VOLUME I

VOLUME II

Appendix 8A

APPENDIX VI-1-A

ENTRAINMENT PROCESS AND SAMPLING

A.. Description of the Process

Power plant water intakes are usually equipped with intake screens to prevent clogging of the condenser cooling system and pumps. Along with the water, however, organisms smaller than the screen openings (usually 0.25- to 0.5-in. mesh) can be drawn into the system, a process called entrainment. Planktonic organisms (phytoplankton, microzooplankton, macrozooplankton, and ichthyoplankton) are susceptible to entrainment because their small size and limited swimming ability allow passage through the mesh of the traveling screens and prevent escape from the entrained water mass. Some of the entrained organisms are young life stages of fish, in part from recreationally and commercially significant species. Organisms pass through the circulating pumps and are carried with the flow through the intake conduits toward the condenser units. The cooling water and entrained organisms are drawn through one of a multitude of condenser tubes used to cool the turbine exhaust steam. The raw cooling water and organisms then enter the discharge canal or conduit for return to the water. During their passage through the plant, entrained organisms experience a variety of stresses, some of which may cause death. The stresses encountered by the entrained organisms were described by Schubel and Marcy (1978) and are summarized below and depicted in Figure 1.

Physical

Organisms can be exposed to physical stresses at a variety of points throughout the cooling water system. The initial point is passage through the trash racks and intake screens themselves. Organisms just small enough to go through the screens may incur abrasions or compression as they are pulled through the mesh. Further damage may occur during passage from the traveling screens to the pumps.

Passage through the pump is where the most severe shocks occur, creating an almost instantaneous jump in pressure; direct collision with the impeller will occur for some 3.5% of the entrained organisms. Velocities and shear forces can also remain quite high during passage through the condenser tubes. Finally, depending upon the nature of the discharge structure, turbulence and shear may be encountered when the cooling water is returned to the water body.

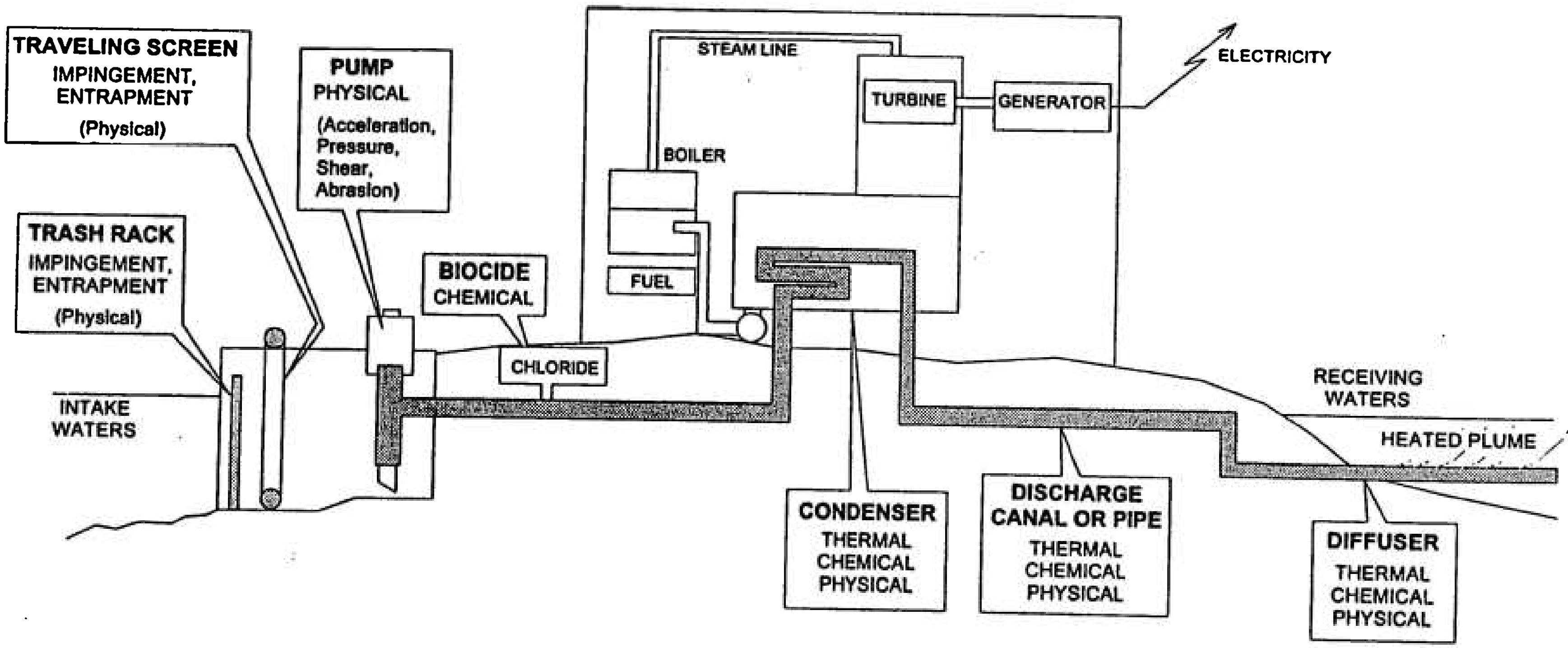


Figure 1. Schematic diagram of a typical steam electric generating station with once-through cooling water.

Thermal

Entrained organisms can be exposed to elevated temperatures during passage through the condenser tubes, where the rise in cooling water temperature is almost instantaneous, and in the discharge canal or conduit, where organisms may be exposed to elevated temperatures from less than a minute to more than 30 minutes, depending on the type and length of the discharge structure. Figure 2 describes, in general terms, the temperature rise experienced by entrained organisms.

Chemical

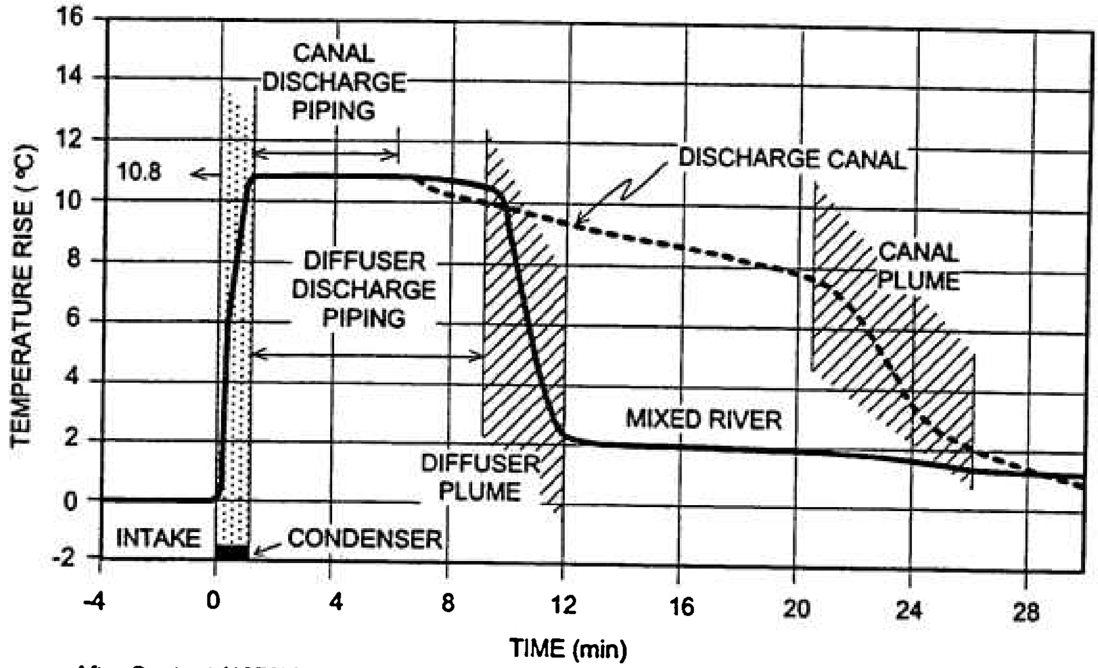
To prevent fouling during certain times of the year, some power plants inject intermittent pulses of biocide into the coolant. Some organisms may be directly exposed to chlorine.

All Stresses Combined

Organisms that survive entrainment may be exposed to thermal and biocidal stresses for seconds to hours after discharge, depending upon whether a diffuser, multiport jet, weir, or canal forms the outfall. In addition, if a diffuser is present, the organisms may be exposed to shear stresses as they are discharged through the diffuser and into the river with the cooling water. However, the shear stresses generated at the diffuser and when the dilution water from the river is mixed with the discharge plume are considerably less than those encountered by the organisms during passage through the plant and well below the lethal range.

The number of ichthyoplankton entrained depends on factors such as location in relation to the plant intakes (e.g., vertical distribution in the water column); physiology and condition of the organisms; and power plant factors such as intake design, zone of water withdrawal, velocities at the screen face, screen mesh size, pumping rates, and operation schedules. Early life stages such as eggs and yolk-sac larvae behave like passive particles, i.e., they will be carried with the river velocities and those flows entering the plant intake. As ichthyoplankton mature into post-yolk-sac and juveniles, they develop increasing swimming ability and their susceptibility to entrainment may be dictated more by behavior and other factors than by flows at the intakes. It is often assumed that they behave as passive particles and are entrained at rates directly proportional to the intake flow. This approach results in the linear relationship (shown in Figure 3) between the number of organisms entrained and the plant's flow rate. Annual entrainment abundance estimates are often calculated based on this direct proportion and total plant flows.

The approximate relationship between numbers entrained and flow rate does not accurately depict the relationship between the flow rate and the number of organisms cropped by entrainment. The latter relationship is complicated by the fact that the temperature change across the condensers, ΔT, increases when plant flow rate is reduced below the design condition (Figure 4). The increased ΔT may cause the cooling water temperature to exceed the organisms' lethal limit. Beyond this point, additional decreases in the plant flow rate



After Coutant (1970b)

Figure 2. Hypothetical time-courses of temperature changes experienced by organisms entrained in condenser cooling water and subsequently discharged.

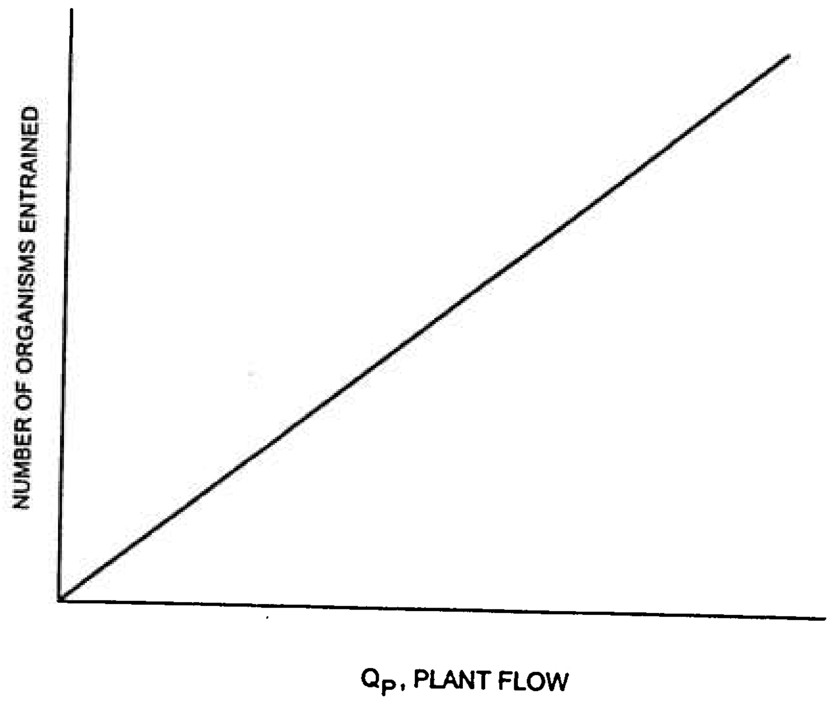


Figure 3. Relationship between number of organisms entrained and plant flow rate (Q_P).

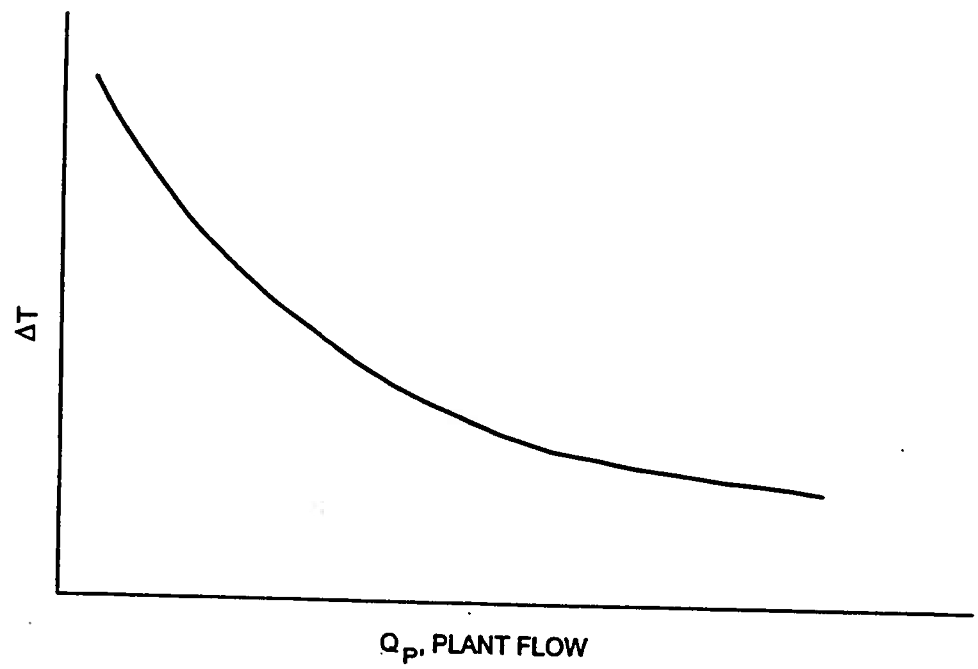


Figure 4. Relationship between temperature increase across the condenser (Δ_T) and plant flow rate (Q_P).

will result in further increases in the thermal mortality rate until it reaches 100% (Figure 5).

The influence of an increase in thermal mortality rate on the mortality rate due to all stresses combined depends on the organisms' tolerance of physical and chemical stresses in the absence of thermal stresses. If mortality due to physical and chemical stresses is 100%, the thermal mortality rate has no influence on the total rate, and decreases in plant flow translate directly into reductions in the numbers of organisms lost due to entrainment. However, if a large fraction of the entrained organisms survive the physical and chemical stresses, the combined mortality rate will increase when ΔTs reach the range over which thermal mortality occurs. For fragile organisms, i.e., that small fraction that survives physical and chemical stresses, the combined mortality rate also increases with ΔT but at a less dramatic rate.

For fragile organisms, when plant flows are increased enough that ΔTs decrease and thermal mortality diminishes, the number lost due to entrainment may decline or remain nearly constant over a range of plant flows. After this range of flows, the number lost increases with flow but at a lower rate determined by the magnitude of the mortality rate due to nonthermal stresses. A similar pattern evolves for hardy organisms, i.e., those with a relatively low mortality rate in response to nonthermal stresses. After the transitional range of plant flows, the number lost resumes its pattern of increase but at a lower rate.

B.. Data to Estimate Entrainment Effects

The Long River Programs summarized in Section V-D are described in the annual reports listed in Appendix V-1. Studies concerned with the impacts of entrainment have been conducted periodically at the generating stations since 1972. The following sections summarize the studies conducted at each plant.

Roseton

Sampling to estimate the numbers of organisms entrained has been conducted at the Roseton Generating Station from 1974 to 1987. These studies focused on the seasonal and diel abundance patterns associated with various fish species and life stages. Early entrainment studies at Roseton also included macrozooplankton. Water quality, plant operating conditions, and environmental conditions (i.e., tidal stage) were recorded with each sample.

In addition to the routine entrainment abundance monitoring, a variety of other entrainment studies have been conducted at Roseton Generating Station. These studies have included estimates of survival and evaluation of mitigation measures and sampling gear and design.

Entrainment survival studies began at Roseton in 1975 and continued through 1980. Initial studies included phytoplankton, zooplankton, and ichthyoplankton survival estimates. Later studies focused on estimates of initial and latent survival of striped bass, white perch, Atlantic tomcod, and herring.

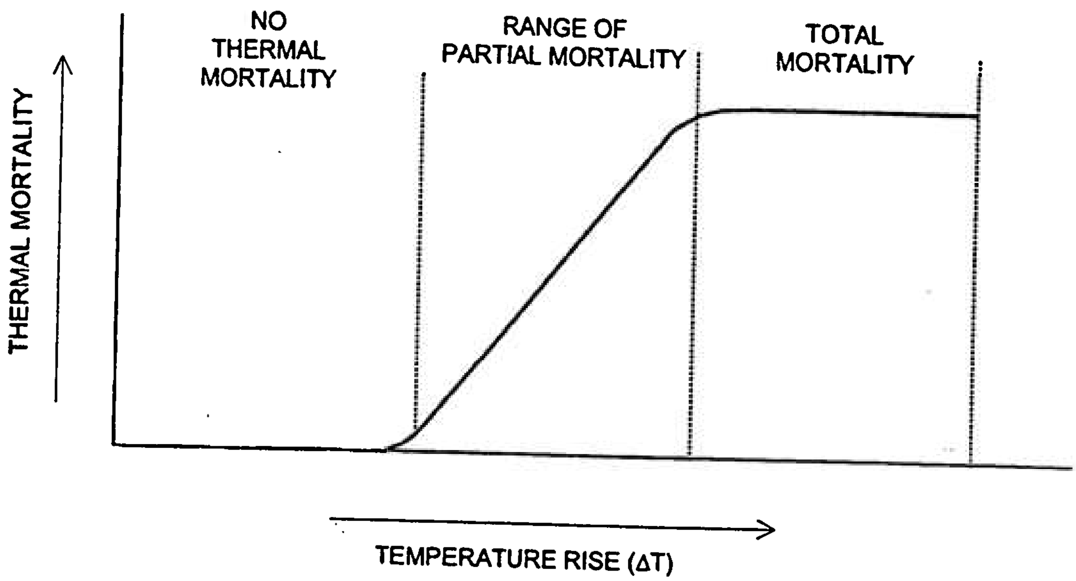


Figure 5. Variation of number of entrained organisms killed by thermal stress as a function of temperature rise.

Indian Point

Entrainment sampling began at Indian Point Generating Station in 1972 and, with the exception of 1982, was continued until 1987. Annual reports describing the entrainment studies conducted at Indian Point are listed in Appendix V-1. Entrainment abundance studies were designed to quantify and identify the species and life stages entrained at each unit. In the 1970s, entrainment sampling concentrated on selected species of macrozooplankton and striped bass ichthyoplankton at both the intake and discharge structures. During the 1980s, entrainment sampling at Indian Point focused on ichthyoplankton entrainment. Annual entrainment programs have evaluated seasonal, diel, and tidal abundance patterns as well as length frequency distributions of selected species.

Special studies concerning entrainment mitigation, survival, and differences in sampling gear and design have also been conducted at Indian Point. Survival studies have considered initial and latent survival as well as the differences between thermal and mechanical mortality. Survival studies conducted in 1988 examined mechanical mortality after the installation of the dual and variable speed pumps at Units 2 and 3, respectively (EA 1989). Studies have focused on selected species: striped bass, white perch, herrings, bay anchovy, and Atlantic tomcod.

Bowline Point

Entrainment sampling at Bowline Point Generating Station began in 1973 and continued until 1987. Appendix V-1 lists the annual reports of each study. Initial studies included phytoplankton and zooplankton sampling to define temporal variations in species and life-stage composition. Subsequent studies focused on entrainment effects on striped bass, white perch, Atlantic tomcod, and bay anchovy.

Data collected included abundance according to species and life stage, and length frequencies for selected species. Special studies concerning the survival of fish larvae and juveniles were also conducted on a regular basis at Bowline Point between 1975 and 1979. These studies examined the thermal and mechanical components of entrainment mortality and the length frequency distributions associated with species survival.

C.. *Qualitative Description of Entrainment Effects*

Entrainment sampling has been conducted at the Roseton, Indian Point, and Bowline power plants for 14, 14, and 15 years, respectively. The number of taxa identified in these sampling efforts at these stations is 52, 34, and 37, respectively. However, for most of these species the numbers caught were small. Tables 1, 2, and 3 indicate that 95% of the catch at the three stations was composed of six species (bay anchovy, blueback herring and alewife, striped bass, white perch, and American shad). Based on the relative importance of species to the ecosystem, their current or potential value as recreational or commercial resources, and their appearance in entrainment samples, certain species were selected by DEC for analysis here.

TABLE 1

COMPOSITION OF ENTRAINMENT ABUNDANCE SAMPLES AT ROSETON GENERATING STATION, 1981-1987

TAXON	EGGS	YOLK-SAC LARVAE	POST YOLK-SAC LARVAE	JUVENILE	UNIDENTIFIED LIFESTAGE	TOTAL(a)
Clupeidae	28.78	9.10	70.38	16.31	53.59	48.61
White perch	69.20	14.26	9.94	53.70	1.80	33.49
Striped bass	0.76	36.96	13.70	5.21	0.50	9.27
Cyprinidae	0.81	17.04	1.58	0.37	3.99	2.43
Tessellated darter	0.04	18.99	1.25	5.04	0.22	1.89
Morone spp.	—	0.10	1.13	0.49	20.68	1.76
Unidentified	0.29	0.12	0.07	—	16.74	1.15
American shad	0.01	0.81	1.00	2.16	1.18	0.61
Bay anchovy	0.02	<0.01	0.51	3.58	0.02	0.27
Yellow perch	<0.01	1.24	0.26	—	0.14	0.21
Atlantic tomcod	<0.01	1.25	0.01	2.81	1.10	0.16
Rainbow smelt	<0.01	0.01	0.09	0.77	—	0.05
Hogchoker	0.06	—	0.02	1.30	—	0.04
Centrarchidae	<0.01	0.07	0.04	0.04	—	0.02
American eel	—	—	—	2.93	—	0.01
Blueback herring	—	—	—	2.12	0.01	0.01
Fundulus spp.	0.01	0.02	0.01	0.45	—	0.01
Banded killifish	<0.01	<0.01	0.01	0.16	—	0.01
Atlantic menhaden	—	—	0.01	0.12	—	<0.01
Spottail shiner	—	—	<0.01	1.10	—	<0.01
Percidae	—	0.01	<0.01	—	0.03	<0.01
Fourspine stickleback	—	<0.01	—	0.49	—	<0.01
White sucker	—	0.01	<0.01	—	—	<0.01
Brown bullhead	—	—	<0.01	0.41	—	<0.01
Silverside	<0.01	—	<0.01	—	—	<0.01
Pomoxis spp.	—	<0.01	<0.01	—	—	<0.01
White catfish	—	—	<0.01	0.08	—	<0.01
Alewife	—	—	—	0.12	—	<0.01
Summer flounder	—	—	—	0.08	—	<0.01
Redbreast sunfish	—	<0.01	<0.01	—	—	<0.01
Threespine stickleback	—	—	—	0.08	—	<0.01
Etidolus spp.	<0.01	—	—	—	—	<0.01
Trout-perch	—	—	<0.01	—	—	<0.01
Largemouth bass	—	—	<0.01	—	—	<0.01
Creek chubsucker	—	—	—	0.04	—	<0.01
Atlantic needlefish	—	<0.01	—	—	—	<0.01
Northern pipefish	—	—	—	0.04	—	<0.01

Note: Clupeidae includes both herring and alewife. Some individuals identified only to family or genus.
(a)Includes all life stages and individuals.

TABLE 2

COMPOSITION OF ENTRAINMENT ABUNDANCE SAMPLES AT BOWLINE POINT GENERATING STATION, 1981-1987

TAXON	EGGS %	YOLK-SAC LARVAE %	POST YOLK-SAC LARVAE %	JUVENILE %	UNIDENTIFIED LIFESTAGE %	TOTAL (a) %
Bay anchovy	60.65	1.50	87.92	49.23	0.23	85.02
Clupeidae	.68	31.31	6.93	3.20	—	6.72
Striped bass	0.06	37.66	2.66	24.22	—	2.95
White perch	32.22	3.45	1.10	4.70	—	2.53
Morone spp.	1.46	.015	0.28	0.16	44.94	0.53
Unidentified	3.91	25.24	0.81	10.27	53.26	1.84
American shad	0.88	—	0.07	0.10	—	0.10
Centrarchidae	—	0.11	0.01	—	1.53	0.02
Hogchoker	—	0.19	0.01	—	—	0.02
Silverside	—	0.04	0.02	0.03	—	0.02
Northern pipefish	—	—	<0.01	0.73	—	<0.01
Cyprinidae	0.01	0.04	<0.01	—	—	<0.01
Weakfish	—	—	<0.01	0.07	—	<0.01
Atlantic tomcod	—	—	<0.01	.045	—	<0.01
Percidae	—	—	<0.01	—	—	<0.01
American eel	—	—	—	0.33	—	<0.01
Eastern mudminnow	—	0.02	<0.01	0.24	—	<0.01
Fundulus spp.	—	0.28	0.01	0.09	—	0.01
Gizzard shad	—	—	<0.01	—	—	<0.01
Rainbow smelt	—	—	0.01	—	—	0.01
Rough silverside	—	—	<0.01	0.02	—	<0.01
Inland silverside	—	—	0.03	0.02	—	0.03
Atlantic silverside	—	—	0.01	0.07	—	<0.01
Tessellated darter	—	—	<0.01	—	—	0.01
Yellow perch	—	—	<0.01	—	—	<0.01
Bluefish	—	—	—	0.10	—	<0.01
Sciaenidae	—	—	<0.01	—	—	<0.01
Naked goby	—	—	<0.01	1.58	—	<0.01
Gobiidae	—	—	0.12	3.48	0.03	0.02
Blueback herring	—	—	—	0.03	—	0.14
Alewife	—	—	—	0.03	—	<0.01
Atlantic needlefish	—	—	—	0.02	—	<0.01
Fourspine stickleback	—	—	—	0.09	—	<0.01
Threespine stickleback	—	—	—	0.07	—	<0.01
Windowpane	—	—	—	0.02	—	<0.01
Winter flounder	—	—	—	0.02	—	<0.01

Note: Clupeidae includes both herring and alewife. Some individuals identified only to family or genus.
(a)Includes all life stages and individuals.
All species and life stages were not identified for all years.

