediate discharge area.

Studies by VIMS concluded that there is little likelihood that the discharge is altering the indigenous community and appreciable harm to the balanced indigenous phytoplankton population is not occurring nor is likely to occur as a result of the heated discharge from Surry Power Station. While the presence of blue-green algae species was noted, VIMS found no evidence to suggest that a shift toward nuisance species of phytoplankton had occurred nor was it likely that it would occur.

Further reading into the effects of Surry Power Station operation on phytoplankton populations in the oligohaline reach of the James River may be found in Appendices H and P.

F. THREATENED AND ENDANGERED SPECIES

The following species, whose known or suspected range includes the area of the Surry Power Station, have been officially classified as endangered or threatened by the U. S. Fish and Wildlife Service:

Mammals - none.

Birds -

Southern Bald Eagle, *Halieetus leucocephalus leucocephalus*
American Peregrine Falcon, *Falco peregrinus anatum*
Arctic Peregrine Falcon, *Falco peregrinus tundrius*
Brown Pelican, *Pelecanus occidentalis*
Kirtlands Warbler, *Dendroica kirtlandii*
Red Cockaded Woodpecker, *Dondrocopos borealis*.

Reptiles - none.

Fish -

Shortnose Sturgeon - *Acipenser brevirostrum*.

Snails - none.

Clams - none.

Insects - none.

Plants - none.

None of the named species has been, or is likely to be, affected by the thermal discharge from Surry Power Station. Two Southern Bald Eagles are known to reside on the Hog Island Wildlife Refuge, feeding largely in the freshwater ponds on the island. Shortnose sturgeon are suspected to occur in Chesapeake Bay and its tributaries although none have been reported from the James River in recent years and none were taken during VIMS and Vepco fish surveys.

G. VERTEBRATES OTHER THAN FINFISH

The location of Surry Power Station near the oligohaline zone of the James River precludes the presence of most aquatic vertebrates other than finfish. For example, there are no manatees, sharks, or whales in the area. Other major vertebrates in the area include the ducks and geese found on the Hog Island Wildlife Refuge. These species are in no way adversely affected by the heated effluent from Surry Power Station.

XI. SUMMARY

The foregoing demonstration contains all of the information necessary to meet the statutory and regulatory standard for a successful Section 316(a) demonstration. Vepco has conclusively demonstrated in this document and the attached appendices that no appreciable harm has resulted from the thermal component of the Surry Power Station discharge to the balanced, indigenous community of shellfish, fish, and wildlife in and on the James River into which the discharge has been made.

XII. APPENDICES

A. Tennyson, P. S., S. O. Barrick, F. J. Wojcik, J. J. Norcross, and W. J. Hargis, Jr. 1972. "The Chesapeake Bay Bibliography, Volume II, Virginia Waters". Spec. Sci. Rep. 63, Virginia Institute of Marine Science.

B. Meteorological Data.

C. Pritchard-Carpenter, Consultants. n.d. "Hydrology of the James River Estuary with Emphasis upon the Ten-Mile Segment Centered on Hog Point, Virginia". A Report Prepared for Virginia Electric and Power Company, Richmond, Virginia As Supporting Material for The Preliminary Safety Analysis Report, Surry Nuclear Power Station.

D. Brehmer, M. L., 1972. "Biological and Chemical Study of Virginia's Estuaries". VPI-WRRC-BULL 45, Contribution No. 452, Virginia Institute of Marine Science, Gloucester Point, Virginia.

E-1 Hoagman, W. J., J. V. Merriner, W. H. Kriete, Jr. and W. L. Wilson. 1974. "Biology and Management of River Herring and Shad in Virginia". Annual Report Anadramous Fish Project. Virginia Institute of Marine Science.

E-2 Hoagman, W. J., and W. H. Kriete, Jr. 1975. "Biology and Management of River Herring and Shad in Virginia". Annual Report Anadramous Fish Project. Virginia Institute of Marine Science.

E-3 Loesch, J. G. and W. H. Kriete, Jr. 1976. "Biology and Management of River Herring and Shad in Virginia". Completion Report, Anadromous Fish Project, 1974-1976. Virginia Institute of Marine Science.

F. Carriker, M. R. 1967. "Ecology of Estuarine Invertebrates: A Perspective". Edited by George H. Lauff, in Estuaries. W. K. Kellogg Biological Station, Michigan State University. pp. 442-487.

G. Diaz, R. J. 1977. "The Effects of Pollution on Benthic Communities of The Tidal James River, Virginia". Ph.D. Thesis, Department of Marine Science, University of Virginia.

H. Jordan, R. A., R. K. Carpenter, P. A. Goodwin, C. G. Becker, M. S. Ho, G. C. Grant, B. B. Bryan, J. V. Merriner, A. D. Estes. 1976. "Ecological Study of The Tidal Segment of The James River Encompassing Hog Point". Final Technical Report submitted to Virginia Electric and Power Company by Virginia Institute of Marine Science, Gloucester Point, Virginia.