TABLE 3

COMPOSITION OF ENTRAINMENT ABUNDANCE SAMPLES AT INDIAN POINT GENERATING STATION, 1983-1987

TAXON	EGGS %	YOLK-SAC LARVAE %	POST YOLK-SAC LARVAE %	JUVENILE %	UNIDENTIFIED LIFESTAGE %	TOTAL (a) %
Bay anchovy	98.59	5.54	62.00	14.33	4.65	65.14
Clupeidae	0.09	75.74	16.15	1.64	0.04	13.80
Striped bass	0.12	7.79	11.09	4.07	0.33	8.29
White perch	0.83	2.00	7.64	3.86	0.03	5.77
Unidentified	0.30	0.04	0.03	0.06	76.14	2.74
Morone spp.	<0.01	0.11	0.95	0.01	17.63	1.30
American shad	0.01	0.18	0.65	0.29	<0.01	0.48
Weakfish	<0.01	—	0.32	25.83	0.01	0.60
Rainbow smelt	—	0.01	0.21	5.94	0.03	0.24
Atlantic tomcod	—	—	0.02	36.04	0.01	0.54
Gobiidae	—	<0.01	0.16	0.79	—	0.13
Tessellated darter	—	4.64	0.11	0.06	0.01	0.21
Cyprinidae	0.03	3.02	0.14	—	0.17	0.20
Hogchoker	0.01	0.12	0.22	0.22	<0.01	0.16
Yellow perch	—	0.37	0.10	—	0.03	0.08
Common carp	<0.01	0.06	0.04	—	—	0.03
Atherinidae	<0.01	0.07	0.03	—	0.06	0.03
Atlantic menhaden	—	—	0.03	0.34	<0.01	0.16
American eel	—	—	—	2.11	—	0.03
Northern pipefish	—	—	<0.01	3.82	0.01	0.06
Percidae	—	0.10	0.02	—	0.81	0.04
Inland silverside	<0.01	0.03	0.02	—	—	0.01
Centrarchidae	0.01	0.08	0.02	—	<0.01	0.02
Sciaenidae	<0.01	—	0.02	0.33	<0.01	0.02
Fundulus spp.	0.01	0.03	0.01	—	—	0.01
Goldfish	—	—	0.01	—	<0.01	0.01
Winter flounder	—	—	0.01	0.02	—	<0.01
Banded killifish	<0.01	0.03	<0.01	0.01	—	<0.01
Rough silverside	—	0.01	<0.01	0.01	0.01	<0.01
Mummichog	<0.01	<0.01	<0.01	—	—	<0.01
Atlantic silverside	—	0.01	<0.01	—	—	<0.01
Summer flounder	—	—	<0.01	—	—	<0.01
Catostomidae	0.01	—	—	—	—	<0.01
White sucker	<0.01	—	<0.01	—	—	<0.01
Fourspine stickleback	—	<0.01	<0.01	—	—	<0.01
Windowpane	—	—	<0.01	0.02	—	<0.01
Atlantic needlefish	—	—	<0.01	—	—	<0.01
Spot	—	—	<0.01	0.04	—	<0.01
Threespine stickleback	—	—	—	0.02	—	
White catfish	—	—	<0.01	0.01	—	<0.01

Table 3 continued

TAXON	EGGS %	YOLK-SAC LARVAE %	POST YOLK-SAC LARVAE %	JUVENILE %	UNIDENTIFIED LIFESTAGE %	TOTAL (a) %
Seaboard goby	—	—	—	0.02	—	<0.01
Labridae	<0.01	—	—	—	—	<0.01
Searobin	—	—	<0.01	—	—	<0.01
Bluefish	—	—	—	0.02	—	<0.01
Halfbeak	—	—	<0.01	—	—	<0.01
Butterfish	—	—	<0.01	0.04	—	<0.01
Smallmouth flounder	—	—	<0.01	0.01	—	<0.01
Conger eel	—	—	<0.01	0.01	—	<0.01
Spottail shiner	—	—	—	0.03	—	<0.01
Northern puffer	—	—	—	0.01	—	<0.01
Brown bullhead	—	—	—	0.01	—	<0.01
Smallmouth flounder	—	—	—	0.02	—	<0.01

Figures 6, 7, 8 and 9 show the time of occurrence and relative magnitude of entrainment losses for these selected species at Roseton, Indian Point, and Bowline Point.

D. Quantitative Description of Entrainment Effects

Entrainment conditional mortality rate is the probability of fish dying from passage through the cooling water system of a power plant. It is expressed as the fractional reduction in the number of fish in the Hudson River at the end of the first year of life. If there are no density-dependent mechanisms operating, the conditional mortality rate will carry through proportionally to later life stages. If, on the other hand, the survival rate increases for individuals remaining in that cohort, the reduction in the size of the cohort at some later life stage will be less than the estimated conditional mortality rate. Thus, the impact of entrainment on a population depends on the nature (density-dependent/ density-independent) and timing (relative to the conditional mortality) of natural mortality factors.

Two different approaches are available for estimating conditional mortality rates. The first, the Empirical Transport Model (ETM), uses river sampling to determine the portion of the river population entrained at a given power plant. The ETM formulation is based on the spatial and temporal distributions of the organisms; it does not require estimates of the absolute number of organisms in the river or the numbers entrained. Hence, it does not require sampling within the plant to estimate the numbers entrained, but it does require estimates of the ratio or fraction of organisms in the river that are likely to be entrained (i.e., are exposed) and the fraction of the organisms that does not survive plant passage.

The other approach to estimating conditional mortality due to entrainment uses direct estimates of the numbers entrained coupled with estimates of the standing crop of organisms in the river and the fraction of entrained organisms killed by plant passage to estimate the conditional entrainment mortality rate (CEMR). The number of organisms entrained is based on sampling of the cooling water in the discharge canal or pipe. As discussed above, mortality due to exposure to elevated temperatures is typically considered separately from that due to mechanical, pressure, and chemical stresses. A full description of the two modeling approaches, along with the equations used to compute the thermal component of plant mortality are presented in Appendix VI-1-B.

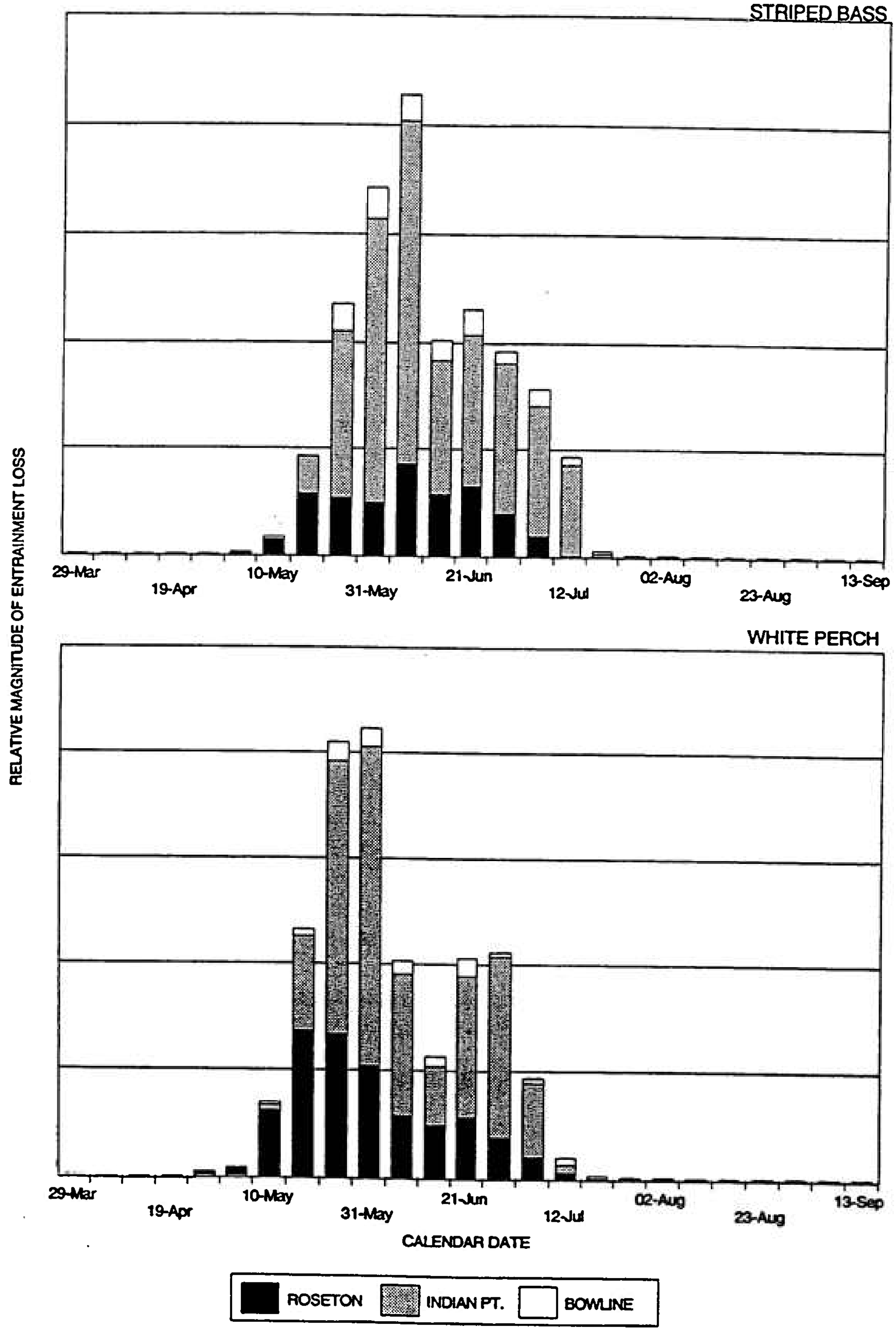


Figure 6. Time of occurrence and relative magnitude of entrainment losses of select species at Bowline Point, Roseton, and Indian Point as related to water withdrawal (1981-1987).

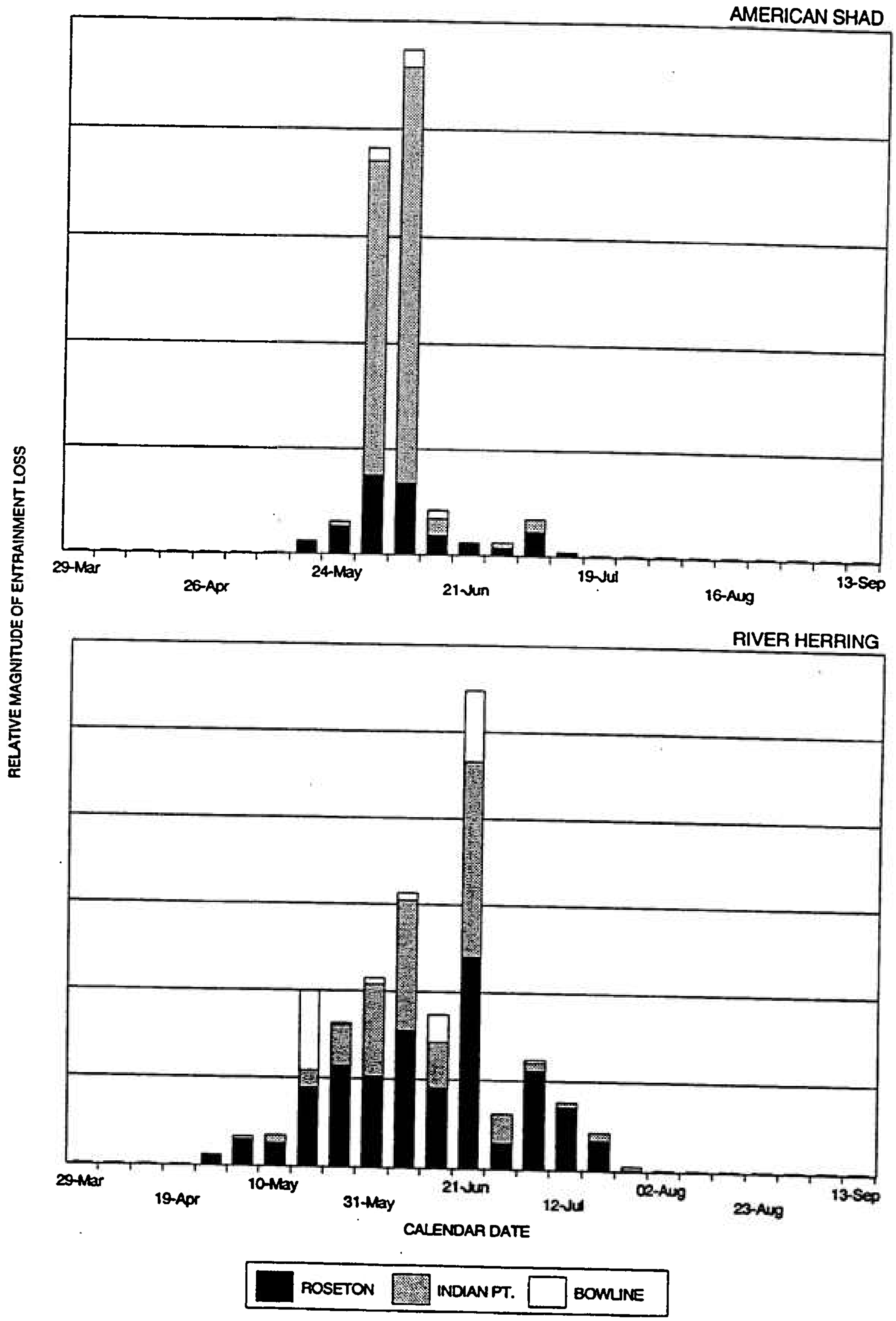


Figure 7. Time of occurrence and relative magnitude of entrainment losses of select species at Bowline Point, Roseton, and Indian Point as related to water withdrawal (1981-1987).

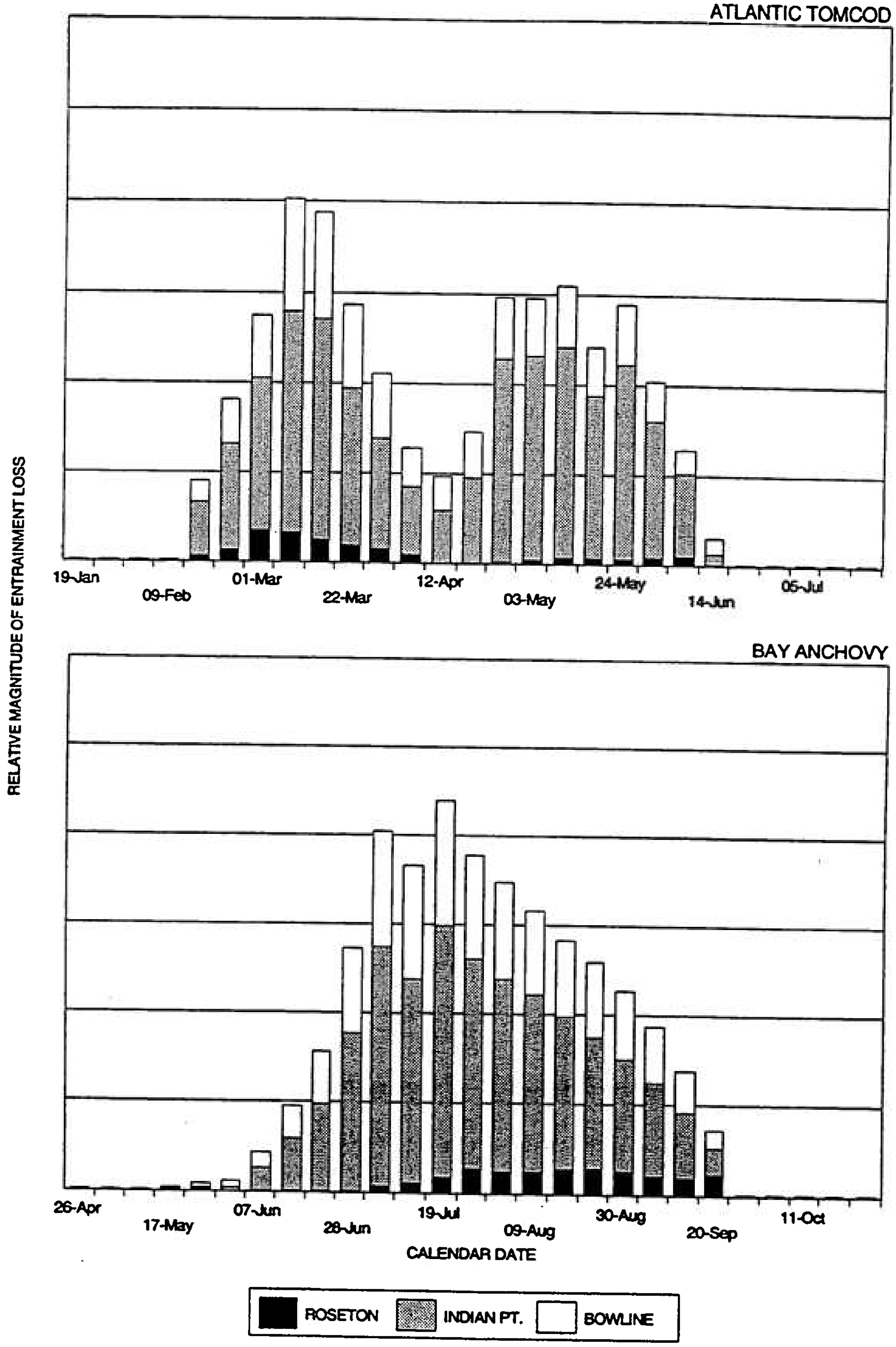


Figure 8. Time of occurrence and relative magnitude of entrainment losses of select species at Bowline Point, Roseton, and Indian Point as related to water withdrawal (1981-1987).

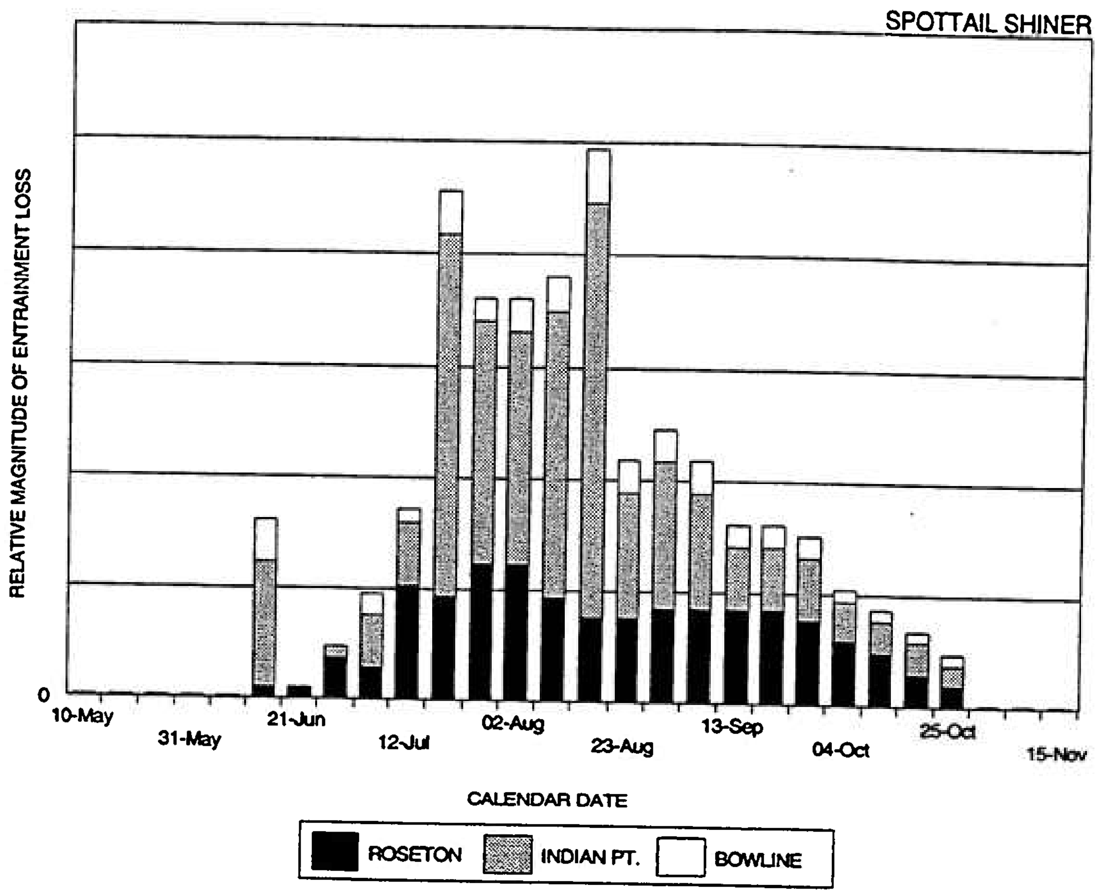


Figure 9. Time of occurrence and relative magnitude of entrainment losses of select species at Bowline Point, Roseton, and Indian Point as related to water withdrawal (1981-1987).

Appendix VI-I-B

Methods Used To Estimate Entrainment Effects

Introduction

Background

The Draft Environmental Impact Statement (DEIS) for the operation of Bowline Point, Indian Point and Roseton power plants includes the estimation of the fractional reduction in young-of-year fish populations due to entrainment and the distribution of effects through time. Sampling programs that began in the mid-1970s as part of the Hudson River Monitoring Program (HRMP), provide measurements on both the abundance of fish populations at various times and in various life stages in the Hudson River estuary and the numbers of fish entrained and killed by the plants. Modeling is used to estimate conditional entrainment mortality rates and to assess the potential effectiveness of alternative mitigation scenarios such as planned outages. For the DEIS, estimates of the conditional entrainment mortality rates (CMR), the fractions of young-of-year populations that would die from entrainment-related causes if no other causes of mortality operated, were made for American shad (*Alosa sapidissima*), Atlantic tomcod (*Microgadus tomcod*), bay anchovy (*Anchoa mitchilli*), striped bass (*Morone saxatilis*), white perch (*Morone americana*), spottail shiner (*Notropis hudsonius*), and "river herring" over the period 1974 through 1995. The river herring designation includes both alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*) due to difficulties in distinguishing the larvae of these two species.

The CMRs for the seven fish employed two estimation methods—the Empirical Transport Model (ETM) and the Conditional Entrainment Mortality Rate (CEMR) model. Each method has specific data requirements that can limit its application to particular years, taxa and power plants. The ETM was originally developed for use with data on river-wide distribution patterns of ichthyoplankton. Numbers entrained are estimated from larval densities and power plant flows. The Type I ETM model was developed for use with field data that identify fish life stages but not ages.

Boreman et al. (1978, 1981) and Boreman and Goodyear (1988) describe model development, assumptions, and previous applications. The ETM (Boreman and Goodyear, 1988) is based on the assumptions that

> (1) the data used to establish the spatial and temporal distributions of organisms are accurate, (2) organisms redistribute instantaneously among regions of the water body between life stages, but do not move among regions within each life stage, (3) power plant effects on organisms do not alter their overall pattern of distribution within the water body, (4) organism distribution parameters are estimated from field measurements of the entire standing crop of each entrainable life stage, and (5) natural mortality of a given life stage is uniform within the modeled system .

The ETM method can be applied to all years of the Longitudinal River Survey (LRS) that allow estimates of river-wide distribution patterns of ichthyoplankton.

The CEMR model was developed later as part of the Outage Evaluation Program, a multi-year program begun in 1982 that was sponsored by the Hudson River Utilities and conducted in cooperation with the New York State Department of Environmental Conservation. The CEMR method was developed to take advantage of direct samples of the entrained ichthyoplankton that were available from programs conducted at the three power plants in 1981 and from 1983 through 1987—the only years the CEMR method could be applied to, to estimate conditional entrainment mortality rates.

Because the CEMR method relies on the most direct source of data for estimating mortality (direct counts of entrained organisms), it is the preferred method for estimating conditional mortality rates—the ETM method is used for years when entrainment data are not available. To produce a consistent time-series of conditional mortality rates based on direct entrainment counts when available and ETM estimates otherwise, the ETM was modified to have an algebraic structure similar to the CEMR model and calibrated against the CEMR model. The calibration was performed using data from 1981 through 1987 (which support both CEMR and ETM estimates) for American shad, river herring, striped bass, white perch, and bay anchovy at four plants (Bowline Point, Indian Point, Roseton and Danskammer). In addition, a calibration was performed for river herring and white perch at the Albany Steam Station using entrainment data from 1983.

Characterization for Historical Conditions

For the purpose of characterizing historical power plant effects, year-specific estimates of CMR (note that CMR refers to the rate and CEMR refers to the model) are needed because what happened in each year is of interest. Each year-specific estimate should be as accurate as possible given the type and amount of data collected for that year—using CEMR (which is based on direct counts of entrained ichthyoplankton) for 1981 through 1987 when entrainment abundance data were collected, and ETM for the remaining years. Because the CEMR method relies on the most direct source of data for estimating mortality (direct counts of entrained organisms), it is the preferred for estimating conditional mortality.

As discussed previously, the ETM was modified and calibrated against the CEMR model to produce a consistent time-series of CMR estimates (including both CEMR-based and ETM-based estimates). The modified ETM model represents the weekly conditional survival fraction as a product of daily conditional survival fractions, just as the CEMR model does. This is a departure from the original ETM, which represents the weekly conditional survival fraction in terms of an exponential decay function with a weekly time step.

To further increase the degree of consistency between the CEMR-based and modified ETM-based CMR estimates, the modified ETM was also calibrated to the CEMR model. The purpose of the calibration was to identify W-ratio values (the quotient of average intake density of a taxon over the average regional density) which could not be directly estimated from field data, for the ETM that make the ETM-based estimates, on average, equal to the corresponding CEMR-based estimates of CMR.

Unsampled Areas

Along with the availability of direct counts of entrained ichthyoplankton, the portion of the Hudson River that is subject to sampling in each year also affects CMR estimates for the historical period. The LRS is the source of data for river-wide abundance estimates used in CEMR and for river-wide distribution pattern estimates used in ETM. It is a major element of the HRMP, which also includes the Fall Shoals Survey (FSS) and Beach Seine Survey (BSS). The HRMP uses a stratified random sampling design to allocate samples to locations in the Hudson River. For the HRMP, the Hudson River is divided into 13 regions (numbered 0 to 12 from the mouth to Albany) and 5 habitat strata (channel, bottom, shoal, shore and beach). The LRS and FSS sample three of these habitat strata (channel, bottom and shoal), whereas the BSS samples two (shore and beach).

In addition to the defined regions and habitat strata, Region 12 was split into two sub-regions, the area from River Mile (RM) 125 to RM 140 and the area from RM 140 to RM 152, because the northern portion was not sampled by the LRS in all years of the program. All together, the 14 regions/subregions and 5 strata of the HRMP define 70 statistical strata, covering the entire area of interest from the Battery to the Troy Lock.

Although the majority of the volume of the Hudson River has been subject to sampling by the LRS, not all statistical strata have been sampled in all years. Twenty-seven (27) of the 70 statistical strata were sampled in all years. Thirty-seven (37) of the statistical strata, including all beach areas, shore zones and some shoals, have not been sampled by the LRS, although the volume associated with some of these strata is small in comparison to the volume of sampled strata. Six (6) of the statistical strata, including Region 0 and the northern portion of Region 12, have been sampled in recent years but were not sampled in earlier years. Table X-1 summarizes the unsampled strata for the LRS.

The presence of unsampled areas in the historical database can introduce biases into estimates of abundances and distribution patterns used in estimates of CMR. For example, excluding the northern- and/or southern-most portions of the River from distribution pattern estimates (e.g., as used in ETM) could cause estimates of the fraction of the population inhabiting the middle regions of the River to be biased high if fish inhabited that area of the River. If this occurred, the ETM would produce over-estimates of CMR. Similarly, excluding any area inhabited by a fish taxon and life stage of interest would cause CEMR to over-estimate CMR.

An approach to reducing this type of bias is to use data from sampled areas in each year to predict the densities in adjacent unsampled areas. The resulting data set would be complete for each year—using either an actual density estimate or a predicted density for each of the 70 statistical strata. This method could be viewed as an extension of the method used to predict densities in unsampled shoal, shore zone, and beach areas.

In 1986 and 1987, the Utilities conducted special studies in traditionally unsampled shoals, shore zone, and beach areas in the Poughkeepsie, Catskills, and Tappan Zee regions. Data from these studies were used to develop adjustment factors used to predict densities in unsampled areas based on densities in adjacent sampled areas (Coastal 1991a and b). Analyses similar to those conducted with data from the 1986 and 1987 unsampled areas studies were applied to data collected in areas that were unsampled in some, but not all, years. In 1987, the LRS was expanded to sample the northern portion of Region 12, which was not sampled in previous years. In 1988, the LRS was expanded further to include sampling of Region 0, which was not sampled in earlier years. Data from these later years have been used to develop prediction equations that could be applied to data from the earlier years. For example, data collected after 1986 in the northern portion of Region 12 (coupled with data collected in the southern portion of Region 12 in those years) provide a basis for predicting densities in the northern portion of Region 12 (based on observed densities in the southern portion of Region 12) in years when the northern portion was not sampled. For each year, the entire volume of Region 12 is then used in estimating river-wide abundances for CEMR, and distribution patterns for ETM. These adjusted estimates are used for analyses based on Regions 0 through 12 and for analyses based on Regions 1 through 12 only.

Annual data sets of ichthyoplankton densities that were standardized using this type of approach are now used as input to abundance indices and for assessments of conditional mortality rates using either ETM or CEMR. The standardized annual data sets used for these analyses provide a high level of consistency between ETM and CEMR.

Changing Environmental Conditions

The approach discussed above to account for fish inhabiting unsampled areas assumes that the relationship between densities in the unsampled area and the adjacent sampled area is stationary over time. For example, ichthyoplankton densities in Region 1 could be used to predict densities in Region 0 for years prior to 1988 (based on the relationship between densities in Regions 1 and 0 during the years 1988 through 1995). This approach would produce a consistent time-series of CMR estimates (for the entire historical period) if the relationship between densities in Region 1 and Region 0 did not change from the earlier years of the historical period (1974 through 1987) to the later years (1988 through 1995). However, as discussed below, water quality data collected by the HRMP suggest that a change in environmental conditions occurred in the late 1980s that may have affected the relationship between densities in Region 0 and Region 1.

Due to this uncertainty about environmental change, two sets of CMR estimates are computed for the years prior to 1988. One set includes predicted Region 0 densities (to reduce bias associated with omitting a portion of the river wide fish population from CMR calculations), and one set includes only Regions 1 through 12 (to avoid possible biases due to any change that may have occurred in the relationship between Region 1 and Region 0 densities).

Assessment of Future Effects of Power Plant Operations

For the purposes of assessing the likely future effects of power plants under alternative plant operating scenarios, CMR estimates that reflect representative future conditions (i.e., conditions like ichthyoplankton distribution patterns that would affect entrainment) are desirable. Although it is not possible to accurately predict future distribution patterns of ichthyoplankton, and the approach presented here is to select historical years that span a range of conditions that might be expected in the future.

It can be argued that recent conditions (e.g., 1991 through 1995) better reflect future conditions than do past conditions (e.g., 1981 through 1987, or pre-1981). This argument is supported by improvements in water quality in the lower Hudson River that occurred in 1991, and may have affected distribution patterns of some species and life stages. These water quality improvements appear to be due to upgraded wastewater treatment facilities in the lower Hudson River. The North River wastewater treatment plant (WWTP) achieved full secondary treatment in 1991.

Due to changing environmental conditions in the Hudson River and the inclusion of Region 0 in LRS sampling since 1991, CMR estimates from these later years are used to assess the likely future effects of alternative plant operating scenarios.

Approach for Estimating CMR

Tables X-2a and b summarize the methods for estimating CMR for all years of the historical period. Estimates for all years were used to characterize the effects of power plants during the historical period (1974 through 1995). One set of CMR estimates included 13 regions. The other set included 12 regions (Regions 1 through 12) for the period 1974 to 1987. For both of these sets of CMR estimates, the ETM model was re-calibrated to the CEMR model using both 12-region and 13-region analyses.

CMR estimates for 1991 through 1995 were used to assess the likely effects of future plant operations. These CMR estimates are based on actual field data for all 13 regions.

Structure of this Report

The remaining sections of this report describe the models, the modifications that were made to the algebraic structure of ETM, the calibration of the modified ETM, the derivation of additional constituent parameters, descriptions of the sources of data for ETM and CEMR, and modeling results. Except where otherwise noted, the equations are specific to power plant, year, and taxon.

Modeling Methods: Comparison of ETM and CEMR

Empirical Transport Model (ETM)

In ETM, the total entrainment mortality (m_T) is calculated as

$$m_T = 1 - \sum_{s=1}^{S} R_s \left[\prod_{j=0}^{J} \left[\prod_{l=1}^{L} \left[\sum_{k=1}^{K} D_{s+j,kl} \quad e^{-(E_{s+j,kl}\ C_{s+j,sl}\ t)} \right] \right] \right] \tag{1}$$

where

m_T	=	total conditional entrainment mortality rate; and
s	=	week 1, 2, 3, ..., S of the spawning period (subscript s will also denote cohorts born in those weeks);
j	=	age 0, 1, 2, ..., J of entrainable individuals in weeks;
l	=	life stage 1, 2, 3, ..., L;
k	=	river region 1, 2, 3, ..., K;
R_s	=	proportion of spawning that occurred in week s, so that $\sum_{s=1}^{S} R_s = 1$;
$D_{s+j,kl}$	=	average proportion of river-wide abundance of life stage l individuals during week $s+j$ that are in region k, with $\sum_{k=1}^{K} D_{s+j,kl} = 1$ for each week, cohort and life-stage;
$E_{s+j,kl}$	=	instantaneous entrainment mortality rate constant for life stage l individuals during week $s+j$ in region k (units of per day);
$C_{s+j,sl}$	=	proportion of week $s+j$ that individuals of cohort s spend in life stage l; and
t	=	duration in days of week $s+j$ (i.e., $t = 7$).

This formulation differs slightly from the formulation presented by Boreman and Goodyear (1988) because it allows for cohort-specific life-stage durations (C_{wsl}) and week-specific distribution patterns (D_{wl}) with $w = s + j$.

The instantaneous entrainment mortality rate constant is defined as

$$E_{s+j,kl} = P_{s+j,k} \quad f_{s+j,kl} \quad W_{s+j,kl} / V_k \tag{2}$$

where

$P_{s+j,k}$	=	rate of water withdrawal from region k in week $s+j$ (units of $m^3\ d^{-1}$);
$f_{s+j,kl}$	=	fraction of life-stage l individuals in region k during week $s+j$ entering the intake that eventually are killed by plant passage;
$W_{s+j,kl}$	=	ratio of the average intake density to average regional density of life-stage l individuals during week $s+j$ in region k; and

V_k = volume of region k (units of m³).

In the application of this model to Hudson River data, the region-specific subscripts (k) on the terms $f_{s+j,kl}$ and $W_{s+j,kl}$ are dropped because the data do not support region-specific estimates of these parameters. Also, average values for $W_{s+j,kl}$, rather than week-specific values, are used, and so the week-specific subscript ($s+j$) is dropped.

This formulation of the ETM also can be written in term terms of calendar week (w) instead of age (j) as

$$m_T = 1 - \sum_{s=1}^{S} R_s \left[\prod_{w=s}^{s+J} \left[\prod_{l=1}^{L} \left[\sum_{k=1}^{K} D_{wkl} \quad e^{-(E_{wkl} C_{wsl} t)} \right] \right] \right], \tag{3}$$

with $w = s + j$.

Conditional Entrainment Mortality Rate Model (CEMR)

The CEMR model was patterned after the ETM, but was developed to use direct estimates of the number of ichthyoplankton entrained available from discharge sampling at the power plants. The CEMR model is a discrete-time model with a daily time step and does not account for any variability in cohort abundance within a day. The parameters s, S and J have the same meaning as in ETM except that they are defined in terms of days rather than weeks. For each day, two underlying parameters are defined: the river wide abundance of the cohort, and the number of individuals in the cohort that die from entrainment. The general formulation of the CEMR model is

$$m_T = 1 - \sum_{s=1}^{S} R_s \left[\prod_{d=s}^{s+J} \left[\prod_{l=1}^{L} \left(1 - \frac{X_{ds}}{N_{ds}} \right)^{\delta_{dsl}} \right] \right] \tag{4}$$

where N_{ds} = the river-wide abundance of cohort s on day d;

X_{ds} = the number of individuals in cohort s that are killed by entrainment during day d; and

δ_{dsl} = the proportion of day d that individuals of cohort s spend in life-stage l ($\sum_{l} \delta_{dsl} = 1$ for each day of entrainment vulnerability for cohort s).

The daily conditional mortality rate due to entrainment for cohort s (CMR_{ds}) is the fractional reduction in the abundance of the cohort due to the presence of entrainment (note that CEMR refers to the CEMR model, CMR denotes an estimate of the conditional mortality rate). The daily conditional mortality rate is defined as $CMR_{ds} = X_{ds} / N_{ds}$, and the daily conditional survival rate (CSR_{ds}) is (1 - CMR_{ds}). These expressions are based on the assumption that the number of individuals that are killed by entrainment in any day does not affect the number that die from natural mortality. The number that die from natural causes in a day, however, can affect the number that die from entrainment without violating this assumption.

Due to data limitations, an additional assumption and an adjustment factor are required in order to estimate CMR_{ds}. Cohort-specific data on river-wide abundance and on the number killed by entrainment are not available. Therefore, data that are life-stage specific (but aggregated over all cohorts that are in the same life stage) are used as a surrogate for cohort-specific data. The assumption is made that the daily conditional mortality rate for individuals in cohort s and life-stage l on day d is the same as the daily conditional mortality rate for the entire population of life-stage l individuals on day d. The daily conditional mortality rate for life-stage l individuals on day d is defined as

$$CMR_{dl} = \sum_{s}^{S} X_{dsl} \Big/ \sum_{s}^{S} N_{dsl} \qquad (5)$$

where N_{dsl} = the river-wide abundance of cohort s individuals that are in life-stage l on day d; and

X_{dsl} = the number of individuals in cohort s that are in life-stage l and are killed by entrainment during day d.

The number of individuals killed (X_{dsl}) is defined as the product of two terms,

$$X_{dsl} = NE_{dl} \, f_{dl} \qquad (6)$$

where NE_{dl} = the number of individuals in life-stage l that are entrained on day d; and

f_{dl} = the fraction of life-stage l individuals entering the intake on day d that eventually are killed by plant passage.

Therefore, CSR_{ds} is defined for estimation as

$$CSR_{ds} = \prod_{l}^{L} (CSR_{dl})^{\delta_{dsl}} \qquad (7)$$

where $$CSR_{dl} = 1 - \left(\frac{NE_{dl} \;\; f_{dl}}{N_{dl}} \right).$$

The ratio of the number entrained to the river-wide abundance is estimated using field data collected by two different gear types: ichthyoplankton trawls in the river and pump samplers in the power plant discharge canals. Therefore, an adjustment factor is needed to correct for the difference in gear efficiencies. The adjustment factor is termed the relative probability of capture (RPC_{dl}), and it includes the quotient of ichthyoplankton trawl gear efficiency (q_{1dl}) over pump gear efficiency (q_{2dl}) for larvae of life-stage l on day d. As discussed below, RPC_{dl} also implicitly includes a term for changes in density due to destruction of larvae (preventing identification to taxa of interest) during collection by either gear and by transit through the plant.

When the RPC_{dl} factor is explicitly included in the formula for the daily conditional survival rate, the rate can be rewritten as

$$CSR_{dl} = 1 - \left(\frac{NE'_{dl} \;\; f_{dl}}{N'_{dl}} \;\; RPC_{dl} \right) \qquad (8)$$

where N'_{dl} = $N_{dl} q_{1dl}$, the measured river-wide abundance of life-stage l individuals on day d not adjusted for ichthyoplankton trawl gear efficiency;

NE'_{dl} = $NE_{dl} q_{2dl}$, the measured number of life-stage l individuals entrained on day d not adjusted for pump gear efficiency; and

RPC_{dl} = q_{1dl} / q_{2dl}, the ratio of the gear efficiencies for larvae of life-stage l on day d.

Relative probability of capture estimates are taxon, life-stage, and length specific. Therefore, for each day d, RPC_{dl} is assigned a value, RPC_{lc}, where RPC_{lc} is the relative probability of capture for life-stage l individuals in length class c and the mean of life-stage l individuals on day d is within length-class c.

With these two modifications to address data limitations, the full CEMR model as applied in the DEIS is

$$m_T = 1 - \sum_{s=1}^{S} R_s \left[\prod_{d=s}^{s+J} \left[\prod_{l=1}^{L} \left(1 - \frac{NE'_{dl} f_{dl}}{N'_{dl}} RPC_{dl} \right)^{\delta_{dsl}} \right] \right]. \qquad (9)$$

The RPC_{lc} factors for striped bass and white perch yolk-sac larvae (YSL) and post yolk-sac larvae (PYSL) are taken from an earlier field study at Indian Point (Coastal, 1991a). The RPC factors for PYSL bay anchovy were computed using data from a 1988 RPC study at Indian Point and the methods described in Coastal (1991a). In the field studies, it was not possible to separate the effects of relative gear efficiencies and changes in observable ichthyoplankton density due to larval destruction within the gears or cooling system. Therefore the estimated RPC_{lc} factor adjusts for the combination of these effects. When applying the RPC_{lc} factor values in the calculation of the CEMR model estimates, distinguishing between these effects is not necessary because the larval counts are affected by, and need to be adjusted for, all of the effects present when the RPC_{lc} values are estimated.

For the remaining life stages of bay anchovy, striped bass and white perch, and for all stages of American shad and river herring, an RPC_{dl} value of 1.0 is used. No estimates are available for the eggs or juveniles of American shad, striped bass, or white perch, nor for any stages of river herring, Atlantic tomcod, or spottail shiner. American shad estimates for yolk-sac larvae and post yolk-sac larvae are available from the field study, but because the relationship between the RPC_{lc} estimates and the length of the larvae could not be explained in terms of factors thought to affect relative probability of capture (e.g., gear avoidance and extrusion), an RPC_{dl} value of 1.0 is used in the present CEMR calculations for all lengths of these stages of American shad larvae. For each taxon, life-stage and length, the value for RPC_{dl}, derived for Indian Point, is applied for all plants.

Model Comparison

Although the CEMR model is based on a discrete one-day time step, the daily conditional mortality rate can be interpreted in terms of a continuous-time model (within each day) with competing sources of mortality. The continuous-time model is based on the assumption that during any day both natural and entrainment mortality act on the individuals at risk. The reduction in the number of individuals at any time during the day reduces the number that can be entrained subsequently during the day. The ETM is also based on this type of continuous-time model for mortality. Under this assumption, the number of individuals entrained (X^{*}_{ds}) can be represented as

$$X^{*}_{ds} = N_{d,hr=0,s} \frac{E_{ds}}{E_{ds} + M_{ds}} \left[1 - e^{-(E_{ds} + M_{ds})} \right] \tag{10}$$

where $N_{d,hr=0,s}$ = the river-wide abundance of cohort s at the beginning of day d;

E_{ds} = the mean instantaneous entrainment mortality rate (per day) for individuals of cohort s on day d; and

M_{ds} = the mean instantaneous natural mortality rate (per day) for individuals of cohort s on day d.

Equation (10) is the Baranov catch equation (Ricker, 1975) for single age groups as applied to entrainment mortality.

The daily river-wide abundance as used in CEMR can be interpreted as being the average river-wide abundance over day d (N^{*}_{ds}) and represented as

$$\begin{aligned} N^{*}_{ds} &= N_{d,hr=0,s} \int_{0}^{1} e^{-(E_{ds} + M_{ds})t} \, dt \\ &= N_{d,hr=0} \, (E_{ds} + M_{ds})^{-1} \left[1 - e^{-(E_{ds} + M_{ds})} \right]. \end{aligned} \tag{11}$$

In this case, the daily conditional mortality rate as computed for CEMR could be interpreted as $CMR^{*}_{ds} = X^{*}_{ds} / N^{*}_{ds} = E_{ds}$ and would be equal to the instantaneous entrainment mortality rate rather than the fraction of the abundance lost to entrainment over a discrete time interval. If the assumptions of this continuous-time model are satisfied, the conditional survival rate (as a fraction) would be computed as $CSR^{*}_{ds} = \exp\left(-X^{*}_{ds} / N^{*}_{ds}\right)$ rather than $CSR_{ds} = 1 - X_{ds} / N_{ds}$.

These two formulations produce very similar values when the daily conditional mortality rate is small, although the discrete-time formulation of the daily conditional survival rate (in CEMR) always produces lower values of conditional survival than the corresponding continuous-time formulation (in ETM), and hence produces higher conditional mortality rates. For example, with a daily conditional mortality rate of 0.01, the daily conditional survival rate for the discrete-time model is 1 - 0.01000 = 0.99000 compared to exp (-0.01000) = 0.99005 for the continuous-time model (Figure X-1). If a cohort were exposed to a daily conditional survival rate of 0.01 for 60 days, the overall conditional survival rate would be $(0.99000)^{60} = 0.547$ for the discrete-time model and $(0.99005)^{60} = 0.549$ for the continuous-time model (Figure X-2). Average daily conditional mortality rate estimates (X_{ds} / N_{ds}) computed separately for each taxon (American shad, river herring, striped bass, and white perch), life stage (egg, yolk-sac larvae, post yolk-sac larvae, and juvenile), and power plant (Bowline Point, Indian Point and Roseton) over all days of entrainment vulnerability for 1981 and for 1983 through 1987 are less than 0.01 with one exception. The average estimate for striped bass post yolk-sac larvae at

Indian Point was 0.022. For values from close to 0 up to 0.022, the discrete-time and continuous-time models produce nearly equal conditional survival rate estimates (Figures X-1 and X-2).

General Model of Conditional Entrainment Mortality Rate

The Type I ETM and CEMR model can be viewed as special cases of a general model. For comparison, the ETM convention of weekly cohorts is adopted. The annual conditional mortality rate is represented as a weighted average of cohort-specific conditional mortality rates ($m_{T,s}$). Accordingly, the weighting factor for the weighted average is R_s, the proportion of the total spawn that occurred in week s, so that

$$m_T = \sum_{s=1}^{S} R_s \; m_{Ts} . \tag{12}$$

Each cohort-specific conditional mortality rate is equal to one minus a product of weekly conditional survival rates:

$$m_{Ts} = 1 - \prod_{w=s}^{s+J} CSR_{sw} . \tag{13}$$

Each weekly conditional survival rate depends on the fraction of the week spent in each life-stage, as represented by the general formula

$$CSR_{sw} = \prod_{l=1}^{L} \left(\overline{CSR}_{d \in w,l} \right)^{\sum_{d \in w} \delta_{dsl}} \tag{14}$$

where $\overline{CSR}_{d \in w,l}$ = the average daily conditional survival rate for life-stage l individuals in week w;

$d \in w$ = day d within week w; and

$\sum_{d \in w} \delta_{dsl}$ = $7\, C_{wsl}$ (from equation 1).

The general model for overall conditional mortality rate can then be represented as

$$m_T = 1 - \sum_{s=1}^{S} R_s \left[\prod_{w=s}^{s+J} \left[\prod_{l=1}^{L} \left(\overline{CSR}_{d \in w,l} \right)^{\sum_{d \in w} \delta_{dsl}} \right] \right] . \tag{15}$$

The ETM and CEMR models differ in the way that the weekly conditional survival rate is estimated. In ETM (equation 3), the weekly conditional survival rate for individuals from cohort s for the portion of the week spent in life-stage l is defined as a weighted average of region-specific, weekly conditional survival rates:

$$\left(\overline{CSR}_{d\in w,l}\right)^{\sum_{d\in w}\delta_{dsl}} = \sum_{k=1}^{K} D_{wkl}\left[\left(e^{-E_{wkl}}\right)^{\sum_{d\in w}\delta_{dsl}}\right]. \tag{16}$$

In the CEMR model (equation 4), the weekly conditional survival rate for individuals from cohort s, for the portion of the week spent in life-stage l, is defined in terms of the product of daily conditional survival rates:

$$\left(\overline{CSR}_{d\in wl}\right)^{\sum_{d\in w}\delta_{dsl}} = \prod_{d=d\in w}\left(1-\frac{X_{dl}}{N_{dl}}\right)^{\delta_{dsl}}. \tag{17}$$

Equations (16) and (17) estimate the same parameter of the general model (equation 15) in different ways. In the ETM, weekly conditional survival rates are estimated from data on the river-wide distribution pattern of fish larvae. In CEMR, they are estimated from direct samples of entrained larvae. The difference in equations (16) and (17), therefore, captures the major difference between the ETM and the CEMR approaches to estimating CMR.

Modified ETM

In order to produce conditional mortality rate estimates based on ETM that are consistent with CEMR-based estimates, the algebraic structure of ETM is modified to be more like the algebraic structure of the CEMR model. The modification was made to the definition of the weekly conditional survival rate. The modified definition of the weekly conditional survival rate for individuals from cohort s, for the portion of the week spent in life-stage l is

$$\left(\overline{CSR}_{d\in wl}\right)^{\sum_{d\in w}\delta_{dsl}} = \prod_{d\in w}\left[1-\left(\sum_{k} D_{wkl}\,\frac{P_{wk}\; f_{wl}\; W_{wl}}{V_k}\right)\right]^{\delta_{dsl}} \tag{18}$$

and the resulting modified ETM is

$$m_T = 1-\sum_{s=1}^{S} R_s\left[\prod_{w=s}^{s+J}\left[\prod_{l=1}^{L}\left[\prod_{d\in w}\left[1-\left(\sum_{k=1}^{K} D_{wkl}\,\frac{P_{wk}\; f_{wl}\; W_{wl}}{V_k}\right)\right]^{\delta_{dsl}}\right]\right]\right]$$

$$= 1-\sum_{s=1}^{S} R_s\left[\prod_{w=s}^{s+J}\left[\prod_{l=1}^{L}\left(1-\sum_{k=1}^{K} D_{wkl}\,\frac{P_{wk}\; f_{wl}\; W_{wl}}{V_k}\right)^{\sum_{d\in w}\delta_{dsl}}\right]\right]. \tag{19}$$

The modified ETM retains the major features of ETM. The fraction entrained is still defined in terms of a weighted average of region-specific ratios of (1) the volume of cooling water withdrawn from a region to (2) the volume of the region. The weighting factor for each region is the proportion of the river-wide abundance that is in the region. Like the CEMR model, the modified ETM does not adjust the daily fraction entrained for continuous reduction of abundance due to entrainment within the day. The modified ETM and the CEMR models are similar in both algebraic structure and component parameters (Table X-3).