I. Cain, T., R. Peddicord, R. Diaz, D. Dressel, E. Tennyson, M. Bender. 1972. "Surry - Pre-Operational Ecological Studies". Report 1 and 2 submitted to Virginia Electric and Power Company by Virginia Institute of Marine Science, Gloucester Point, Virginia.

J. Jenson, L. D. 1974. "Environmental Responses To Thermal Discharges From The Chesterfield Station, James River, Virginia". The Johns Hopkins University, Department of Geography and Environmental Engineering, Report No. 13.

K. Woolcott, W. S. 1974. "The Effects of Loading by The Bremo Power Station on a Piedmont Section of The James River, Volume I and II". Virginia Institute for Scientific Research, Richmond, Virginia.

L. Pritchard - Carpenter, 1967. "Temperature Distribution in The James River Estuary Which Will Result From The Discharge of Waste Heat From The Surry Nuclear Power Station". A Report Prepared for Virginia Electric and Power Company, Richmond, Virginia.

M-1 Bolus, R. L., S. N. Chia and C. S. Fang. "The Design of The Monitoring System for The Thermal Effect Study of The Surry Nuclear Power Plant on the James River". VIMS Special Report in Applied Marine Science and Ocean Engineering, No. 16, Gloucester Point, Virginia, October 1971.

M-2 Chia, S. N., C. S. Fang, R. L. Bolus and W. J. Hargis, Jr. "Thermal Effects of The Surry Nuclear Power Plant on The James River, Virginia, Part II Results of Monitoring Physical Parameters of The Environment Prior to Plant Operation". VIMS Special Report in Applied Marine Science and Ocean Engineering, No. 21, Gloucester Point, Virginia, February 1972.

M-3 Shearls, E. A., S. N. Chia, W. J. Hargis, Jr., C. S. Fang and R. N. Lobecker. "Thermal Effects of The Surry Nuclear Power Plant on The James River, Virginia, Part III. Results of Monitoring Physical Parameters of The Environment Prior to Plant Operation". VIMS Special Report in Applied Marine Science and Ocean Engineering, No. 33, Gloucester Point, Virginia, February 1973.

M-4 Parker, G. C., E. A. Shearls and C. S. Fang, "Thermal Effects of The Surry Nuclear Power Plant on The James River, Virginia, Part IV. Results of Monitoring Physical Parameters During The First Year of Plant Operation". VIMS Special Report in Applied Marine Science and Ocean Engineering, No. 51, Gloucester Point, Virginia, February 1974.

M-5 Parker, G. C. and C. S. Fang, "Thermal Effects of The Surry Nuclear Power Plant on The James River, Virginia, Part V. Results of Monitoring Physical Parameters During The First Two Years of Plant Operation". VIMS Special Report in Applied Marine Science and Ocean Engineering, No. 92, Gloucester Point, Virginia, June 1975.

M-6 Fang, C. S. and G. C. Parker, "Thermal Effects of The Surry Nuclear Power Plant on The James River, Virginia, Part VI. Results of Monitoring Physical Parameters". VIMS Special Report in Applied Marine Science and Ocean Engineering, No. 109, Gloucester Point, Virginia, May 1976.

N. White, J. C., Jr., J. T. Baranowski, C. J. Bateman, I. W. Mason, R. A. Hammond, P. S. Wingard, B. J. Peters, M. L. Brehmer and J. D. Ristroph, 1972. "Young Littoral Fishes of The Oligohaline Zone, James River, Virginia, 1970-1972". Surry Nuclear Power Station Preoperational Studies. Virginia Electric and Power Company manuscript.

O. White, J. C., Jr. editor, 1976. "The Effects of Surry Power Station Operations on Fishes of The Oligohaline Zone, James River, Virginia". Virginia Electric and Power Company manuscript.

P. Jordan, R. A., R. K. Carpenter, P. A. Goodwin, C. G. Becker, M. S. Ho, G. C. Grant, B. B. Bryan, J. V. Merriner, A. D. Estes. 1977. "Ecological Study of The Tidal Segment of the James River Encompassing Hog Point". Final Technical Report submitted to Virginia Electric and Power Company by Virginia Institute of Marine Science, Gloucester Point, Virginia.

Q. Anon. 1974. "Fish Kill 73-025, James River". Bureau of Surveillance and Field Studies, Virginia State Water Control Board.

R. Byrd, M. A. 1975. "Study of The Vascular Flora and Terrestrial Fauna of the VEPCO Surry Nuclear Plant Area, Surry County, Virginia". Submitted to Virginia Electric and Power Company by College of William and Mary, Williamsburg, Virginia.

S. White, J. C., Jr. and M. L. Brehmer, in press. "Eighteen-Month Evaluation of the Ristroph Traveling Fish Screens".