Calibration of Modified ETM

The modified ETM is calibrated using intermediate calculations from the CEMR model and available data from 1981 through 1987 (no data were available for Danskammer in 1981 nor for Indian Point in 1982). The calibration is accomplished by estimating $W_{wk.l}$ (W-ratio) from the conditional survival rates as defined for the two models. Precise estimates of the W-ratio have always been problematic, therefore this term is chosen for calibration.

Based on the approximate equality of the conditional survival rate terms ($\overline{CSR}_{d\epsilon w,l}$) used in the two models (equations 17 and 18),

$$1-\left(\frac{\overline{X}_{d\epsilon w.l}}{\overline{N}_{d\epsilon w.l}}\right)\cong 1-\left(\sum_{k=1}^{K} D_{wkl}\ \frac{P_{wk}\quad f_{wl}\ W_{wl}}{V_k}\right) \tag{20}$$

from which

$$W_{wl}\cong\left(\frac{\overline{X}_{d\epsilon w.l}}{\overline{N}_{d\epsilon w.l}}\right)\left(\sum_{k=1}^{K} D_{wkl}\ \frac{P_{wk}\quad f_{wl}}{V_k}\right)^{-1}. \tag{21}$$

Since the W-ratios are not affected by the through-plant mortality rate, equation (21) was simplified by setting the through-plant mortality rate (f_{wl}) equal to 1 in both the CEMR and ETM formulations of $\overline{CSR}_{d\epsilon w,l}$. Plant-specific, weekly W-ratios were then estimated as

$$\hat{W}_{wl}=\left(\frac{\sum_{d\epsilon w}\hat{NE}'_{dl}}{\sum_{d\epsilon w}\hat{N}'_{dl}}\ \hat{R}PC_{dl}\right)\left(\sum_{k=1}^{K}\hat{D}_{wkl}\ \frac{P_{wk}}{V_k}\right)^{-1} \tag{22}$$

where hats denote estimates.

W-ratios averaged over all years were computed in two steps. First, average W-ratios were computed by year (y) as weighted averages of the arc-tangent transformed week-specific estimates with weights being relative measures of exposure to entrainment:

$$\hat{W}_{yl}=\arctan\left[\left[\sum_{w}\tan(\hat{W}_{ywl})\left(\sum_{s=1}^{S}\hat{R}_s\hat{C}_{wsl}\right)\right]\left[\sum_{w}\left(\sum_{s=1}^{S}\hat{R}_s\hat{C}_{wsl}\right)\right]^{-1}\right]. \tag{23}$$

Then overall average W-ratios ($\hat{W}_l$) were computed as simple averages of the year-specific averages:

$$\hat{W}_l=\frac{1}{n_y}\sum_{y}\hat{W}_{yl}, \tag{24}$$

where n_y is the number of years with year-specific averages.

Parameters and Data

Parameters Addressed

This section addresses methods and data used to estimate model parameters listed in Table X-3. Table X-4 presents definitions, and identifies the equations using the Table X-3 parameters. The parameters and data can be roughly divided into two groups--those that are based on facilities and data collected on plant operation and those that are based on data collected on fish populations.

Plant Operation Parameters and Data

For both the CEMR model and the ETM models the plant operations data sets originally constructed for the June 1993 DEIS were used for years covered by that version of the DEIS (1974 to 1991). For the year's 1992 through 1995 data were acquired from a variety of sources. The plant operation data sets are described on a per-facility basis later in this in section.

The CEMR model requires daily flow rates, intake and discharge temperatures, and transit time (exposure duration) for each power plant. The ETM, like the CEMR model, requires flow rates (weekly rather than daily), intake and discharge temperatures, and exposure duration from each facility. The same plant operation data sets were used for the CEMR and ETM estimates for the Bowline Point, Danskammer, Indian Point and Roseton power plants for the years with entrainment sampling.

Fish Population Parameters and Data

For each species addressed, ETM requires estimates of relative regional abundance by life stage, relative cohort size, life stage duration, combined thermal and mechanical mortality rates, and relative density in withdrawn water relative to the overall region. CEMR requires estimates of the densities of entrained organisms by life stage, mechanical and thermal mortality rates, life stage durations, and daily river-wide abundances.

V_k.— Table X-6 presents the volumes of the river segments as obtained from the utilities' year class reports.

L and J.—The life stage at any age (l, with a maximum of L) and the maximum age at which a fish species could be entrained (J) were obtained or estimated using published data on life stage duration and growth.

The duration in days of each life stage was based on (1) values from Boreman et al. (1982), (2) equations predicting duration as a function of water temperature, or (3) a review of the literature to estimate the age at which juveniles became too large to entrain (Table X-7).

Life stage duration was predicted from water temperature (HRU, 1988d) for the egg and YSL life stages for American shad and striped bass and for the egg stage of white perch. For American shad, an exponential model was fit to data from Table 20 in Boreman (1983). The resulting equations are

$$L_E = \exp(4.118164) \times \exp(-0.127013 \times T_E) \text{ and}$$

$$L_Y = \exp(3.006309) \times \exp(-0.088367 \times T_Y)$$

where

L_E and L_Y = duration in days of the egg (*E*) and YSL (*Y*) life stages; and

T_E and T_Y = river-wide water temperature, averaged over regions and strata weighted by the estimated abundance of egg (*E*) or YSL (*Y*).

If temperatures were outside the range of the experimental data (< 12EC for egg and YSL, > 27EC for egg, and > 17EC for YSL), then T_E or T_Y was set equal to the nearest experimental value.

For striped bass, the following equations from Boreman (1983) were used:

$$L_E = 10.77 \times \exp(-0.0934 \times T_E) \text{ and}$$

$$L_Y = 14.95 - (0.453 \times T_Y).$$

For white perch YSL, the following equation from Boreman (1981) was used:

$$L_E = \exp(2.635925) \times \exp(-0.105852 \times T_E).$$

If temperatures were outside the range of the experimental data (< 11.1EC or > 25EC), then T_E was set equal to the nearest experimental value.

For Atlantic tomcod and bay anchovy, all life stage durations were taken from Boreman et al. (1982). For spottail shiner, only the maximum age of entrainable juveniles was needed. This was estimated as the difference between age at maximum entrainable size and age at metamorphosis from PYSL to juvenile.

The age of spottail shiner at metamorphosis from PYSL to juvenile was not available in the literature. The largest larval size reported was 14.25 mm (Scott and Crossman, 1973), and the smallest juvenile reported in several years of sampling at a mid-western lake (McCann, 1959) was 13 mm. Length at metamorphosis was therefore assumed to be 14 mm. Length-at-age data were available only for emerald shiner—a linear regression on the emerald shiner data predicted age at 14 mm to be 22.6 days (p # 0.004).

Spottail shiners were not measured during entrainment sampling, so a conservative estimate of 60 mm (the maximum over all species for which length data were available) was used as the estimate of the maximum entrainable length. Spottail shiner juveniles reached 60 mm in length 3 to 4 months (90-120 days) after spawning (McCann, 1959), and the average of 105 days was assumed to be the age of juvenile spottail shiners at 60 mm of length.

Assuming age at metamorphosis to be 22 days, and age at maximum entrainable length to be 105 days, the life stage duration of entrainable juveniles is 83 days. The slowest reported growth rate in the literature for spottail shiner juveniles was 0.63 mm/day (McCann, 1959), which give an estimate of 73 days to grow from 14 to 60 mm. Using an estimated life stage duration of 83 days should be a conservative estimate that should somewhat overestimate the length of exposure to entrainment mortality and thus the total effect on the population.

S and R_S—The week of the spawning period is represented by s, and the maximum number of weeks in the spawning period is represented by S. Because weekly cohorts are defined by the week in which they were spawned, weekly cohorts are also represented by s and S. The temporal distribution of spawning across the spawning period determines relative cohort size, which is expressed by R_S, the proportion of spawning that occurred in week s.

For American shad, bay anchovy, river herring, striped bass, and white perch, the relative size of each daily egg cohort was calculated as described for the CEMR model and then summed over days within each week to convert to a weekly time step.

For Atlantic tomcod, cohort size was based on YSL rather than eggs. The LRS did not begin sampling early enough in the year to provide an empirical estimate of YSL abundance in 1981-1987. The two years with the earliest LRS sampling were 1976 and 1977. For each of these years, relative weekly Atlantic tomcod YSL cohort size was estimated as described earlier for egg cohorts, then averaged over years. The total period of YSL presence in the river was from week 8 to week 16 (where week 1 begins with the first Monday of the year), but the last three weeks accounted for less than 0.1% of all YSL. Given that the last significant numbers of YSL occurred in week 13 and assuming a 4-week life stage duration for YSL (Boreman et al., 1982), the last cohort would have matured from egg to YSL in week 10. Relatively few YSL were collected in the first week when data were available (6% of the total, compared to 21.5% in the next week), but it was possible that YSL first appeared prior to the first week of LRS sampling (week 8). Assuming that this is the case, on average four weekly cohorts of Atlantic tomcod occur, beginning in week 7 (approximately February 15). In the absence of information on relative cohort size, equal size was assigned to the four cohorts ($R_c = 0.25$ for all cohorts).

For spottail shiner, no adequate data were available on eggs or larvae that could be used to estimate cohort number and size. Spawning in Lake Erie has been reported as occurring in late June or early July, with ripe females reported on May 15 (Scott and Crossman, 1973). A total of 6 weekly cohorts were assumed to occur beginning in the first week of June, with each cohort being of equal size ($R_c = 0.167$).

δ_{dsl}—This parameter is the proportion of day d that individuals of cohort s spend in life stage l. Life stage duration estimates (Table X-7) were used to estimate the proportion of each day spent in each life stage for each daily cohort (δ_{dsl}). For the weekly time step in the ETM model,

$$\delta_{ds_w l} = \frac{\sum_{s_d \in s_w} \sum_{d \in w} \delta_{ds_d l}}{\eta_w} \qquad (25)$$

where

$\delta_{ds_w l}$ = the proportion of week w that weekly cohort c_w spends in life stage l;

$\delta_{ds_d l}$ = the proportion of day d that daily cohort c_d spends in life stage l;

η_w = the total number of daily cohort-days in week w;

$s_d \in w$ are all daily cohorts present in week w, and $d \in w$ are all days in week w.

N_{dsl} and RPC_{dl}—Table X-4 defines N_{dsl} and RPC_{dl}. For any species, the river-wide abundance of cohort s individuals that are in life-stage l on day d (N_{dsl}) is determined from data on the density of individuals in the river, estimates of the relative probability of capture of gear (RPC_{dl}), estimates of weekly survival rates, and information on life stage duration. The derivation of these quantities is described below.

River-wide Abundance (N_{dsl})—River-wide abundance was estimated using data from the river sampling program chosen as being most appropriate for each species and life stage. Data were used from the LRS (HRU, 1988c, 1989a), BSS (HRU, 1988c, 1989a) and FSS (HRU, 1988c, 1989a). For the entrainable juveniles a combination of programs was often used (Table X-8). In general, river-wide estimates were based on estimates for portions of the river defined by region (12 regions covering river miles 12 to 152, or 13 regions covering river miles 0 to 152) and strata (defined by water depth).

For most species, river-wide abundance estimates for the egg, YSL, and PYSL life stages were made using the LRS program (Table X-8). The following volume-weighted average of abundance estimates by region and strata was used:

$$N_{ld} = \frac{\sum_k \sum_h N_{ldkh} \times V_{kh}}{\sum_k \sum_h V_{kh}} \qquad (26)$$

where

$N_{ld} =$ the river-wide abundance of life stage l on day d;

$N_{ldkh} =$ the abundance of life stage l on day d in region k and strata h; and

$V_{kh} =$ the water volume of stratum h in region k,

and

$$N_{ldkh} = V_{kh} \times \vartheta_{ldkh}$$

where

$\vartheta_{ldkh} =$ the density of life stage l on day d in region k and stratum h;

and

$$\vartheta_{ldkh} = \frac{\sum_i B_{dkhji}}{\sum_i V_{dkhi}}$$

where

B_{ldkhi} = the number caught in sample i on day d in region k and stratum h of organisms in life stage l; and

V_{dkhi} = the volume of sample i on day d in region k and stratum h.

Daily density estimates were calculated from LRS data sets for each date sampled by the LRS. Missing dates were then filled in using linear interpolation within each region and stratum. Densities in unsampled strata within each region were then estimated as

$$\vartheta_{ldkh} = \vartheta_{ldkh^*} \times k_{lh}$$

where

k_{lh} = a coefficient used to estimate density in stratum h based on density in stratum h^*.

In regions 1 through 4 and 6, density in the shore strata (6 to10 feet deep) and beach strata (1 to 5 feet deep) were estimated from the density of the shoal strata (10 to 20 feet deep). In regions 5 and 7 to 12, density in the shore, shoal, and beach strata were estimated from the density of the bottom strata (> 20 feet deep, within 10 feet of the bottom). Table X-9 presents coefficients by species, life stage, and stratum.

Prediction equations were developed for predicting ichthyoplankton densities in Region 0 based on observed densities in Region 1. Separate analyses were conducted for each taxon, life stage and stratum. The prediction equations had the following mathematical form:

$$\ln(D_{0,w}) = \alpha + \beta \ln(D_{1,w})$$

where $D_{0,w}$ = density in Region 0 in week w; and

$D_{1,w}$ = density in Region 1 in week w.

The coefficients, α and β, were estimated using linear regression and data from all years and weeks in which both Region 0 and Region 1 were sampled. A prediction equation was kept only if the regression was statistically significant with a probability level less than 0.05. Table X-10a lists the estimated coefficients for the significant prediction equations.

The same method was used to develop equations for predicting densities in the northern portion of Region 12 based on the observed densities in the southern portion of Region 12. Table X-10b presents the estimated coefficients for the significant prediction equations from these analyses.

For both the Region 0 and Region 12 analyses, an assessment was conducted to determine whether covariates (i.e., conductivity, dissolved oxygen or temperature) would improve the predictions. For both sets of analyses, the inclusion of covariates did not significantly improve the predictions. Therefore, covariates were not included in the prediction equations.

Once regional densities had been estimated, the water volume for the entire region was used when needed as either a weighting factor or multiplier to obtain river-wide abundance.

For American shad, bay anchovy, striped bass, and white perch a PYSL-based projection was used as the initial estimate of juvenile river-wide abundance (Table X-8). For river herring the juvenile abundances based upon the LRS program were used as the first estimate. The river-wide abundances of juvenile Atlantic tomcod and spottail shiner were not estimated, because the CEMR model is not used for these species. The estimation of the distribution of these two species among regions, required by the ETM model, is discussed in a later section.

The gear used in the LRS was not designed to fully sample the juveniles of American shad, bay anchovy, striped bass, white perch, or the river herring. The nets are too small and towed too slowly for these larger larvae, and gear avoidance is likely leading to underestimates of the number of these individuals in the river. However, the LRS was judged to do an adequate job of sampling the juvenile stage of these species for the purpose of estimating the proportion of juveniles in the various regions of the river for the ETM model, and as the beginning step in estimating the river-wide abundance of river herring juveniles for the CEMR model. The FSS and BSS programs start too late and use field-sampling methods designed for collecting juveniles predominantly larger than the entrainable size of interest. Therefore, neither of these programs could be used directly to estimate entrainable juvenile abundance. For American shad, bay anchovy, striped bass, and white perch the abundance of juveniles is initially made using the PYSL-based projection, and then revised using data from the FSS. For river herring the revision using the FSS data is applied to the estimates of juvenile abundance arising directly from the LRS.

The PYSL-based projection results in an estimate of juvenile abundance based upon the estimated sizes of the PYSL cohorts and the PYSL survival rate:

$$PROJN_{Jw} = (\sigma_P)^{l_P} \sum_s N_{Ps} \times \sigma_P^{\,w-(s+l_P)} \quad (27)$$

where

$PROJN_{Jw}$ = the projected daily abundance of juvenile fish in week w (day represented as a fraction of week);

σ_P = the estimated weekly survival rate of PYSL for the year if a sufficient number of cohorts were present (if not the mean of all other years estimated weekly PYSL rates was used);

l_P = the duration of the PYSL life stage; and

N_{Ps} = the estimated initial river-wide abundance of PYSL cohort s.

The initial river-wide abundance of PYSL cohort s (N_{Ps}) and the PYSL survival rate for the current year (σ_P) were estimated using the model

$$N_{Pw} = \sum_s N_{Ps} \times \sigma_P^{w-s} \times X_{sw} \quad (28)$$

where

N_{Pw} = the observed weekly PYSL river-wide abundance in week w;

N_{Ps} = the estimated river-wide abundance of PYSL cohort s in its first week;

σ_P = the estimated weekly survival rate of PYSL for the year; and

X_{sw} = 1 if cohort s is present during week w.

The solution to this model was found using non-linear regression. The first week when the cumulative abundance of the PYSL life stage exceeded 5% of the annual total was designated as the week of the first cohort. The last cohort was identified by counting back l_P weeks (the PYSL duration) from the last week when the PYSL stage was found in the river. The total number of cohorts for the year is then found by counting from the first cohort to the last cohort. If the LRS sampling program sampled two or more cohorts during the year then both the initial river-wide abundance of PYSL cohort s (N_{Ps}) and the PYSL survival rate for the current year (σ_P) were estimated. If there was only one cohort, or if the initial regression model for the species and year did not yield a reasonable solution for σ_P (e.g., estimated = 1), then the average of all of the σ_P values from years with solutions was placed into the model, and this modified model was then solved to find estimates of the initial river-wide abundance of PYSL cohorts (N_{Ps}'s).

The PYSL-based projection is a conservative estimate of the abundance of the juveniles, because the lower PYSL survival rate is used as a surrogate for the higher survival rate of the juvenile stage of the species.

The FSS data were then used to revise the initial estimates of juvenile abundance. The FSS revision is based upon a simple premise—the river-wide estimate of the number of older juveniles from the FSS must be less than or equal to the river-wide abundance of the juveniles of that species earlier in the year. Therefore, for a given week, if the FSS data resulted in a higher abundance than the initial estimate, then the FSS estimate was used for that week and earlier weeks of lower juvenile abundance. As stated earlier, the initial estimates for American shad, bay anchovy, striped bass, and white perch were made based upon the PYSL projection, while the initial estimates for river herring were made based directly upon the juvenile counts in the LRS data.

Relative Probability of Capture (RPC)—Table X-11a summarizes the RPC values for striped bass and white perch from the Coastal (1991a) study, while Table X-11b presents the RPC factors for bay anchovy.

D_{wkl}—Table X-4 defines D_{wkl}. For any species, the average proportion of river-wide abundance of life stage l individuals that are in region k (D_{wkl}) is determined from two quantities—(1) the river-wide abundance of life stage l at any time; and (2) the proportion of the river-wide population of that life stage at that time that is in each region k. The derivation of river-wide abundance is discussed in the previous section. Calculation of the distribution by region is described below.

The relative abundance by region is represented as:

$$U_{lwk} = \frac{N_{lwk}}{\sum_{k} N_{lwk}} \tag{36}$$

where

U_{lwk} = the proportion of the river-wide population of life stage l in week w that is in region k; and

N_{lwk} = the abundance of life stage l in week w in region k.

For each species, U_{lwk} was estimated for each week that data were collected by the sampling program appropriate to life stage l. For American shad, river herring, striped bass, and white perch, the regional abundance estimates were calculated for the egg, YSL, PYSL, and entrainable juvenile stages as described in the River-wide Abundance section. For Atlantic tomcod the abundances of YSL, PYSL, and entrainable juvenile stages were calculated using the same methods, however the regional abundances were used only as an intermediate step in the calculation of the regional distribution pattern. For spottail shiner only the distribution of the entrainable juvenile stage was estimated, and this was done using the BSS data:

$$N_{Ywk} = \frac{\sum_{i} B_{Ywki}}{n_{wk}} \times V_k \tag{37}$$

where

N_{Ywk} = the relative abundance of juveniles in week w in region k;

B_{Ywki} = the total catch of juveniles in haul i in week w, region k;

n_{wk} = the total number of beach seine hauls in week w, region k; and

V_k = the area of the water within the shore stratum in region k.

Within a given region during a year, there are no missing U_{lwk} values for dates falling between the first and last days of sampling of that region for the applicable program (BSS for SS juveniles, LRS for all others). This is because the regional densities, upon which the regional distributions are based (via the regional abundance estimates), were "filled-in" across dates using linear interpolation. However, in some years regions were totally left out of the sampling or were not sampled early or late in the program. In these cases, U_{lwk} values may be missing for all or some regions during a given week.

For any week with a missing U_{lwk} value a substitute value was used. The substitutions were based upon, as detailed below, the values contained in a data set of the "average" regional distributions for each week. The averages contained in this data set were calculated using all available years of sampling from the applicable program. For a given week (1 to 52), data from all years with all regions sampled during that week were used to calculate an overall mean U_{lwk} value for that week. To ensure these weekly values still summed to 1 for the river as a whole, these averages were standardized by summing within the week and dividing each regional U_{lwk} value by the river-wide sum.

If the substitution data set had non-missing U_{lwk} values for a week in which all of the year-specific regional values for U_{lwk} were missing, then the entire set (all 12 or 13 regions) of U_{lwk} values for that week from the substitution data set was used. If only some of the regions had missing values, then the non-missing U_{lwk} values were first re-scaled so that their sum matched the sum of the same regions within the substitution data set, then the year-specific missing values were directly replaced with the values from the substitution data set. For example, assume in a given year that regions 1 through 3 were not sampled during a week late in the LRS sampling program. The U_{lwk} values for regions 1, 2, and 3 would be missing, but the initial U_{lwk} values for the remaining regions (4-12) would be non-missing, and would be a better estimate of the distribution of the larvae among regions 4 to 12 than the corresponding values from the substitution data set. Further assume that the total proportion for regions 4 to 12 in the substitution data set is 0.8 (of the total of 1.0 river-wide). Using this method, each of the U_{lwk} values for regions 4 to 8 would be divided by 0.8 so that their sum would be 0.8 as it is in the substitution data set. Since the current year's non-missing values have been re-scaled; the values for regions 1 to 3 from the substitution data set could then be directly substituted.

W_l

The ratio of the average plant intake density of a given life stage to the average regional density (W_l) adjusts for non-uniform distribution of fish in the river. For American shad, bay anchovy, river herring, striped bass, and white perch at Bowline Point, Indian Point, Roseton and Danskammer, W_l values for 12 and 13 regions were estimated based on a calibration of the ETM and CEMR models (Tables X-12a, and X-12b). For river herring and white perch at the Albany Steam Station, a calibration was performed based on data from the Albany Steam State Pollution Discharge Elimination System (SPDES) (LMS, 1984d). For all other species and plants, W_l was assumed to be 1.0 for all life stages.

P_{wk}

The rate of water withdrawal from any region k in any week was calculated from the rates of water withdrawal by the following facilities.

Albany Steam Station—Daily flow values for 1981 through 1985 were keypunched from Discharge Monitoring Worksheets. Monthly average flows in 1986 and 1987 were obtained from the computer file provided by NYSDEC (1993). A SAS computer file was created containing daily flow in m^3/day for 1981-1987, assigning the monthly average value to each day of the month in 1986 and 1987.

Bowline Point.—Flow data at Bowline Point for March through September were provided by the utilities for each year from 1981-1987 (HRU, 1990b). For 1981-1985, plant flow rate by unit was computed for each hour during the day from the plant operating condition (pump and condenser configuration). Table X-13 summarizes the flow resulting from each condition. For 1986 and 1987, flow rate data were only available by unit on an average daily basis.

For January-February and October-December, average monthly flow rates were keypunched from tables in annual impingement reports (LMS, 1982b, 1983b, 1984b, 1985b, 1986a, 1987a, and 1988b). The flow rate on each day of the month was assumed to be equal to the average daily flow rate for the month.

Danskammer.—The average monthly combined-unit flow rate at Danskammer for 1982-1987 was keypunched from tables in annual Roseton/Danskammer impingement reports (LMS, 1983a, 1984a, 1987c, 1988d, EA, 1985b, and 1986). No entrainment sampling took place in 1981, and so no flow data were required for that year. The flow rate on each day of the month was assumed to be equal to the daily average for the month. Per-unit flow was estimated by assuming that the total flow was distributed among units in proportion to their maximum flow capacity:

$$P_i = \frac{P_{Pi}}{\sum_i P_{Pi}} \times P_C \qquad (38)$$

where

$P_i =$ flow rate (m³/sec) at unit *I*;

$P_{Pi} =$ full-capacity flow rate at unit *i*, where $P_{P1} = P_{P2} = 2.55$ m³/sec, $P_{P3} = 4.92$ m3/sec, $F_{F,4} = 9.00$ m³/sec; and

$P_C =$ the combined-unit flow rate.

Indian Point.—Daily flow data at Indian Point for all of 1981 and for May to mid-August for 1986-1987 were provided by the utilities (HRU, 1990d). Average daily flow rates by unit for 1983-1985 were taken from tables in entrainment reports (EA, 1984 and 1985a, NAI, 1987). Missing data were filled in using monthly average flow for the combined units, with a few still-missing values keypunched from entrainment reports (NAI, 1987, 1988). The flow rate on each day of the month was assumed to be equal to the daily average for the month.

Lovett Generating Station.—Average monthly combined-unit flows (1981-1982) or daily per-unit flows (1983-1987) at Lovett were keypunched from tables in annual impingement reports (LMS, 1982c, 1983c, 1984c, 1985c, 1986b, 1987b, 1988c). The flow rate on each day of the month was assumed to be equal to the daily average for the month. Flows by unit in 1981 and 1982 were estimated by assuming that the total flow was distributed among units in proportion to their maximum flow capacity (unit 3 = 15.9% of the total, unit 4 = 39.2%, and unit 5 = 44.9%).

Roseton.—Flow data at Roseton for March through September were provided by the utilities for each year from 1981-1987 (HRU, 1990f). For 1981-1985, plant flow rate by unit was computed for each hour during the day from the plant operating condition (pump and condenser configuration). Table X-14 shows the flow resulting from each condition. For 1986 and 1987, flow rate data were only available by unit on an average daily basis.

For January-February and October-December, average monthly flow rates for combined units were keypunched from tables in annual impingement reports (LMS, 1982a, 1983a, 1984a, 1987c, 1988d, EA, 1985b, and 1986). The flow rate on each day of the month was assumed to be equal to the daily average for the month.

Empire State Plaza.—Average daily flow rates by month from April 1986 through December 1987 were available in a computer file (NYSDEC, 1993). For a few additional months (June-August 1981 and May-September 1985), Discharge Monitoring worksheets provided monthly average flow rates. No flow data were available for other months in the 1981-1987 window. For months when data were available, a computer file was created that contained daily flow rates in m^3/day, where the daily average for the month was assigned to each day of that month.

Westchester RESCO.—Neither daily nor monthly flow data from 1981-1987 were available for Westchester RESCO. Analyses were therefore run assuming the maximum permitted discharge rate of 38,000 gallons per minute (Table X-5). Daily flow rates (in m^3/day) were assumed to be equal to the maximum rates.

Facility-Specific Proportion of Water Withdrawn

For each facility that withdrew more than 50 mgd of Hudson River water (Table X-5), ETM required the facility's proportion of total water withdrawal that originated in each region of the river. Table X-15 summarizes these values.

f_{dl}

This parameter expresses the fraction of life stage *l* individuals that enter an intake on day *d* and eventually are killed by plant passage. The fractions of individuals killed were calculated from the instantaneous through-plant mortality rate. That rate has two components, the thermal mortality rate and the mechanical mortality rate. Mechanical mortality rates were estimated from empirical entrainment survival studies. Thermal mortality rates were estimated from discharge temperature and duration of exposure (transit time).

Through-plant mortality rates used in the ETM model were calculated for each facility as:

$$m_{lw} = 1 - (1 - m_{Tlw}) \times (1 - m_{Mlw}) \qquad (39)$$

where

m_{lw} =	the through-plant mortality rate of an entrained organism in life stage *l* in week *w*;
m_{Tlw} =	the thermal mortality rate for life stage *l* in week *w*; and
m_{Mlw} =	the mechanical mortality rate for life stage *l* in week *w*.

For American shad, Atlantic tomcod, river herring, spottail shiner, striped bass and white perch, daily rates were estimated as described above and then averaged over days within weeks, weighted by daily flow rates. For bay anchovy, 100% through-plant mortality was assumed.

Mechanical Mortality

Mechanical mortality rates for each species and life stage were estimated based on empirical entrainment survival studies. The data used were compiled from studies using either pumped or flume collection gear at Indian Point (pump gear in 1978 and 1979, flume gear in 1979, 1980, and 1988; EA, 1979, 1981b, 1982, 1987), Roseton (pump gear in 1977, 1978 and 1980, flume gear in 1980; EA, 1980, 1983), and Bowline Point (pump gear in 1979 and 1979, flume gear in 1979; EA, 1981a). Fish collected at intake and discharge sampling locations were classified as live or dead, with "stunned" fish counted as dead.

For each combination of plant, gear, year, species and life stage, data were used only if the survival rate for samples collected in the intake was greater than 0, and only if the total number collected in the discharge was large enough that at least one surviving fish would be expected based on intake survival rates. The mechanical mortality rate due to entrainment was estimated as the ratio of survival in discharge samples to survival in intake samples to correct for mortality due to the sampling procedure itself. The method is

$$m_M = 1 - \frac{\sigma_D}{\sigma_I} \tag{40}$$

where

σ_I = the survival rate in intake samples (total living / total collected); and

σ_D = the survival rate in discharge samples.

Mechanical mortality rates were weighted by the inverse of their variance before averaging over gear and year:

$$wt = \frac{1}{\left(\frac{\sigma_D}{\sigma_I}\right)^2 \times \left(\frac{\frac{1}{B_I} \times \sigma_I \times (1-\sigma_I)}{\sigma_I^2} + \frac{\frac{1}{B_D} \times \sigma_D \times (1-\sigma_D)}{\sigma_D^2} \right)} \tag{41}$$

where

wt = the weight used in averaging over gear and year;

B_I = the total number of organisms collected in intake samples; and

B_D = the total number of organisms collected in discharge samples.

Due to frequent zero survival rates for river herring (leading to undefined variance), the weight used for herring was based on sample sizes only:

$$wt = \frac{1}{\left(\frac{1}{N_I} + \frac{1}{N_D} \right)}. \tag{42}$$

Data were pooled over all plants due to the absence of sufficient data to provide accurate plant-specific estimates. Adequate empirical data were available to provide estimates for:

- Atlantic tomcod YSL, PYSL, and juvenile;
- herring PYSL;
- minnow PYSL;
- striped bass YSL, PYSL, and juvenile; and
- white perch PYSL and juvenile.

Herring (American shad, blueback herring, and alewife) were treated as one species. Adequate data were not available for spottail shiner, but it was assumed that spottail shiner mechanical mortality rates were equal to those estimated for "minnows". For herring and spottail shiners, the PYSL mortality rate was assumed to be valid for YSL and juvenile. Similarly, for white perch, the PYSL rate was assumed to be valid for YSL. For all species, egg mortality was assumed to be 1.0. Table X-16 presents mechanical mortality estimates.

Thermal Mortality

Thermal mortality was estimated using a double hinged line model based on exposure temperature (discharge temperature and duration of exposure for each unit, each plant). A double hinged line model specifies a function such that the function takes on a constant value (0 in this case) when the value of an independent variable is less than a lower boundary and a different constant value (1 in this case) when the value of the same independent variable is greater than an upper boundary as follows:

$$m_T = \begin{cases} 0 \text{ if } T_D < X_1 \\ 1 \text{ if } T_D > X_2 \\ m_T^* \text{ otherwise} \end{cases} \qquad (43)$$

and

$$m_T^* = \left[\frac{1}{X_2 - X_1}\right](T_D - X_1) \qquad (44)$$

where

M_T^* = the thermal mortality rate for a given species and life stage;

T_D = the discharge temperature (EC);

X_1 = the lower temperature boundary (EC) for the double hinged line model; and

X_2 = the upper temperature boundary (EC) for the double hinged line model.

For striped bass, boundary values were estimated using nonlinear regression from experimental data (Kellogg et al., 1984, HRU, 1992b) as

$$X_1 = a1 + (b1 \times T_A) + (c1 \times \log_{10}(t_i))$$ and

$$X_2 = a2 + (b2 \times T_A) + (c2 \times \log_{10}(t_i))$$

where

$T_A =$ intake temperature; and

$t_i =$ transit time through unit *i*.

Table X-17 summarizes the coefficients (*a1-c1*, *a2-c2*) for each life stage. The striped bass equations were used for white perch with the exception of the YSL life stage, where thermal mortality was estimated using an equation from LMS (1988a):

$$M_T = 0.9915 - [(0.07205 \times T_D \times \log_{10}(t_i)) + (0.01451 \times T_D \times T_A) + (3.293 \times \log_{10}(t_i)) - (0.5921 \times T_A)]$$

Table X-18 presents boundary values for Atlantic tomcod, American shad, river herring, and spottail shiner. For Atlantic tomcod YSL and PYSL, X_1 was set equal to the average TL95 thermal tolerance limits at 10 minutes of exposure, as reported in Table 5.2-5 in EA (1978). X_2 was set equal to the average TL5 limit reported in the same source. The boundary values for the juvenile life stage were set equal to those for PYSL.

For American shad and river herring YSL and PYSL, X_1 was set equal to the average TL95 thermal tolerance limits for alewife at 10 minutes of exposure, as reported in Table 5.2-5 in EA (1978). X_2 was set equal to the average TL5 limit reported in the same source. The boundary values for the juvenile life stage were set equal to those for PYSL.

For spottail shiner, X_1 was set equal to the TL95 thermal tolerance limits for the early juvenile life stage reported in EA (1978), and X_2 was set equal to the TL5 limit reported in the same source.

Discharge Temperature

Albany Steam Station.—Daily water temperatures recorded at Poughkeepsie Waterworks were used to estimate intake temperatures at Albany Steam Station (HRU, 1991b). The water works is about 65 miles downstream of the steam station. Linear interpolation was used to estimate temperatures on days when no measurements were taken. Monthly average discharge temperature data were keypunched from Discharge Monitoring Worksheets for January-March and October-December 1981; January-April, August-September, and November 1982; May and August-December 1983; January-March 1984; May and August-December 1986; and January-December 1987. In all other months, daily discharge temperature was estimated from intake (Poughkeepsie Waterworks) temperatures. The following statistically significant linear regression was used to predict discharge temperature from Poughkeepsie Waterworks temperatures in 1987, the only year with a complete set of Discharge Monitoring Worksheets available:

$$T_d = 6.72447 + 0.868815 \times T_w$$

where

$T_d =$ discharge temperature (EC) at Albany Steam Generating Station, and

$T_w =$ water temperature (EC) recorded at Poughkeepsie Waterworks.

Bowline Point.—Temperature data at Bowline Point during entrainment sampling (May-August) were provided by the utilities for each year from 1981-1987 (HRU, 1990b). For 1981-1985, intake and discharge temperatures were provided for each unit on an hourly basis. For 1986-1987, average intake and discharge temperature were provided for each unit on a daily basis.

On dates when temperature data were not available on computerized utility files, intake temperatures at the Indian Point Generating Station, located 6 miles upstream of Bowline Point, were used to estimate intake temperatures at Bowline Point (HRU, 1991a).

The average rise in temperature at Units 1 and 2 was estimated for each of the following three operating conditions (EA, 1985c) by averaging over dates when the plant was operating at that flow level:

3 pumps full (384,000 gpm)

2 pumps full with condenser open (316,000 gpm), and

2 pumps throttled (257,000 gpm).

For each hour of the day, the average rise in temperature was calculated for each of the above conditions at each unit. When necessary, discharge temperature was estimated as intake temperature plus this rise, using either on hourly estimates or the average rise over all hours of the day.

Danskammer.—Intake temperatures at Danskammer were assumed to be equal to those at Roseton (less than 1 mile downstream) on dates when temperature data at Roseton were available (see previous section). On all other dates, intake temperature was assumed to be equal to river temperature measured at the Poughkeepsie Waterworks about 6 miles upstream of Danskammer (HRU, 1991b). Linear interpolation was used to estimate temperatures at Poughkeepsie on dates when no measurements were taken.

The temperature increases at Danskammer generating units were estimated using the following equations from Boreman et al. (1982):

$$\Delta_3 = (9.345 \times G_3 + 125.8) / P_3 \text{ or}$$

$$\Delta_4 = (18.810 \times G_4 + 177.7) / P_4$$

where

Δ_3 or Δ_4 = the rise in temperature (EF) at Unit 3 or Unit 4; and

G_3 or G_4 = the generating load at Unit 3 or Unit 4 as a percent of dependable maximum net generation.

Generating load, taken from Table VII-8 in Boreman et al. (1982), varied by month (Table X-19). No estimate was available prior to April or after August. For these months, the value for the closest month (April or August) with available data was used. No equations were available for estimating rise in temperature at Units 1 or 2. Both these units were assumed to have a constant rise of 18EF (10EC), using the maximum value from Table 1.2-1 in EA (1977). Discharge temperature was calculated as the sum of the estimated rise in temperature (converted to degrees Centigrade) and the intake temperature.

Indian Point.—Temperature data at Indian Point during entrainment sampling (May-August) were provided by the utilities for 1981 and 1983-1987 (HRU, 1990d). For 1981 and 1983-1985, intake and discharge temperatures were provided for each unit at Indian Point on an hourly basis. For 1986-1987, average intake and discharge temperatures were provided for each unit on a daily basis.

On a few dates in 1981 when temperature data were not available on utility files (for any facility), river temperatures measured at Poughkeepsie Waterworks (over 30 miles upstream) were used as an estimate of intake temperature (HRU, 1991b). Discharge temperature was calculated based on the average rise in temperature as a function of flow rate:

$$\Delta_i = \frac{P_P \times \Delta_{Pi}}{P_i}$$

where

Δ_i = the rise in temperature (EC) at unit *I*;

P_i = the flow rate (m^3/sec) at unit *i*, with P_P being the full flow (maximum capacity) rate of unit *I*; and

Δ_{Pi} = the full flow design change in temperature at unit i, with Δ_{P2} = 8.85 EC and Δ_{P3} = 9.6 EC.

For each day when discharge temperature data were not available, the rise in temperature at each unit was calculated and added to the intake temperature to provide an estimate of discharge temperature.

Lovett Generating Station.—For 1983-1987, daily per-unit intake and discharge temperature data were keypunched from tables in annual impingement reports (LMS, 1982c, 1983c, 1984c, 1985c, 1986b, 1987b, 1988c). For 1981-1982, intake temperatures were assumed to be equal to those at Indian Point (about 1 mile upstream). A linear regression was run for each unit predicting discharge temperature from intake temperature using Lovett data for 1983-1987. The regressions were all significant (p values < 0.001), and the following regression equations were used to estimate discharge temperature:

$T_{D,3} = 6.253319 + (1.020405 \times T_I)$ or

$T_{D,4} = 8.252059 + (1.017982 \times T_I)$ or

$T_{D,5} = 7.631272 + (1.010216 \times T_I)$

where

$T_{D,i}$ = discharge temperature (EC) at Unit i (i=3, 4, or 5); and

T_I = intake temperature (EC) recorded at Indian Point.

The combined-unit discharge temperature was calculated as the average over all units weighted by unit flow.

Roseton.—Temperature data at Roseton during entrainment sampling (May-August) were provided by the utilities for each year from 1981-1987 (HRU, 1990f). For 1981-1985, intake and discharge temperatures were provided for each unit on an hourly basis. For 1986-1987, average intake and discharge temperatures were provided for each unit on a daily basis.

On dates when temperature data were not available on utility files, river temperatures at Poughkeepsie Waterworks (about 6 miles upstream of Roseton) were used as estimates of intake temperature (HRU, 1991b). Discharge temperature was calculated based on the average rise in temperature as a function of flow rate. The average rise in temperature at Units 1 and 2 was estimated for each of the following three operating conditions (LMS, 1986c) by averaging over dates when data were available:

2 units, 2 pumps operating (418,000 gpm)

2 units, 3 pumps operating (561,000 gpm), and

2 units, 4 pumps operating (641,000 gpm).

For each hour of the day, the average rise in temperature was calculated for each condition at each unit. When necessary, discharge temperature was estimated as intake temperature plus this rise, using either hourly estimates or the average rise over all hours of the day.

Empire State Plaza.—No information on transit time as a function of flow rate was available for Empire State Plaza. Analyses were therefore based on a 100% mortality rate, and no intake or discharge temperature data were required.

Westchester RESCO.—No information on transit time as a function of flow rate was available for Westchester RESCO. Analyses were therefore based on a 100% mortality rate, and no intake or discharge temperature data were required.

Transit Time

Albany Steam Station.—Based on estimates of a 450-foot discharge canal length and an average velocity in the canal of 4.5 feet/second (Young, 1993), the transit time at Albany Steam was calculated to be 1.67 minutes (100 seconds).

Bowline Point.—Transit time at Bowline Point was assumed to be inversely proportional to flow rate. A proportionality constant was computed based on the transit time values reported in EA (1981a) and the corresponding flow under each condition:

$$t = 129.6 / P$$

where

$t =$ transit time in minutes; and

$P =$ flow rate in m^3/second.

Danskammer.—Unit-specific transit times at Danskammer were estimated as a function of flow rate using the following equations from Boreman et al. (1982):

$$t_3 = 145.013 \times P_3^{-0.996} \text{ or}$$

$$t_4 = 73.317 \times P_4^{-0.999}$$

where

t_3 or $t_4 =$ transit time (minutes) at Unit 3 or 4; and

P_3 or $P_4 =$ flow rate (1000 gallons per minute) at Unit 3 or 4.

No equations were available for estimating transit time at Units 1 or 2. Both these units were assumed to have a constant transit time of 6.9 minutes, using the maximum exposure duration from Table 1.2-1 in EA (1977).

Unit 4 at Danskammer was off line from 27 September 1986 to 1 March 1987, and Unit 3 was off line from 13 March 1987 to 23 September 1987. The combined-unit flows used in analyses accurately reflected these outages. However, in estimating thermal mortality, flow was assumed to be occurring in all four units. This led to overestimates of thermal mortality. The 1986-1987 outage at Unit 4 occurred at a time of year when thermal mortality was already zero, so estimates for 1986 were not affected. In 1987, a moderate (15% difference on average) overestimate of thermal mortality occurred for American shad and river herring. Since mechanical mortality was high for these species, the effect on total mortality estimates was less than 3%. Striped bass and white perch thermal mortality rates were relatively low (25-35% on average, vs. 76% for herring), and the degree of overestimation was also relatively low (1.5-7.2% for the life stages affected). Bay anchovy were assumed to experience 100% mortality, and even with the overestimate total entrainment at Danskammer for Atlantic tomcod and spottail shiner was less than 0.1%. In summary, in 1987 entrainment effects at Danskammer were slightly overestimated for American shad, river herring, striped bass, and white perch.

Indian Point.—Transit time at each unit of Indian Point was calculated as a function of flow rate using the following equations presented in EA (1984):

$$t_2 = 1 / (-0.0008275907 + 0.000108864 \times P_2 + 0.00003650407 \times P_3), \text{ and}$$

$$t_3 = 1 / (-0.003645829 + 0.0001525479 \times P_3 + 0.0001306958 \times P_2)$$

where

t_2 or t_3 = transit time in minutes at unit 2 or unit 3;

P_2 or P_3 = the flow rate (1000 gpm) at unit 2 or unit 3.

Lovett Generating Station.—Unit-specific transit time at Lovett was estimated as a function of flow rate, using the following equations from Boreman et al. (1982):

$t_4 = 93.87 / P_4$ or

$t_5 = 252.0 / P_5$

where

t_4 or t_5 = transit time (minutes) at Unit 4 or 5; and

P_4 or P_5 = flow rate (1000s of gallons per minute) at Unit 4 or 5.

No equation was available for estimating transit time at Unit 3. The equation for Unit 5 (using Unit 3 flows) appeared to approximate the values expected for Unit 3 (Saksen, 1993), so Unit 3 transit times were estimated using the proportionality constant for Unit 5. The combined-unit transit time was calculated as the average over all units weighted by unit flow.

Roseton.—Transit time at Roseton was assumed to be inversely proportional to flow rate. A proportionality constant was computed based on the transit time values reported in LMS (1985a) and the corresponding flow under each condition:

$t_1 = 132.7 / P$ or

$t_2 = 141.7 / P$

where

t_1 or t_2 = transit time in minutes when one (1) or two (2) units are operating, and

P = flow rate (combined over both units) in m^3/second.

Empire State Plaza.—No information on transit time as a function of flow rate was available for Empire State Plaza. Analyses were therefore based on a 100% mortality rate, and no intake or discharge temperature data were required.

Westchester RESCO.—No information on transit time as a function of flow rate was available for Westchester RESCO. Analyses were therefore based on a 100% mortality rate, and no intake or discharge temperature data were required.

NE_{dl}

NE_{dl} represents the number of individuals in life stage *l* that are entrained on day *d*. It has two components—the rate of water withdrawn for each facility, described above, and the daily entrainment density, described below.

Daily Entrainment Density—Daily density by species was estimated based on in-plant entrainment sampling as follows:

$$\vartheta_{ld} = \frac{\sum_i B_{ldi}}{\sum_i V_{di}}$$

where

ϑ_{ld} = the density of life stage l entrained on day d;

B_{ldi} = the total number of life stage l caught in sample i on day d; and

V_{di} = the water volume sampled during sample i on day d.

At Bowline Point (HRU, 1988a, 1990a) and Roseton (HRU, 1990e), density was estimated separately for each operating unit, while at Indian Point (HRU, 1988b, 1990c) and Danskammer (HRU, 1993), density was estimated for the combined units. For each species and life stage, data files contained the sample date, the time and volume of the sample, and the total count of organisms collected.

For sampling events that spanned multiple days, the total number caught and volume sampled were assigned among days based on the ratio of the number of hours out of each day which were in the sample to the total number of hours in the sample. At Bowline Point samples were sometimes taken at only one of the units. On any day that samples were taken at only one unit, the density computed in the sampled unit was used as the estimate of the density in the unsampled unit. To adjust for the fact that sampling did not occur on each day, the density for days on which no sampling occurred was estimated using linear interpolation between the estimated density on proximate days.

4. RESULTS

The annual CMR estimates are presented in Tables X-20a through g, X-21a through f, X-22a through g, and X-23a through g. Tables X-20a through g present the results for 12 regions and estimated through-plant mortality and Tables X-21a through f present the results for 13 regions and estimated through-plant mortality. Tables X-22a through g present the results for 12 regions and assumed 100% through-plant mortality and Tables X-23a through g present the results for 13 regions and assumed 100% through-plant mortality. Estimates for spottail shiner for 13 regions are not presented because the riverwide abundance for this species is estimated using the Beach Seine Survey, which only samples 12 regions. Estimates for Westchester RESCO are only presented for 1984-1995 because the plant began operation in 1984.

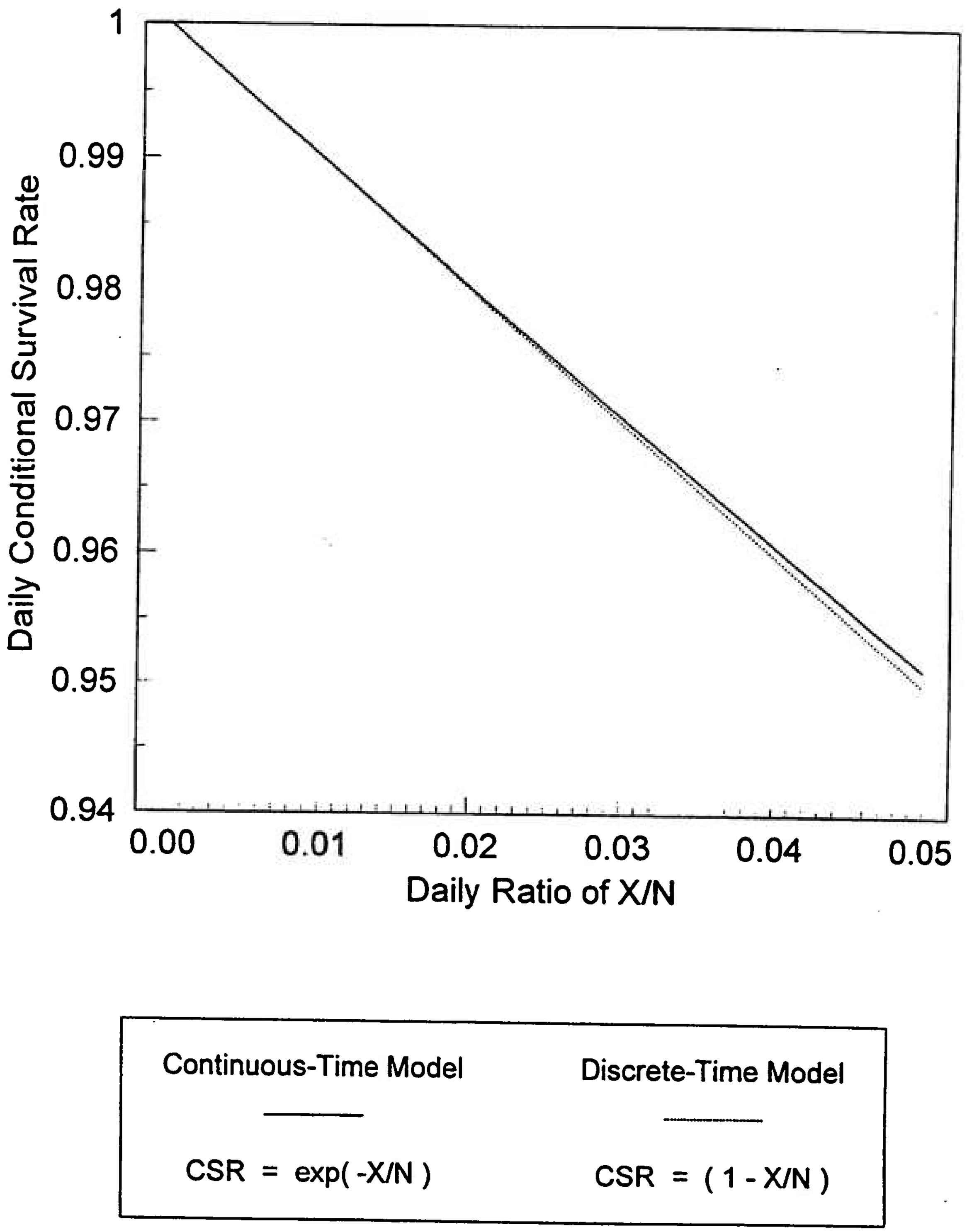


Figure X-1. Comparison of daily conditional survival rates as a function of the quotient of the number killed by entrainment to the river-wide abundance (*X/N*) based on discrete-time and continuous-time models.

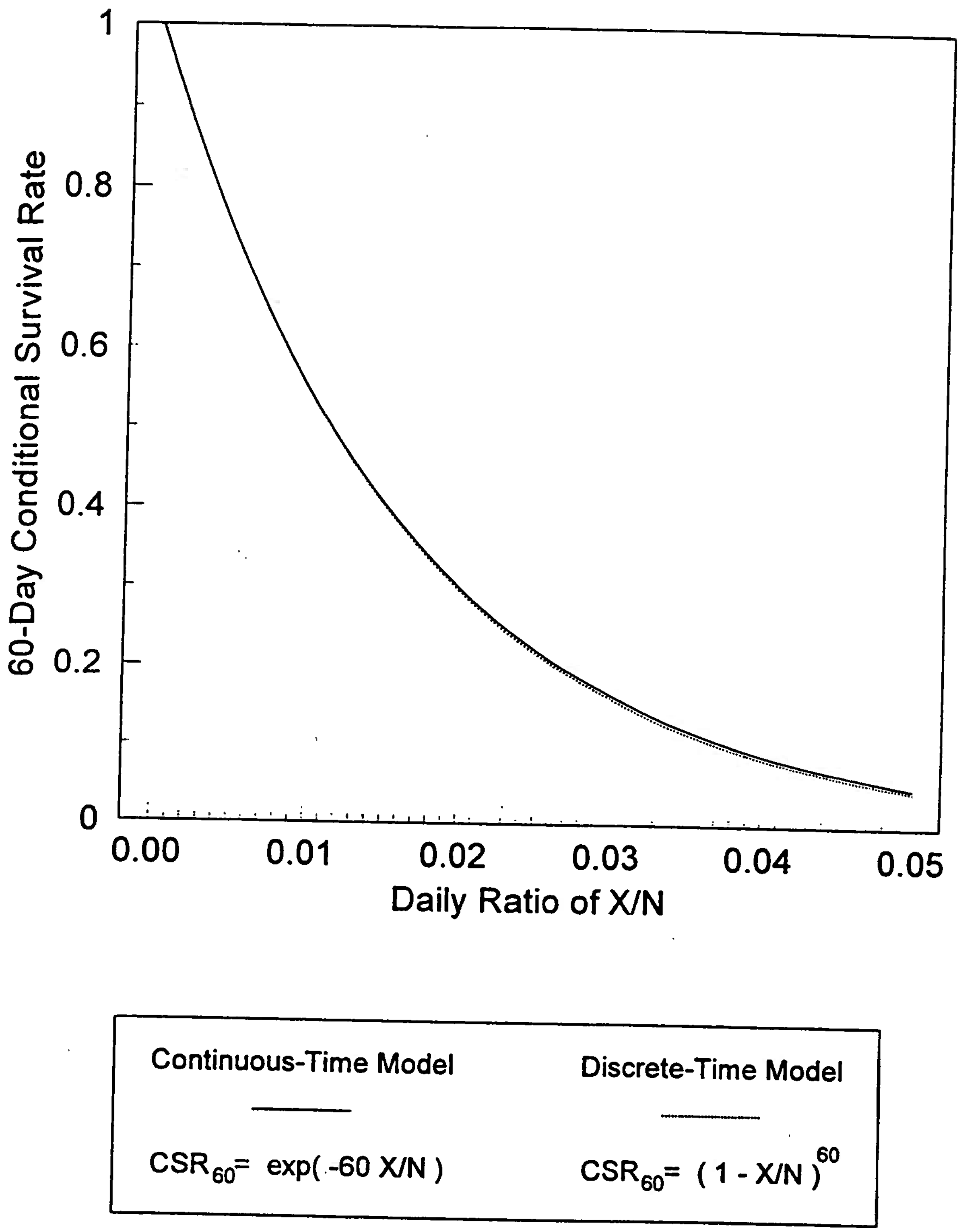


Figure X-2. Comparison of conditional survival rates (for 60 days) as a function of the quotient of the number killed by entrainment to the river-wide abundance (*X/N*) based on discrete-time and continuous-time models.

Table X-1.—Summary of Longitudinal River Survey unsampled areas.

Region (River Miles)	Habitat Stratum				
	Channel	Bottom	Shoal	Shore	Beach
12 (RM 140 - RM 152)	[13]	[7]	[6]	[1]	[<1]
12 (RM 125 - RM 139)	[19]	[6]	[10]	[6]	[2]
11 (RM 107 - RM 124)	[84]	[42]	[21]	[10]	[3]
10 (RM 94 - RM 106)	[113]	[43]	[8]	[9]	[3]
9 (RM 86 - RM 93)	[94]	[35]	[6]	[4]	[1]
8 (RM 77 - RM 85)	[131]	[32]	[1]	[1]	[<1]
7 (RM 62 - RM 76)	[229]	[63]	[1]	[4]	[1]
6 (RM 56 - RM 61)	[95]	[37]	[1]	[5]	[2]
5 (RM 47 - RM 55)	[179]	[26]	[1]	[1]	[<1]
4 (RM 39 - RM 46)	[162]	[33]	[6]	[5]	[2]
3 (RM 34 - RM 38)	[61]	[33]	[35]	[14]	[5]
2 (RM 24 - RM 33)	[138]	[62]	[91]	[23]	[8]
1 (RM 12 - RM 23)	[143]	[59]	[21]	[4]	[1]
0 (RM 0 - RM 11)	[142]	[48]	[19]	[0]	[0]
River-wide (RM 0 - RM 152)	[1,603]	[528]	[229]	[88]	[29]

Notes:

Unsampled in All Years Unsampled in Some Years [Volume in 1,000,000 cu.m.]

Stratum Definitions:

Channel—Water more than 10 ft (3m) from the river bottom in more than 20 ft (6m) depth.

Bottom—Water within 10 ft (3m) of the river bottom in more than 20 ft (6m) depth.

Shoal—Water between 10 ft (3m) and 20 ft (6m) depth.

Shore—Water between 5 ft (1.5m) and 10 ft (3m) depth.

Beach—Water less than 5 ft (1.5m) depth.

[Note: In Year Class Reports, the Shoal stratum is defined as all water less than 20 ft (6m) depth. In Table X-1 (above), the portion of the River with less than 20 ft depth is divided into 3 strata: Shoal (10-20 ft depth), Shore (5-10 ft depth), and Beach (0-5 ft depth), which correspond to the strata sampled during the 1986/87. Unsampled Areas Study. The sum of Shoal (10-20 ft), Shore (5-10 ft) and Beach (0-5 ft) volumes in Table 1 equals the Shoal volume reported in Year Class Reports].

Table X-2a.—CMR estimates based on 12-region ETMs and CEMR models. For all estimates, Region 12 is defined to include river miles 125-152.

Years	Water Withdrawal Facility	Taxon						
		American shad	River herring	Striped bass	White perch	Bay anchovy	Atlantic tomcod	Spottail shiner
1974 through 1980	Bowline Point	ι	ι	ι	ι	ι	ι	ι
	Indian Point	ι	ι	ι	ι	ι	ι	ι
	Roseton	ι	ι	ι	ι	ι	ι	ι
	Danskammer	ι	ι	ι	ι	ι	ι	ι
	Lovett	ι	ι	ι	ι	ι	ι	ι
	Empire State Plaza	ι	ι	ι	ι	ι	ι	ι
	Albany Steam Station	ι	ι	ι	ι	ι	ι	ι
	Westchester RESCO	ι	ι	ι	ι	ι	ι	ι
1981 through 1987	Bowline Point					ι	ι	ι
	Indian Point [a]	ι	ι	ι	ι	ι	ι	ι
	Roseton					ι	ι	ι
	Danskammer [b]	ι	ι	ι	ι	ι	ι	ι
	Lovett	ι	ι	ι	ι	ι	ι	ι
	Empire State Plaza	ι	ι	ι	ι	ι	ι	ι
	Albany Steam Station	ι	ι	ι	ι	ι	ι	ι
	Westchester RESCO	ι	ι	ι	ι	ι	ι	ι
1988 through 1997	Bowline Point	ι	ι	ι	ι	ι	ι	ι
	Indian Point	ι	ι	ι	ι	ι	ι	ι
	Roseton	ι	ι	ι	ι	ι	ι	ι
	Danskammer	ι	ι	ι	ι	ι	ι	ι
	Lovett	ι	ι	ι	ι	ι	ι	ι
	Empire State Plaza	ι	ι	ι	ι	ι	ι	ι
	Albany Steam Station	ι	ι	ι	ι	ι	ι	ι
	Westchester RESCO	ι	ι	ι	ι	ι	ι	ι

ι ETM   CEMR

a   CMR estimates based on ETM for 1982, and CEMR for the remainder.

b   CMR estimates based on ETM for 1981, and CEMR for the remainder.

Table X-2b.—CMR estimates based on 13-region ETM models. For all estimates, Region 12 is defined to include river miles 125-152.

Years	Water Withdrawal Facility	Taxon						
		American shad	River herring	Striped bass	White perch	Bay anchovy	Atlantic tomcod	Spottail shiner
1974	Bowline Point	φ	φ	φ	φ	φ	φ	φ
through	Indian Point	φ	φ	φ	φ	φ	φ	φ
1980	Roseton	φ	φ	φ	φ	φ	φ	φ
	Danskammer	φ	φ	φ	φ	φ	φ	φ
	Lovett	φ	φ	φ	φ	φ	φ	φ
	Empire State Plaza	φ	φ	φ	φ	φ	φ	φ
	Albany Steam Station	φ	φ	φ	φ	φ	φ	φ
	Westchester RESCO	φ	φ	φ	φ	φ	φ	φ
1981	Bowline Point					φ	φ	φ
through	Indian Point [a]	φ	φ	φ	φ	φ	φ	φ
1987	Roseton					φ	φ	φ
	Danskammer [b]	φ	φ	φ	φ	φ	φ	φ
	Lovett	φ	φ	φ	φ	φ	φ	φ
	Empire State Plaza	φ	φ	φ	φ	φ	φ	φ
	Albany Steam Station	φ	φ	φ	φ	φ	φ	φ
	Westchester RESCO	φ	φ	φ	φ	φ	φ	φ
1988	Bowline Point							
through	Indian Point							
1995	Roseton							
	Danskammer							
	Lovett							
	Empire State Plaza							
	Albany Steam Station							
	Westchester RESCO							

φ ETM—Region 0 densities predicted from Region 1 densities ETM—Region 0 densities based on observations from Region 0

CEMR

a CMR estimates based on ETM for 1982, and CEMR for the remainder.

b CMR estimates based on ETM for 1981, and CEMR for the remainder.

Table X-3.—List of component parameters in the modified ETM and the CEMR models[a].

Parameter	ETM	CEMR
D_{wkl}		
V_k		
P_{wk}		
$W_{w,l}$		
R_s		
S		
J		
L		
δ_{dsl}		
f_{dl}		
NE_{dl}		
N_{dsl}		
RPC_{dl}		

[a] Bullet indicates presence.

Table X-4.—Definition of component parameters in the modified ETM and the CEMR models.

Parameter	Definition	Eqn.
D_{wkl}	average proportion of river-wide abundance of life stage l individuals during week $s+j$ that are in region k, with $\sum_{k=1}^{K} D_{s+j,kl} = 1$ for each week, cohort and life-stage	(1)
V_k	volume of region k (units of m^3)	(2)
P_{wk}	rate of water withdrawal from region k in week $s+j$ (units of $m^3\ d^{-1}$)	(2)
W_{wl}	ratio of the average intake density to average regional density of life-stage l individuals during week $s+j$ in region k	(2)
R_s	proportion of spawning that occurred in week S, so that $\sum_{s=1}^{S} R_s = 1$	(1)
S	s = week 1, 2, 3, ..., S of the spawning period (subscript S will also denote cohorts born in those weeks)	(1)
J	j = age 0, 1, 2, ..., J of entrainable individuals in weeks	(1)
L	l = life stage 1, 2, 3, ..., L	(1)
δ_{dsl}	the proportion of day d that individuals of cohort s spend in life-stage l ($\sum_{l} \delta_{dsl} = 1$ for each day of entrainment vulnerability for cohort s)	(4)
f_{dl}	the fraction of life-stage l individuals entering the intake on day d that eventually are killed by plant passage	(6)
NE_{dl}	the number of individuals in life-stage l that are entrained on day d	(6)
N_{dsl}	the river-wide abundance of cohort s individuals that are in life-stage l on day d	(5)
RPC_{dl}	q_{1dl} / q_{2dl}, the ratio of the gear efficiencies for larvae of life-stage l on day d	(8)

Table X-5.—Facilities withdrawing 50 million gallons per day (mgd) or greater from the Hudson River.

Facility	River Mile	Permitted Discharge[a] (gpm)
Empire State Plaza	146	75,000
Albany Steam Station	142	357,000
Danskammer Point Generating Station	66	318,000
Roseton Generating Station	66	641,000
Charles Point Resource Recovery Facility (Westchester RESCO)	43	38,000
Indian Point Station	43	1,680,000
Lovett Generating Station	42	345,000
Bowline Point Generating Station	37	768,000

[a] NYSDEC SPDES files

Table X-6.—Volumes of river segments.

Region	Volume (m^3)			Area (m^2)
	Channel	Bottom	Shoal	Shore Zone
0	141809822	48455129	18747833	0
1	143452543	59312978	26654767	3389000
2	138000768	62125705	121684992	20446000
3	61309016	32517633	53910105	12101000
4	162269471	33418632	12648163	4147000
5	178830022	25977862	2647885	1186000
6	94882267	36768629	8140123	4793000
7	228975052	63168132	5990260	3193000
8	131165041	32012000	2307625	558000
9	93657021	35479990	12332868	3874000
10	113143296	42845077	20307338	7900000
11	83924081	42281206	34526456	8854000
12	32025080	13517183	25606842	6114000

Source: Versar (1987).

Table X-7.—Life stage duration estimates for striped bass, American shad, white perch, Atlantic tomcod, bay anchovy, river herring, and spottail shiner.

Species	Life Stage Duration (days)[a]			
	Egg	YSL	PYS	JUV
Striped bass	1.2-4.0[b]	3.4-10.2[b]	28	28
American shad	2.2-13.4[b]	4.5-7.0[b]	21	28
White perch	1.0-4.3[b]	5	32	28
Atlantic tomcod	-	28	42	21
Bay anchovy	1	1	30	42
River herring	4	3	28	28
Spottail shiner	-	-	-	83[c]

Notes:

[a] Boreman et al. (1982)

[b] Range of values estimated based on water temperature

[c] See text

Table X-8.—Sampling program(s) used to estimate river-wide abundance and/or distributions.

Species	Life Stage EGG	YSL	PYS	JUV
American shad	LRS	LRS	LRS	LRS PYSL projection + FSS[a]
Atlantic tomcod[b]	not applicable	LRS	LRS	LRS
Bay anchovy[c]	LRS	LRS	LRS	LRS PYSL projection + FSS[a]
River herring	LRS	LRS	LRS	LRS abundance + FSS[d]
Striped bass	LRS	LRS	LRS	LRS PYSL projection + FSS[a]
Spottail shiner[b]	not applicable	not applicable	not applicable	BSS
White perch	LRS	LRS	LRS	LRS PYSL projection + FSS[a]

Notes:

[a] Juvenile abundances for CEMR estimates were first estimated using projections of juvenile abundance based upon PYSL cohort abundances and survival rates, then further revised based upon FSS estimates of older juvenile abundance. See text for details of revision methods. Distribution patterns for ETM based solely upon LRS.

[b] No river-wide abundance estimates were constructed for Atlantic tomcod nor spottail shiner, because the CEMR model was never used for these species. Data from indicated sampling programs were used solely for the distribution patterns required by the ETM model.

[c] All life stage abundances for bay anchovy used solely for weekly CEMR estimates, generated only for purposes of calibrating ETM.

[d] Juvenile abundances for CEMR estimates from LRS were revised based upon FSS estimates of older JUV abundance. See text for details of abundance revision method. Distribution patterns for ETM based solely on LRS.

Table X-9.—Coefficients for predicting densities in unsampled strata, by species and life stage (Coastal 1991b).

Species	Life Stage	Unsampled Stratum		
		Beaches	Shores	Shoals
American shad	Egg	0.03	0.03	0.14
	YSL	1.00	1.00	1.00
	PYS	3.05	23.14	0.84
Striped bass	Egg	0.07	1.00	2.21
	YSL	1.82	1.00	8.40
	PYS	0.65	3.08	2.24
White perch	Egg	0.51	0.03	0.58
	YSL	1.19	1.04	1.25
	PYS	0.69	1.00	1.01

Table X-10a.—Coefficients for prediction equations for predicting densities in Region 0 based on densities in Region 1.

Taxon	Life Stage	Stratum	$\hat{\alpha}$	$\hat{\beta}$
Atlantic tomcod	PYSL	Bottom	-0.97	1.00
Atlantic tomcod	Juveniles	Bottom	-1.91	0.49
Atlantic tomcod	Juveniles	Channel	-2.53	0.52
Bay anchovy	Eggs	Bottom	-0.25	0.75
Bay anchovy	Eggs	Channel	0.18	0.84
Bay anchovy	PYSL	Bottom	-0.03	0.82
Bay anchovy	PYSL	Channel	-0.22	0.82
Bay anchovy	Juveniles	Bottom	-1.01	0.88
Bay anchovy	Juveniles	Channel	-1.92	0.76
River herring	PYSL	Bottom	0.67	1.13
River herring	Juveniles	Bottom	-3.00	0.38
Striped bass	PYSL	Bottom	-3.48	0.69
Striped bass	PYSL	Channel	-3.46	0.49

Table X-10b.—Coefficients for prediction equations for predicting densities in the northern portion of Region 12 based on densities in the southern portion of Region 12.

Taxon	Life Stage	Stratum	$\hat{\alpha}$	$\hat{\beta}$
American shad	YSL	Bottom	-1.31	0.56
American shad	YSL	Channel	-0.98	0.85
River herring	YSL	Bottom	-1.13	0.57
River herring	YSL	Channel	-0.32	0.68
River herring	PYSL	Bottom	-1.82	0.46
River herring	PYSL	Channel	-1.42	0.61
River herring	Juveniles	Bottom	-3.30	0.60
White perch	YSL	Bottom	-2.85	0.59
White perch	YSL	Channel	-2.41	0.36

Table X-11a.—Estimates of relative probability of capture (RPC) for striped bass and white perch (Coastal 1991a).

Species	Length (mm)	RPC Plant density/River density
Striped bass	0-4.5	0.76
	-6.5	0.22
	-8.5	0.33
	-10.5	0.57
	-12.5	0.98
	-14.5	1.75
	-16.5	2.72
	-18.5	4.00
	-20.5	3.21
	>20.5	5.26
White perch	0-4.5	0.09
	-6.5	0.16
	-8.5	0.24
	-10.5	0.43
	-12.5	0.77
	-14.5	1.84
	>14.5	3.24

Table X-11b.—Estimates for relative probability of capture (RPC) for bay anchovy.

Species	Length (mm)	RPC Plant density/River density
Bay anchovy	0-7.5	3.05
	-12.5	0.27
	-17.5	0.26
	-22.5	1.59
	>22.5	2.60

Table X-12a.—Overall W estimates by stage and plant for 12 regions (see text).

Species	Stage	Plant: Bowline Point	Indian Point	Roseton	Danskammer	Albany Steam
American shad	Egg	0.0000	0.4318	0.1852	0.2828	0.3552
	YSL	0.0000	0.1850	0.1639	0.2883	1.4162
	PYSL	0.6119	0.4335	1.1576	1.7852	3.1204
	JUV	0.0037	0.0224	0.0139	0.0538	0.0000
Bay anchovy	Egg	0.0015	0.4059	0.0000	0.0000	1.0000
	YSL	0.0396	0.8933	NA	NA	1.0000
	PYSL	0.4450	0.5636	0.6571	0.6521	1.0000
	JUV	0.0051	0.0056	0.0053	0.0011	1.0000
River herring	Egg	0.5584	3.4291	11.9278	39.3233	0.3552
	YSL	0.1202	1.4007	0.3864	0.5523	1.4162
	PYSL	0.4637	0.8596	0.8210	1.0325	3.1204
	JUV	0.0435	0.0422	0.1549	0.2117	0.0000
Striped bass	Egg	0.0289	0.0504	0.3208	0.7795	1.0000
	YSL	0.1959	0.3472	0.7034	1.3433	1.0000
	PYSL	0.4104	1.5324	1.0316	2.1697	1.0000
	JUV	0.0572	0.0784	0.1861	0.2212	1.0000
White perch	Egg	3.8776	0.6469	2.2064	8.5748	0.5269
	YSL	0.2157	0.7286	2.8533	4.7590	0.7609
	PYSL	0.3828	1.3302	0.7564	0.8317	0.2147
	JUV	0.0125	0.0512	0.0621	0.0541	0.0000

Table X-12b.—Overall W estimates by stage and plant for 13 regions (see text).

Species	Stage	Plant			
		Bowline Point	**Indian Point**	**Roseton**	**Danskammer**
American shad	Egg	0.0000	0.4318	0.1852	0.2828
	YSL	0.0000	0.1850	0.1639	0.2883
	PYSL	0.6119	0.4335	1.1576	1.7852
	JUV	0.0024	0.0140	0.0123	0.0451
Bay anchovy	Egg	0.0015	0.4047	0.0000	0.0000
	YSL	0.0396	0.8944	1	1
	PYSL	0.4450	0.5640	0.6576	0.6512
	JUV	0.0057	0.0058	0.0072	0.0018
River herring	Egg	0.5584	3.4291	11.9278	39.3233
	YSL	0.1202	1.4007	0.3863	0.5522
	PYSL	0.4638	0.8593	0.8210	1.0325
	JUV	0.0434	0.0427	0.1560	0.2133
Striped bass	Egg	0.0289	0.0504	0.3208	0.7795
	YSL	0.1959	0.3472	0.7034	1.3433
	PYSL	0.4104	1.5324	1.0316	2.1696
	JUV	0.0558	0.0755	0.1921	0.2323
White perch	Egg	3.8776	0.6469	2.2064	8.5748
	YSL	0.2157	0.7285	2.8533	4.7590
	PYSL	0.3828	1.3303	0.7565	0.8318
	JUV	0.0109	0.0378	0.0237	0.0174

Table X-13.—Flow rate (gallons per minute) as a function of plant operating condition at Bowline Point Generating Station.

Unit Operating Condition	Flow Rate (gpm)[a]
3 pumps full	384,000
2 pumps full (condenser open)	316,000
2 pumps full (condenser closed)	285,000
2 pumps throttled	257,000
1 pump full	185,000
1 pump throttled	150,000

[a] EA (1985c), HRU (1989b)

Table X-14.—Flow rate (gallons per minute) as a function of plant operating condition at Roseton Generating Station.

Plant OperatingCondition		
Number of Pumps	Number of Units	Flow Rate[a] (gpm)
1	1	218,000
	2	228,000
2	1	376,000
	1 full 1 at 5%	378,000
3	1	526,000
	1 full 1 at 5%	528,000
	2	561,000
4	2	641,000

[a] LMS (1985c), HRU (1989b)

Table X-15.—Proportion of water withdrawal originating in each region of the river.

Region	Power Plant							
	Bowline[a]	Lovett[a]	Indian Point[a]	RESCO[b]	Roseton[a]	Dans-kammer[a]	Albany Steam[b]	Empire State[b]
YK	0	0	0	0	0	0	0	0
TZ	0.271	0	0	0	0	0	0	0
CH	0.358	0.369	0.298	0.164	0	0	0	0
IP	0.371	0.549	0.562	0.586	0	0	0	0
WP	0	0.082	0.140	0.250	0	0	0	0
CW	0	0	0	0	0.273	0.196	0	0
PK	0	0	0	0	0.727	0.804	0	0
HP	0	0	0	0	0	0	0	0
KG	0	0	0	0	0	0	0	0
SG		0	0	0	0	0	0	0
CK	0	0	0	0	0	0	0	0
AL	0	0	0	0	0	0	1.0	1.0

[a] Boreman et al. (1982)

[b] Appendix titled "Parameters used in ETM estimates for 1974-1980 and 1981-1991".

Table X-16.—Mechanical mortality rate estimates by species and life stage (see text).

Species	Life Stage			
	EGG	YSL	PYS	JUV
American shad	1.0	0.794	0.794	0.794
Atlantic tomcod	1.0	0.683	0.469	0.425
Bay anchovy	1.0	1.0	1.0	1.0
River herring	1.0	0.794	0.794	0.794
Striped bass	1.0	0.266	0.287	0.254
Spottail shiner	1.0	0.129	0.129	0.129
White perch	1.0	0.566	0.566	0.464

Table X-17.—Coefficients used to estimate boundary temperatures (X_1 and X_2) for the double hinged line model used to estimate thermal mortality rates for striped bass and white perch (see text).

	Life Stage			
Coefficient	**EGGS**	**YSL**	**PYSL**	**JUV**
a1	21.762	53.875	29.672	24.120
a2	39.246	24.537	41.254	36.266
b1	0.943	-1.354	0.147	0.516
b2	0.136	1.090	-0.031	0.142
c1	-1.110	-0.407	-0.312	-0.806
c2	-1.741	-2.672	-1.471	-1.122

Table X-18.—Boundary temperatures (EC) used in estimating thermal mortality rates for American shad, Atlantic tomcod, river herring, and spottail shiner, using a double hinged model. Thermal mortality was 0 at temperatures below X_1, 100% at temperatures above X_2, and interpolated linearly from 0 to 100% between X_1 and X_2.

	Life Stage					
	YSL		PYS		JUV	
Species	X_1	X_2	X_1	X_2	X_1	X_2
American shad	33.5	38.0	29.8	32.9	29.8	32.9
Atlantic tomcod	24.2	28.2	24.8	28.7	24.8	28.7
River herring	33.5	38.0	29.8	32.9	29.8	32.9
Spottail shiner	--	--	--	--	35.1	36.9

Table X-19.—Monthly projected generating load as percent of dependable maximum net generation for Units 3 and 4 and Danskammer. From Table VII-8, Boreman et al. (1982).

	Month				
Unit	**April**	**May**	**June**	**July**	**August**
3	76.0	74.0	70.0	70.0	78.0
4	74.0	72.0	65.0	67.0	67.0

Table X-20a Annual CMR values by year for American Shad for 12 Regions and estimated flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	0.1	0.24	0.15	0.88	0.68	0.11	1.02	.	3.15
1975	0.11	0.38	2.68	2.35	1	1.84	30.91	.	36.51
1976	0.22	0.34	2.01	1.3	0.59	1.9	31.33	.	35.59
1977	0.02	0.49	1.42	0.99	1.22	0.38	2.96	.	7.27
1978	0.09	0.26	1.92	1.33	0.43	0.78	14.9	.	18.93
1979	0.04	0.21	1.06	0.98	0.07	1.71	26.6	.	29.55
1980	0	0.04	0.31	0.31	0.14	2	35.99	.	37.77
1981	0.02	0.2	0.35	0.81	0.24	0.95	13.29	.	15.5
1982	0.16	0.47	0.33	0.91	1.04	0.72	8.17	.	11.46
1983	0.02	0.09	0.74	1.19	0.6	1.28	15.68	.	18.95
1984	0.05	7.57	1.08	0.89	1.12	0.98	10.84	0.32	21.18
1985	0	0	0.17	0.27	0.07	1.63	17.77	0.03	19.55
1986	0	3.56	0.32	0.73	0.09	0.46	5.92	0.02	10.73
1987	0.01	0	0.42	0.3	0.12	3.82	26.61	0.05	30.04
1988	0.01	0.2	0.2	0.24	0.86	2.19	36.45	0.18	38.89
1989	0.2	0.32	1.16	0.97	1.21	1.96	35.44	0.24	39.25
1990	0.09	0.46	1.34	1.4	1.5	3.43	49.83	0.29	53.97
1991	0.01	0.09	0.41	0.47	0.77	1.51	30.64	0.12	32.96
1992	0.01	0.07	0.22	0.16	0.5	1.34	50.85	0.16	52.04
1993	0.01	0.17	0.23	0.24	1.19	1.29	6.46	0.32	9.64
1994	0.03	0.13	0.37	0.27	0.47	2.61	18.32	0.13	21.56
1995	0.01	0.13	0.39	0.37	0.61	1.33	9.75	0.12	12.39
1996	0.03	0.45	0.25	0.37	0.64	1.27	3.39	0.17	6.41
1997	0.01	0.06	0.3	0.5	0.71	2	13.64	0.13	16.8

Table X-20b.—Annual CMR values by year for Atlantic Tomcod for 12 Regions and estimated flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	5.91	3.93	0.27	0.63	3.16	0	0	.	13.24
1975	9.2	6.8	1.2	0.25	2.72	0	0	.	18.87
1976	10.65	8.8	0.96	0.37	2.89	0	0	.	21.93
1977	5.49	10.33	3.42	1.02	1.16	0	0	.	19.92
1978	9.23	10.71	2.32	0.81	2.98	0	0	.	23.82
1979	6.89	19.32	2.35	0.72	1.57	0	0	.	28.31
1980	6.15	25.75	1.82	0.59	5.17	0	0	.	35.5
1981	8.21	12.14	1.66	0.61	4.18	0	0	.	24.47
1982	6.82	17.99	1.74	0.71	4.13	0	0	.	28.53
1983	6.97	8.07	1.6	0.59	2.41	0	0	.	18.36
1984	5.99	17.32	1.63	0.7	1.53	0	0	1	25.98
1985	6.9	35.03	2.04	0.79	4.06	0	0	1.91	44.68
1986	8.64	12.01	1.84	0.72	3.79	0	0.02	1.8	26
1987	4.75	15.37	2.21	0.88	1.87	0	0	1.03	24.12
1988	7.53	25.33	1.86	0.8	3.47	0	0	1.68	36.2
1989	7.95	4.61	1.72	0.68	2.88	0	0	1.06	17.64
1990	7.12	5.84	2.02	0.82	2.74	0	0	0.88	18.07
1991	7.1	7.33	1.83	0.64	6.15	0	0.02	1.05	22.04
1992	7.68	14.9	1.66	0.51	2.79	0	0	1.04	26.06
1993	5.63	3.9	1.05	0.29	1.48	0	0	0.83	12.58
1994	4.72	8.03	1.58	0.47	2.61	0	0	0.85	17.11
1995	7.43	6.67	1.33	0.55	3.71	0	0.01	1.82	19.86
1996	1.62	9.06	0.84	0.31	1.17	0	0	0.55	13.08
1997	0.61	15.63	1.65	0.75	2.16	0	0	1.07	20.78

Table X-20c.—Annual CMR values by year for Bay Anchovy for 12 Regions and estimated flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	5.73	8.21	0.21	0.05	8.46	0	0.01	.	21
1975	4.63	7.09	0.41	0.08	6.51	0.05	0.65	.	18.14
1976	4.32	4.06	0.65	0.1	3.85	0	0.05	.	12.45
1977	5.28	14.14	0.66	0.09	8.2	0.01	0.19	.	26.06
1978	6.66	13.76	1.14	0.17	8.29	0	0	.	27.14
1979	6.69	11.29	1.3	0.2	4.38	0	0.03	.	22.07
1980	6.75	19.26	0.62	0.11	9.48	0	0.02	.	32.35
1981	4.55	20.42	0.61	0.13	9.7	0	0.01	.	31.92
1982	2.26	4.8	0.73	0.16	5.75	0	0.03	.	13.11
1983	3.41	9.97	1.05	0.24	6.86	0	0	.	20.06
1984	3.42	7.03	0.94	0.24	5.07	0	0.01	0.89	16.52
1985	3.35	10.73	0.86	0.22	8.64	0.05	0.55	1.18	23.41
1986	2.36	5.99	0.43	0.07	4.98	0	0.01	0.8	13.92
1987	6.24	11.02	0.87	0.12	6.14	0.01	0.12	1.31	23.59
1988	6.08	20.15	1.52	0.39	7.56	0.02	0.31	1.24	33.07
1989	4.53	9.69	0.56	0.04	5.31	0	0.01	0.66	19.4
1990	6.34	25.17	1.72	0.43	9.91	0	0.03	1.3	39.04
1991	4.51	11.11	2.44	0.68	8.02	0	0.01	1.1	25.19
1992	3.94	7.75	0.41	0.08	7.63	0.01	0.27	0.83	19.44
1993	3.43	7.65	0.93	0.33	7.46	0.01	0.15	0.88	19.35
1994	3.47	8.16	0.24	0.06	8.23	0.02	0.12	1.03	19.83
1995	3.83	15.95	2.45	1.01	7.2	0.01	0.05	1.03	28.35
1996	1.46	18.24	0.1	0.05	7.99	0	0	1.06	26.77
1997	3.92	7.47	2.35	1.12	8.37	0.01	0.04	1.04	22.2

Table X-20d.—Annual CMR values by year for River Herring for 12 Regions and estimated flow-through mortality (actual flow).. See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	0.17	0.85	0.65	2.97	0.47	1.76	22.03	.	27.25
1975	0.18	1.45	13.1	13.34	0.45	1.54	18.6	.	40.9
1976	0.79	1.89	5.81	4.52	0.58	1.62	19.83	.	31.35
1977	0.49	2.59	6.31	8.89	0.43	1.57	17.58	.	33.16
1978	0.2	1.32	3.14	2.19	0.34	1.75	20.95	.	27.79
1979	0.09	2.25	4.26	3.5	0.1	1.85	18.34	.	27.76
1980	0.06	0.63	3	2.82	0.48	1.23	18.58	.	25.08
1981	0.03	0.61	2.4	2.62	0.23	0.3	6.59	.	12.26
1982	0.15	1.03	3.33	1.87	1.51	0.42	3.46	.	11.25
1983	0.3	13.25	18.96	17.18	1.09	0.91	8.26	.	47.81
1984	0.15	5.33	1.65	1.76	1.26	1.1	15.57	0.33	24.95
1985	0	0.02	1.02	1.87	0.01	1.16	11.02	0	14.61
1986	0.01	0.92	1.73	3.77	0.1	0.26	3.83	0.03	10.26
1987	0.47	0.04	2.75	2.47	0.06	3.82	25.98	0.02	32.87
1988	0.04	0.55	3.77	4.54	0.19	1.35	16.05	0.05	24.55
1989	0.41	1.63	4.99	3.77	1.17	1.75	23.55	0.24	33.67
1990	0.85	3.18	2.52	2.23	1.24	1.95	21	0.3	30.21
1991	0.08	0.42	1.69	1.27	0.27	1.31	17.81	0.05	21.91
1992	0.06	0.47	2.16	1.38	0.44	1.68	35.9	0.09	39.82
1993	0.04	0.32	1.08	0.97	0.41	0.95	8.21	0.12	11.73
1994	0.07	0.54	2.24	1.54	0.34	1.77	12.07	0.11	17.73
1995	0.02	0.15	4.46	4.2	0.13	1.37	5.44	0.04	14.94
1996	0.01	0.59	1.46	1.96	0.22	1.73	2.56	0.07	8.32
1997	0.25	0.99	3.37	6.7	1.61	2.54	8.24	0.39	21.96

Table X-20e.—Annual CMR values by year for Striped Bass for 12 Regions and estimated flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	0.87	5.67	0.39	2.16	2.96	0	0.03	.	11.6
1975	1.15	7.82	1.81	1.56	3.17	0.05	0.2	.	14.92
1976	1.65	4.76	2.68	2.55	1.62	0.05	0.34	.	12.94
1977	1.11	13.91	2.23	1.81	1.76	0.04	0.15	.	19.86
1978	1.59	8.59	1.53	1.19	2.13	0	0.01	.	14.36
1979	1.47	12.02	2.2	1.65	1.41	0.01	0.04	.	17.83
1980	1.17	11.92	3.37	2.73	2.35	0.02	0.09	.	20.19
1981	0.23	4.17	0.43	4.18	2.32	0.02	0.22	.	11.1
1982	3.88	7.07	3.75	4.88	2.75	0.01	0.04	.	20.52
1983	0.59	7.43	2.39	2.36	5.11	0.02	0.08	.	16.85
1984	2.73	17.29	1.72	1.87	1.72	0.01	0.03	1.29	24.76
1985	0.07	3.97	4.3	4.26	0.76	0.23	0.66	0.63	14.06
1986	1.03	16.4	4.06	5.04	1.59	0.01	0.08	1.26	26.82
1987	0.47	2.3	4.78	7.43	0.72	0.08	0.21	0.69	15.73
1988	1.15	11.69	2.99	3.48	2.14	0.02	0.15	1.39	21.25
1989	1.11	6.09	2.39	2.41	1.83	0.01	0.04	1.15	14.2
1990	0.95	6.19	4.07	4.45	1.85	0.02	0.11	0.91	17.27
1991	0.8	4.98	3.77	4.15	6.14	0.23	1.15	1.12	20.43
1992	0.92	6.21	2.96	2.48	2.43	0.01	0.42	1.52	15.86
1993	0.53	5.62	1.28	1.86	1.36	0.02	0.14	0.93	11.26
1994	0.79	6.83	1.69	1	2.18	0.02	0.03	1.32	13.21
1995	0.45	4.25	3.01	2.68	1.24	0.06	0.1	0.84	12.04
1996	0.11	11.69	1.53	1.91	1.42	0.01	0.01	1	16.87
1997	0.51	1.39	3.02	3.47	1.9	0.04	0.07	1.3	11.18

Table X-20f.—Annual CMR values by year for Spottail Shiner for 12 Regions and estimated flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	0.49	0.87	0.22	0.66	0.24	3.32	5.75	.	11.11
1975	0.56	1.04	0.65	1.32	0.27	5.98	10.14	.	18.72
1976	1.17	1.38	1.14	1.03	0.38	3.04	5.48	.	12.93
1977	0.43	1.41	0.59	1	0.18	8.8	14.91	.	25.17
1978	0.79	2.32	0.73	1.14	0.47	5.87	10.01	.	19.82
1979	0.64	1.62	1.45	1.66	0.4	3.74	6.51	.	15.09
1980	0.23	1.66	1.06	2.26	0.3	4.59	7.96	.	16.94
1981	0.36	3.43	0.88	1.06	0.46	2	5.39	.	12.92
1982	0.6	2.06	0.91	1.07	0.36	3.96	6.68	.	14.77
1983	0.43	3.17	1.7	1.24	1.37	4.72	8.11	.	19.16
1984	0.55	1.58	0.79	1	0.19	5.25	9.35	0.28	17.82
1985	0.35	1.77	0.92	1.15	0.41	5.41	6.48	0.36	15.84
1986	0.42	1.55	1.44	1.91	0.34	3.69	4.69	0.4	13.64
1987	0.43	1.53	1.39	1.06	0.16	6.22	8.42	0.28	18.2
1988	0.39	4.1	1.3	2.66	0.52	5.43	7.57	0.29	20.43
1989	0.7	8.32	0.93	1.73	0.76	4.12	7.12	0.35	21.94
1990	0.46	2.18	1.07	2.06	0.26	4.79	7.61	0.3	17.48
1991	0.62	3.92	1.14	3.06	2.66	3.46	8.57	0.45	21.73
1992	0.31	0.99	1.09	0.48	0.24	2.15	6.35	0.3	11.44
1993	0.32	0.89	0.83	0.64	0.56	2.82	4.94	0.28	10.84
1994	0.36	1.1	1.2	0.75	0.38	3.96	5.18	0.27	12.56
1995	0.27	2.54	0.86	0.56	0.28	2.9	2.78	0.19	9.98
1996	0.2	1.89	0.59	0.56	0.48	4.34	2.85	0.34	10.78
1997	0.29	0.64	1.02	0.62	0.33	4.69	3.17	0.34	10.67

Table X-20g.—Annual CMR values by year for White Perch for 12 Regions and estimated flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	9.1	7.45	1.14	4.89	2.73	0.27	0.98	.	24.03
1975	2.96	8.65	7.82	7.86	1.93	0.4	1.81	.	27.8
1976	2.18	3.22	6.66	7.1	0.69	0.47	1.99	.	20.48
1977	2.12	7.28	7.24	5.96	1	0.49	1.35	.	23.07
1978	1.17	5.28	6.88	3.64	0.61	0.93	1.74	.	18.74
1979	0.86	8.03	7.39	4.95	0.43	0.25	1.17	.	21.22
1980	0.4	3.38	7.81	6.9	0.74	0.39	2.03	.	19.99
1981	0.32	6.46	1.7	5.5	1.32	0.16	0.92	.	15.44
1982	0.17	4.34	2.29	2.18	1.28	0.5	2.3	.	12.4
1983	1.05	18.14	7.08	4.84	3.16	0.39	1.57	.	32.01
1984	0.65	8.88	3.88	3.31	0.98	0.5	1.76	0.44	18.93
1985	0.03	0.55	3.53	3.88	0.24	0.31	0.78	0.12	9.14
1986	0.28	4.07	9.4	14.44	0.61	0.08	0.3	0.29	26.79
1987	0.01	0.66	6.87	7.54	0.38	0.64	0.68	0.22	16.09
1988	0.56	7.99	7.51	6.24	1.8	0.57	1.4	0.65	24.1
1989	0.8	4.07	8.54	5.88	1.3	0.48	2.62	0.54	22.06
1990	0.41	3.52	7.63	6.49	1.07	0.89	2.49	0.35	20.93
1991	0.24	1.46	9.99	7.44	1.85	0.29	0.99	0.37	20.93
1992	0.29	2.73	7.13	4.79	1.29	0.21	1.94	0.54	17.61
1993	0.13	2.36	3.31	3.71	1.14	0.21	0.38	0.42	11.15
1994	0.29	3.14	6.72	3.24	0.89	0.41	0.62	0.39	14.83
1995	0.1	1.93	5.56	4.62	0.47	0.37	0.34	0.27	13.02
1996	0.07	4.9	4.54	4.13	0.5	0.59	0.31	0.23	14.44
1997	0.2	1.31	5.53	7.04	1.66	0.53	0.73	0.49	16.41

Table X-21a.—Annual CMR values by year for American Shad for 13 Regions and estimated flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	0.10	0.22	0.15	0.82	0.68	0.11	1.02	.	3.06
1975	0.11	0.35	2.67	2.31	1.00	1.84	30.91	.	36.45
1976	0.22	0.33	2.01	1.28	0.59	1.90	31.36	.	35.61
1977	0.02	0.38	1.42	0.96	1.22	0.38	2.96	.	7.14
1978	0.09	0.24	1.92	1.29	0.43	0.78	14.90	.	18.88
1979	0.04	0.20	1.06	0.96	0.07	1.72	26.61	.	29.53
1980	0.00	0.03	0.31	0.28	0.14	2.00	35.99	.	37.74
1981	0.02	0.20	0.35	0.79	0.24	0.95	13.29	.	15.47
1982	0.16	0.44	0.33	0.91	1.03	0.72	8.17	.	11.43
1983	0.02	0.09	0.74	1.19	0.60	1.28	15.69	.	18.94
1984	0.05	7.50	1.08	0.71	1.11	0.98	10.84	0.32	20.97
1985	0.00	0.00	0.17	0.27	0.07	1.63	17.77	0.03	19.55
1986	0.00	3.56	0.32	0.73	0.09	0.46	5.92	0.02	10.73
1987	0.01	0.00	0.42	0.30	0.12	3.82	26.61	0.05	30.04
1988	0.01	0.15	0.20	0.22	0.86	2.19	36.45	0.18	38.84
1989	0.20	0.28	1.16	0.91	1.20	1.95	35.44	0.24	39.18
1990	0.08	0.43	2.24	1.88	1.68	2.97	42.36	0.31	47.69
1991	0.01	0.07	0.41	0.44	0.74	1.51	30.64	0.12	32.90
1992	0.01	0.05	0.22	0.15	0.48	1.34	50.85	0.15	52.02
1993	0.01	0.13	0.23	0.22	1.19	1.29	6.46	0.32	9.58
1994	0.03	0.12	0.37	0.25	0.47	2.61	18.32	0.13	21.53
1995	0.01	0.10	0.39	0.35	0.61	1.33	9.75	0.12	12.34
1996	0.03	0.42	0.24	0.32	0.65	1.29	3.47	0.17	6.45
1997	0.01	0.05	0.32	0.50	0.76	1.99	13.65	0.14	16.86

Table X-21b.—Annual CMR values by year for Atlantic Tomcod for 13 Regions and estimated flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	5.61	3.65	0.26	0.62	2.98	0.00	0.00	.	12.55
1975	9.16	6.75	1.20	0.25	2.71	0.00	0.00	.	18.78
1976	10.60	8.76	0.94	0.36	2.89	0.00	0.00	.	21.82
1977	5.43	10.15	3.41	1.02	1.14	0.00	0.00	.	19.69
1978	9.18	10.60	2.32	0.81	2.96	0.00	0.00	.	23.66
1979	6.85	18.80	2.33	0.71	1.53	0.00	0.00	.	27.78
1980	6.10	25.47	1.81	0.58	5.13	0.00	0.00	.	35.19
1981	7.88	11.68	1.65	0.60	4.01	0.00	0.00	.	23.65
1982	6.57	17.47	1.72	0.70	3.95	0.00	0.00	.	27.72
1983	6.65	7.69	1.59	0.59	2.31	0.00	0.00	.	17.65
1984	5.77	16.58	1.61	0.70	1.45	0.00	0.00	0.95	25.03
1985	6.70	34.50	2.03	0.78	3.95	0.00	0.00	1.86	44.01
1986	8.22	11.36	1.82	0.70	3.58	0.00	0.02	1.69	24.82
1987	4.53	14.61	2.17	0.86	1.79	0.00	0.00	0.98	23.11
1988	7.15	23.94	1.84	0.78	3.25	0.00	0.00	1.57	34.50
1989	7.47	4.49	1.72	0.68	2.74	0.00	0.00	0.99	16.93
1990	6.72	5.52	2.00	0.80	2.62	0.00	0.00	0.82	17.25
1991	6.65	6.99	1.81	0.63	5.71	0.00	0.01	0.98	20.91
1992	7.25	14.11	1.66	0.51	2.65	0.00	0.00	0.98	24.87
1993	5.38	3.67	1.05	0.29	1.42	0.00	0.00	0.78	12.03
1994	4.48	7.57	1.57	0.47	2.47	0.00	0.00	0.80	16.31
1995	6.75	5.77	1.19	0.50	3.36	0.00	0.01	1.58	17.85
1996	1.61	8.47	0.84	0.31	1.09	0.00	0.00	0.52	12.39
1997	0.55	10.35	1.63	0.74	1.47	0.00	0.00	0.71	14.83

Table X-21c.—Annual CMR values by year for Bay Anchovy for 13 Regions and estimated flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	5.00	7.31	0.05	0.04	7.95	0.00	0.01	.	19.03
1975	4.20	6.61	0.18	0.07	6.10	0.05	0.63	.	16.76
1976	3.67	3.45	0.20	0.07	3.41	0.00	0.06	.	10.47
1977	4.96	13.78	0.22	0.07	8.00	0.02	0.21	.	25.00
1978	6.00	12.54	0.48	0.14	7.86	0.00	0.00	.	24.71
1979	6.30	10.80	0.52	0.16	4.11	0.00	0.04	.	20.43
1980	6.35	18.44	0.21	0.09	9.07	0.00	0.02	.	30.77
1981	4.01	18.56	0.23	0.11	8.94	0.00	0.01	.	29.06
1982	1.82	4.19	0.31	0.14	5.29	0.00	0.02	.	11.32
1983	2.95	9.04	0.51	0.21	6.34	0.00	0.00	.	17.93
1984	3.01	6.26	0.43	0.20	4.63	0.00	0.01	0.82	14.55
1985	3.07	10.06	0.47	0.20	8.17	0.05	0.57	1.11	21.84
1986	1.84	5.07	0.13	0.06	4.52	0.00	0.01	0.71	11.84
1987	5.50	9.99	0.38	0.11	5.67	0.01	0.14	1.21	21.25
1988	5.21	17.73	0.76	0.29	6.83	0.02	0.25	1.13	29.11
1989	3.59	7.96	0.11	0.03	4.62	0.00	0.01	0.57	15.97
1990	5.24	20.85	1.07	0.40	8.48	0.00	0.03	1.10	33.12
1991	3.72	9.09	1.44	0.59	6.99	0.00	0.01	0.95	21.01
1992	3.55	7.12	0.20	0.08	6.82	0.01	0.20	0.74	17.54
1993	3.17	7.08	0.50	0.29	7.03	0.01	0.15	0.82	17.81
1994	2.69	5.94	0.09	0.04	6.85	0.01	0.07	0.85	15.66
1995	3.55	14.99	1.82	0.96	6.74	0.01	0.05	0.96	26.40
1996	1.27	15.55	0.07	0.05	7.19	0.00	0.00	0.94	23.44
1997	3.61	6.62	1.78	0.98	7.95	0.01	0.05	0.98	20.25

Table X-21d.—Annual CMR values by year for River Herring for 13 Regions and estimated flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation. The values shown for the Albany Steam Station are the same as for 12 regions.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	0.17	0.83	0.64	2.91	0.47	1.76	22.03	.	27.18
1975	0.19	1.42	13.00	13.17	0.45	1.53	18.57	.	40.67
1976	0.79	1.85	5.70	4.38	0.58	1.61	19.78	.	31.11
1977	0.49	2.47	6.26	8.81	0.43	1.57	17.58	.	32.98
1978	0.21	1.26	2.99	2.01	0.34	1.75	20.95	.	27.51
1979	0.09	2.24	4.10	3.22	0.10	1.85	18.34	.	27.41
1980	0.06	0.48	2.87	2.62	0.48	1.23	18.58	.	24.71
1981	0.02	0.57	2.30	2.46	0.23	0.30	6.59	.	11.99
1982	0.17	0.81	1.90	1.87	1.51	0.42	3.46	.	9.74
1983	0.31	3.05	4.60	4.97	1.09	0.91	8.26	.	21.21
1984	0.15	5.34	1.65	1.56	1.26	1.10	15.57	0.33	24.80
1985	0.00	0.02	1.03	1.95	0.01	1.16	11.02	0.00	14.69
1986	0.01	0.92	1.62	3.70	0.10	0.26	3.83	0.03	10.09
1987	0.01	0.04	2.89	2.04	0.06	3.82	25.98	0.02	32.36
1988	0.04	0.51	3.59	4.26	0.19	1.35	16.01	0.05	24.12
1989	0.41	1.41	4.53	3.09	1.17	1.74	23.49	0.24	32.67
1990	0.85	2.94	2.31	1.94	1.24	1.95	20.96	0.30	29.65
1991	0.08	0.41	1.55	1.07	0.27	1.31	17.80	0.05	21.62
1992	0.06	0.41	2.04	1.20	0.43	1.68	35.74	0.09	39.45
1993	0.04	0.23	0.91	0.69	0.41	0.95	8.21	0.12	11.25
1994	0.07	0.49	1.96	1.18	0.34	1.75	11.95	0.11	17.03
1995	0.02	0.12	4.23	3.80	0.13	1.37	5.44	0.04	14.34
1996	0.01	0.49	1.31	1.55	0.21	1.73	2.56	0.07	7.70
1997	0.22	0.60	4.83	6.09	1.28	2.08	9.13	0.29	22.37

Table X-21e.—Annual CMR values by year for Striped Bass for 13 Regions and estimated flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	0.72	5.65	0.38	2.16	2.96	0.00	0.03	.	11.43
1975	0.99	7.78	1.71	1.54	3.16	0.05	0.20	.	14.64
1976	1.45	4.73	2.62	2.54	1.61	0.05	0.34	.	12.68
1977	0.98	13.89	2.15	1.80	1.76	0.04	0.15	.	19.67
1978	1.35	8.55	1.41	1.19	2.13	0.00	0.01	.	14.00
1979	1.09	11.92	2.14	1.64	1.41	0.01	0.04	.	17.36
1980	0.95	11.87	3.27	2.72	2.35	0.02	0.09	.	19.88
1981	0.23	4.17	0.43	4.15	2.32	0.02	0.22	.	11.07
1982	0.67	6.99	2.90	4.84	2.74	0.01	0.04	.	17.02
1983	0.58	7.36	2.34	2.33	5.10	0.02	0.08	.	16.72
1984	2.72	17.25	1.72	1.87	1.72	0.01	0.03	1.28	24.71
1985	0.07	3.97	2.09	2.57	0.76	0.23	0.66	0.63	10.53
1986	0.98	16.26	3.99	5.04	1.59	0.01	0.08	1.26	26.61
1987	0.47	2.30	4.75	7.43	0.72	0.08	0.21	0.68	15.69
1988	0.94	11.63	2.90	3.47	2.13	0.02	0.14	1.39	20.94
1989	0.96	5.96	2.28	2.39	1.82	0.01	0.04	1.14	13.82
1990	0.67	6.12	3.97	4.44	1.85	0.02	0.11	0.91	16.88
1991	0.67	4.95	3.62	4.13	6.14	0.23	1.15	1.12	20.16
1992	0.78	6.16	2.87	2.46	2.42	0.01	0.42	1.52	15.60
1993	0.41	5.60	1.25	1.86	1.36	0.02	0.14	0.93	11.12
1994	0.71	6.81	1.54	0.99	2.18	0.02	0.03	1.32	12.97
1995	0.36	4.22	2.91	2.67	1.24	0.06	0.10	0.84	11.82
1996	0.10	12.01	1.44	1.93	1.46	0.02	0.01	1.01	17.16
1997	0.46	1.42	3.00	3.62	1.92	0.04	0.07	1.33	11.31

Table X-21f.—Annual CMR values by year for Spottail Shiner for 13 Regions and estimated flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation. The values shown for the Albany Steam Station are the same as for 12 regions.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	0.49	0.87	0.22	0.66	0.24	3.32	5.75	.	11.11
1975	0.56	1.04	0.65	1.32	0.27	5.98	10.14	.	18.72
1976	1.17	1.38	1.14	1.03	0.38	3.04	5.48	.	12.93
1977	0.43	1.41	0.59	1.00	0.18	8.80	14.91	.	25.17
1978	0.79	2.32	0.73	1.14	0.47	5.87	10.01	.	19.82
1979	0.64	1.62	1.45	1.66	0.40	3.74	6.51	.	15.09
1980	0.23	1.66	1.06	2.26	0.30	4.59	7.96	.	16.94
1981	0.36	3.43	0.88	1.06	0.46	2.00	5.39	.	12.92
1982	0.60	2.06	0.91	1.07	0.36	3.96	6.68	.	14.77
1983	0.43	3.17	1.70	1.24	1.37	4.72	8.11	.	19.16
1984	0.55	1.58	0.79	1.00	0.19	5.25	9.35	0.28	17.82
1985	0.35	1.77	0.92	1.15	0.41	5.41	6.48	0.36	15.84
1986	0.42	1.55	1.44	1.91	0.34	3.69	4.69	0.40	13.64
1987	0.43	1.53	1.39	1.06	0.16	6.22	8.42	0.28	18.20
1988	0.39	4.10	1.30	2.66	0.52	5.43	7.57	0.29	20.43
1989	0.70	8.32	0.93	1.73	0.76	4.12	7.12	0.35	21.94
1990	0.46	2.18	1.07	2.06	0.26	4.79	7.61	0.30	17.48
1991	0.62	3.92	1.14	3.06	2.66	3.46	8.57	0.45	21.73
1992	0.31	0.99	1.09	0.48	0.24	2.15	6.35	0.30	11.44
1993	0.32	0.89	0.83	0.64	0.56	2.82	4.94	0.28	10.84
1994	0.36	1.10	1.20	0.75	0.38	3.96	5.18	0.27	12.56
1995	0.27	2.54	0.86	0.56	0.28	2.90	2.78	0.19	9.98
1996	0.20	1.89	0.59	0.56	0.48	4.34	2.85	0.34	10.78
1997	0.29	0.64	1.02	0.62	0.33	4.69	3.17	0.34	10.67

Table X-21g.—Annual CMR values by year for White Perch for 13 Regions and estimated flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation. The values shown for the Albany Steam Station are the same as for 12 regions.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	9.10	7.45	0.80	4.21	2.73	0.27	0.98	.	23.21
1975	2.96	8.65	6.40	6.89	1.93	0.40	1.81	.	25.90
1976	2.18	3.22	5.98	6.79	0.69	0.47	1.99	.	19.63
1977	2.11	7.27	5.82	5.28	1.00	0.49	1.35	.	21.30
1978	1.17	5.28	4.27	2.63	0.61	0.93	1.74	.	15.57
1979	0.85	8.02	5.91	4.23	0.43	0.25	1.17	.	19.34
1980	0.38	3.36	6.04	5.94	0.73	0.39	2.03	.	17.58
1981	0.32	6.54	1.72	3.74	1.32	0.16	0.92	.	13.96
1982	0.17	4.33	2.49	2.18	1.28	0.50	2.30	.	12.57
1983	1.01	17.23	5.78	3.97	3.16	0.39	1.57	.	29.62
1984	0.65	8.92	3.88	3.31	0.98	0.50	1.76	0.44	18.97
1985	0.05	0.55	3.53	3.88	0.24	0.31	0.78	0.12	9.15
1986	0.28	4.07	9.40	14.44	0.61	0.08	0.30	0.28	26.79
1987	0.01	0.66	6.87	7.54	0.38	0.64	0.68	0.22	16.09
1988	0.53	7.94	4.93	4.88	1.80	0.57	1.40	0.65	20.79
1989	0.78	4.03	6.66	4.98	1.30	0.48	2.62	0.54	19.65
1990	0.38	3.48	5.40	5.27	1.07	0.89	2.49	0.35	17.91
1991	0.22	1.40	7.45	6.08	1.70	0.29	0.99	0.34	17.29
1992	0.28	2.70	6.17	4.31	1.29	0.21	1.94	0.54	16.31
1993	0.12	2.34	1.77	2.96	1.14	0.21	0.38	0.42	9.00
1994	0.28	3.14	4.56	2.19	0.89	0.42	0.64	0.39	11.92
1995	0.09	1.92	5.04	4.29	0.47	0.37	0.34	0.27	12.22
1996	0.07	4.88	2.90	2.61	0.50	0.58	0.30	0.23	11.55
1997	0.16	1.29	4.29	6.24	1.66	0.53	0.73	0.49	14.54

Table X-22a.—Annual CMR values by year for American Shad for 12 Regions and 100% flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	0.13	0.3	0.19	1.05	0.75	0.11	1.24	.	3.71
1975	0.13	0.48	3.35	2.54	1.13	1.84	36.56	.	42.36
1976	0.28	0.42	2.51	1.59	0.64	1.9	37.04	.	41.54
1977	0.03	0.61	1.77	1.16	1.49	0.38	3.38	.	8.52
1978	0.11	0.31	2.4	1.49	0.45	0.78	18.09	.	22.55
1979	0.05	0.24	1.32	1.13	0.08	1.71	31.72	.	34.76
1980	0	0.04	0.39	0.35	0.15	2	42.26	.	43.94
1981	0.03	0.22	0.43	0.95	0.25	0.95	15.64	.	18
1982	0.19	0.57	0.41	1.07	1.25	0.72	10	.	13.73
1983	0.02	0.11	0.87	1.4	0.61	1.28	18.16	.	21.63
1984	0.07	9.4	1.36	1.06	1.36	0.98	12.58	0.32	24.8
1985	0	0	0.22	0.32	0.08	1.63	20.51	0.03	22.32
1986	0	4.49	0.4	0.85	0.1	0.46	6.58	0.02	12.41
1987	0.01	0	0.53	0.36	0.15	3.82	31.75	0.05	35.07
1988	0.01	0.21	0.24	0.26	0.93	2.19	42.78	0.18	45.05
1989	0.25	0.33	1.45	1.08	1.33	1.96	41.7	0.24	45.47
1990	0.11	0.49	1.68	1.7	1.53	3.43	57.42	0.29	61.22
1991	0.01	0.11	0.5	0.48	0.77	1.51	36.23	0.12	38.43
1992	0.01	0.09	0.27	0.19	0.59	1.34	58.82	0.16	59.9
1993	0.01	0.2	0.27	0.26	1.39	1.29	7.95	0.32	11.35
1994	0.04	0.15	0.44	0.3	0.52	2.61	22.24	0.13	25.46
1995	0.01	0.14	0.48	0.45	0.66	1.33	12.09	0.12	14.86
1996	0.04	0.51	0.31	0.43	0.68	1.27	4.16	0.17	7.39
1997	0.01	0.07	0.34	0.58	0.79	2	16.61	0.13	19.84

Table X-22b.—Annual CMR values by year for Atlantic Tomcod for 12 Regions and 100% flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	10.7	7.55	0.43	0.94	5.41	0	0.01	.	22.98
1975	16.13	12.7	1.79	0.35	4.57	0	0.01	.	31.62
1976	19.7	14.44	1.71	0.62	4.84	0	0.01	.	36.15
1977	9.92	15.47	4.99	1.47	1.63	0	0	.	29.88
1978	16.95	18.1	3.72	1.26	5.25	0	0.01	.	38.75
1979	10.93	27.28	4.15	1.12	2.42	0	0	.	40.1
1980	11.22	39.43	3.03	0.77	8.74	0	0	.	52.78
1981	14.1	21.98	2.57	0.93	7.57	0	0	.	40.21
1982	12.09	26.48	2.78	1.1	7.47	0	0	.	42.5
1983	12.34	13.17	2.44	0.9	3.95	0	0	.	29.32
1984	10.65	24.77	2.51	1.07	2.75	0	0	1	37.57
1985	11.56	39.97	3.4	1.24	6.9	0	0	1.91	53.75
1986	14.61	21.12	2.88	1.11	6.69	0	0.04	1.8	40.74
1987	8.48	22.02	3.64	1.39	3	0	0	1.03	34.9
1988	13.59	33.66	2.92	1.18	6.46	0	0	1.68	49.42
1989	14.43	6.3	2.58	1.01	4.77	0	0	1.06	27.15
1990	12.99	9.83	3.23	1.28	4.41	0	0	0.88	28.98
1991	12.64	11.71	2.68	0.89	6.17	0	0.04	1.05	30.96
1992	13.47	24.09	2.51	0.79	4.87	0	0	1.04	40.19
1993	9.51	5.49	1.57	0.44	2.28	0	0	0.83	18.78
1994	8.07	12.59	2.38	0.71	4.31	0	0	0.85	26.1
1995	12.74	12.44	2.41	0.96	6.27	0	0.02	1.82	32.06
1996	2.49	14.36	1.28	0.48	2	0	0	0.55	20.04
1997	1.11	28.03	2.45	1.13	4.15	0	0	1.07	34.92

Table X-22c.—Annual CMR values by year for Bay Anchovy for 12 Regions and 100% flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	5.73	8.21	0.21	0.05	8.46	0	0.01	.	21
1975	4.63	7.09	0.41	0.08	6.51	0.05	0.65	.	18.14
1976	4.32	4.06	0.65	0.1	3.85	0	0.05	.	12.45
1977	5.28	14.14	0.66	0.09	8.2	0.01	0.19	.	26.06
1978	6.66	13.76	1.14	0.17	8.29	0	0	.	27.14
1979	6.69	11.29	1.3	0.2	4.38	0	0.03	.	22.07
1980	6.75	19.26	0.62	0.11	9.48	0	0.02	.	32.35
1981	4.55	20.42	0.61	0.13	9.7	0	0.01	.	31.92
1982	2.26	4.8	0.73	0.16	5.75	0	0.03	.	13.11
1983	3.41	9.97	1.05	0.24	6.86	0	0	.	20.06
1984	3.42	7.03	0.94	0.24	5.07	0	0.01	0.89	16.52
1985	3.35	10.73	0.86	0.22	8.64	0.05	0.55	1.18	23.41
1986	2.36	5.99	0.43	0.07	4.98	0	0.01	0.8	13.92
1987	6.24	11.02	0.87	0.12	6.14	0.01	0.12	1.31	23.59
1988	6.08	20.15	1.52	0.39	7.56	0.02	0.31	1.24	33.07
1989	4.53	9.69	0.56	0.04	5.31	0	0.01	0.66	19.4
1990	6.34	25.17	1.72	0.43	9.91	0	0.03	1.3	39.04
1991	4.51	11.11	2.44	0.68	8.02	0	0.01	1.1	25.19
1992	3.94	7.75	0.41	0.08	7.63	0.01	0.27	0.83	19.44
1993	3.43	7.65	0.93	0.33	7.46	0.01	0.15	0.88	19.35
1994	3.47	8.16	0.24	0.06	8.23	0.02	0.12	1.03	19.83
1995	3.83	15.95	2.45	1.01	7.2	0.01	0.05	1.03	28.35
1996	1.46	18.24	0.1	0.05	7.99	0	0	1.06	26.77
1997	3.92	7.47	2.35	1.12	8.37	0.01	0.04	1.04	22.2

Table X-22d.—Annual CMR values by year for River Herring for 12 Regions and 100% flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	0.21	1.07	0.76	3.31	0.58	1.76	25.26	.	30.84
1975	0.23	1.82	13.65	13.49	0.55	1.54	22.06	.	44.16
1976	0.99	2.37	6.8	4.96	0.71	1.62	23.64	.	36.13
1977	0.61	3.2	7.01	9.12	0.52	1.57	21.25	.	37.3
1978	0.26	1.61	3.77	2.29	0.37	1.75	25.39	.	32.61
1979	0.11	2.74	5.05	3.76	0.13	1.85	21.42	.	31.62
1980	0.07	0.72	3.42	2.98	0.58	1.23	22.24	.	29.02
1981	0.03	0.74	2.97	3.09	0.26	0.3	8.19	.	14.82
1982	0.19	1.27	4.12	2.15	1.88	0.42	4.28	.	13.54
1983	0.36	14	21.73	20.02	1.18	0.91	9.58	.	52.51
1984	0.18	6.66	2.07	2.1	1.54	1.1	18.73	0.33	29.55
1985	0	0.02	1.26	2.06	0.01	1.16	13.25	0	17.1
1986	0.01	1.15	2.11	4.05	0.12	0.26	4.68	0.03	11.88
1987	0.59	0.05	3.05	2.78	0.06	3.82	31.35	0.02	38.22
1988	0.05	0.66	4.41	4.83	0.23	1.35	19.41	0.05	28.38
1989	0.51	1.7	6.07	4.12	1.28	1.75	28.02	0.24	38.66
1990	1.07	3.86	3.05	2.55	1.38	1.95	24.83	0.3	34.89
1991	0.1	0.52	2.05	1.36	0.27	1.31	21.39	0.05	25.74
1992	0.07	0.59	2.66	1.66	0.54	1.68	41.74	0.09	45.87
1993	0.05	0.39	1.26	1.06	0.48	0.95	10.15	0.12	13.96
1994	0.09	0.65	2.62	1.68	0.39	1.77	14.87	0.11	20.92
1995	0.03	0.18	4.9	4.51	0.16	1.37	6.69	0.04	16.76
1996	0.01	0.66	1.79	2.22	0.24	1.73	3.16	0.07	9.5
1997	0.31	1.23	3.78	7.16	1.95	2.54	9.82	0.39	24.5

Table X-22e.—Annual CMR values by year for Striped Bass for 12 Regions and 100% flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	3.08	18.22	1.32	7.04	7.28	0	0.05	.	32.62
1975	3.97	24.31	6.01	4.93	7.98	0.05	0.65	.	40.65
1976	5.7	15.4	8.73	7.31	4.91	0.05	0.76	.	36.34
1977	3.86	40.44	7.39	5.72	5.67	0.04	0.52	.	53.11
1978	5.46	26.07	5.28	3.51	6.3	0	0.03	.	40.16
1979	5.28	35.64	6.57	4.65	4.44	0.01	0.1	.	48.16
1980	4.15	28.73	10.66	8.35	7.24	0.02	0.27	.	48.27
1981	0.8	13.5	1.5	9.57	6.19	0.02	0.32	.	28.54
1982	14.39	22.55	12.87	12.08	9.09	0.01	0.14	.	53.9
1983	2.08	23.71	8.23	5.28	7.91	0.02	0.24	.	40.36
1984	9.5	41.43	6.12	4.09	5.39	0.01	0.12	1.29	55.48
1985	0.25	12.87	14.86	9.86	2.37	0.23	2.53	0.63	37.07
1986	3.55	46.68	13.52	12.03	5.48	0.01	0.15	1.26	63.54
1987	1.68	7.3	13.06	15.07	2.57	0.08	0.76	0.69	35.43
1988	4.12	34.65	9.24	9.28	7.47	0.02	0.22	1.39	53.04
1989	3.94	9.09	8.05	7.24	6.14	0.01	0.14	1.15	31
1990	3.49	18.62	12.31	11.39	6.78	0.02	0.26	0.91	43.78
1991	2.84	16.42	10.99	9.66	6.2	0.23	4.39	1.12	42.23
1992	3.26	20.18	9.03	7.25	8.52	0.01	0.5	1.52	41.6
1993	1.92	18.21	4.24	5.61	4.53	0.02	0.31	0.93	31.65
1994	2.79	21.95	5.75	3.37	7.29	0.02	0.12	1.32	36.87
1995	1.64	14.21	10.16	9.02	4.23	0.06	0.38	0.84	34.79
1996	0.41	33.65	5.11	6.16	4.83	0.01	0.05	1	44.59
1997	1.82	4.79	9.29	9.31	6.09	0.04	0.21	1.3	28.91

Table X-22f.—Annual CMR values by year for Spottail Shiner for 12 Regions and 100% flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	3.71	6.34	1.72	2.36	1.84	3.32	36.93	.	48.2
1975	4.27	7.73	4.95	2.78	2.06	5.98	56.28	.	67.14
1976	8.69	10.09	8.54	3.1	2.89	3.04	35.4	.	55.74
1977	3.26	10.23	4.51	1.82	1.27	8.8	71.62	.	79.19
1978	6	12.01	5.49	1.75	2.02	5.87	55.99	.	68.82
1979	4.85	10.64	10.74	3.81	1.26	3.74	40.74	.	58.88
1980	1.79	5.74	7.93	3.31	0.88	4.59	47.57	.	59.14
1981	2.74	12.24	6.06	2.91	2.09	2	34.97	.	51.43
1982	4.53	9.85	6.86	3.12	2.64	3.96	41.54	.	57.55
1983	3.19	8.77	8.3	3.5	1.69	4.72	48.17	.	62.06
1984	3.44	6.71	5.9	2.85	1.38	5.25	53.38	0.28	64.22
1985	2.43	8.88	6.93	3.14	2	5.41	40.55	0.36	55.99
1986	3.22	11.11	10.66	5.18	1.95	3.69	31.13	0.4	52.8
1987	3.28	6.33	8.03	2.9	1.04	6.22	49.55	0.28	62.22
1988	3.01	11.13	9.13	4.06	1.62	5.43	45.79	0.29	62.2
1989	5.27	13.94	6.98	2.77	2.32	4.12	43.72	0.35	61.28
1990	3.53	11.49	7.97	3.73	1.79	4.79	45.95	0.3	61.88
1991	4.69	13.5	8.54	3.82	2.66	3.46	50.14	0.45	66.17
1992	2.38	7.37	8.18	3.65	1.82	2.15	39.93	0.3	53.97
1993	2.15	6.11	6.04	3.28	1.62	2.82	32.56	0.28	46.32
1994	2.18	5.66	7.39	3.88	1.68	3.96	33.84	0.27	48.82
1995	1.61	6.61	5.09	3.19	1.2	2.9	19.65	0.19	35.05
1996	1.51	13.76	4.45	4.28	1.91	4.34	20.06	0.34	41.92
1997	1.91	4.85	6.45	3.48	1.81	4.69	22.04	0.34	38.73

Table X-22g.—Annual CMR values by year for White Perch for 12 Regions and 100% flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	9.62	11.11	1.98	7.1	3.79	0.27	1.16	.	30.61
1975	3.86	14.49	11.81	10.18	3.32	0.4	2.32	.	38.75
1976	2.86	5.53	9.65	8.52	1.24	0.47	2.66	.	27.42
1977	2.41	11.96	12.2	8.42	1.85	0.49	2.1	.	33.94
1978	1.74	8.97	12.36	5.99	1.08	0.93	2.81	.	29.8
1979	1.22	13.46	12.3	7.25	0.78	0.25	1.72	.	32.36
1980	0.59	5.19	12.75	9.5	1.45	0.39	2.85	.	29.03
1981	0.56	11.06	2.87	8.46	2.54	0.16	1.51	.	24.64
1982	0.28	7.53	3.88	3.17	2.4	0.5	2.57	.	18.79
1983	1.83	28.88	12.41	7.25	4.68	0.39	2.04	.	47.24
1984	1.13	15.02	6.67	4.94	1.84	0.5	2.87	0.44	29.61
1985	0.06	0.96	5.88	5.53	0.47	0.31	1.19	0.12	13.82
1986	0.54	7.13	16.85	19.47	1.15	0.08	0.47	0.29	39.38
1987	0.01	1.13	12.54	10.71	0.78	0.64	1.1	0.22	24.9
1988	0.99	13.59	13.34	9.46	3.45	0.57	1.95	0.65	37.22
1989	1.36	5.3	15.06	9.78	2.41	0.48	2.89	0.54	32.85
1990	0.71	5.9	13.39	9.89	2.14	0.89	3.54	0.35	32.02
1991	0.37	2.63	17.24	11.53	1.85	0.29	1.41	0.37	31.73
1992	0.51	4.84	12.36	8.06	2.54	0.21	2.27	0.54	27.89
1993	0.25	4.15	6.26	6.03	2.27	0.21	0.53	0.42	18.63
1994	0.5	5.45	12	5.59	1.61	0.41	0.83	0.39	24.34
1995	0.17	3.41	8.79	6.58	0.87	0.37	0.53	0.27	19.52
1996	0.13	8.32	8.25	7.27	0.89	0.59	0.39	0.23	23.72
1997	0.35	2.34	9.34	9.98	3.32	0.53	1.01	0.49	24.76

Table X-23a.—Annual CMR values by year for American Shad for 13 Regions and 100% flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	0.13	0.27	0.19	0.98	0.75	0.11	1.24	.	3.62
1975	0.13	0.44	3.34	2.49	1.13	1.84	36.57	.	42.31
1976	0.28	0.40	2.52	1.57	0.64	1.90	37.08	.	41.56
1977	0.03	0.47	1.77	1.13	1.49	0.38	3.38	.	8.37
1978	0.11	0.29	2.40	1.45	0.45	0.78	18.09	.	22.50
1979	0.05	0.23	1.32	1.11	0.08	1.72	31.72	.	34.75
1980	0.00	0.03	0.39	0.31	0.15	2.00	42.26	.	43.92
1981	0.02	0.22	0.43	0.93	0.24	0.95	15.64	.	17.97
1982	0.19	0.54	0.42	1.07	1.25	0.72	10.00	.	13.70
1983	0.02	0.11	0.87	1.40	0.60	1.28	18.17	.	21.62
1984	0.07	9.33	1.36	0.85	1.35	0.98	12.58	0.32	24.57
1985	0.00	0.00	0.22	0.32	0.08	1.63	20.51	0.03	22.32
1986	0.00	4.49	0.40	0.85	0.10	0.46	6.58	0.02	12.40
1987	0.01	0.00	0.53	0.36	0.15	3.82	31.75	0.05	35.07
1988	0.01	0.16	0.24	0.23	0.93	2.19	42.78	0.18	45.00
1989	0.25	0.29	1.45	1.02	1.32	1.95	41.70	0.24	45.40
1990	0.10	0.45	2.66	2.08	1.69	2.97	49.40	0.31	54.40
1991	0.01	0.08	0.50	0.44	0.74	1.51	36.23	0.12	38.37
1992	0.01	0.06	0.27	0.18	0.56	1.34	58.82	0.15	59.87
1993	0.01	0.15	0.27	0.24	1.39	1.29	7.95	0.32	11.29
1994	0.04	0.14	0.44	0.28	0.52	2.61	22.24	0.13	25.43
1995	0.01	0.11	0.48	0.43	0.66	1.33	12.09	0.12	14.82
1996	0.04	0.49	0.30	0.38	0.69	1.29	4.27	0.17	7.45
1997	0.01	0.06	0.37	0.58	0.85	1.99	16.63	0.14	19.91

Table X-23b.—Annual CMR values by year for Atlantic Tomcod for 13 Regions and 100% flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	10.10	6.98	0.42	0.93	5.05	0.00	0.01	.	21.67
1975	16.04	12.59	1.78	0.35	4.54	0.00	0.01	.	31.44
1976	19.59	14.36	1.67	0.61	4.82	0.00	0.01	.	35.95
1977	9.79	15.20	4.98	1.47	1.60	0.00	0.00	.	29.53
1978	16.84	17.94	3.71	1.26	5.21	0.00	0.01	.	38.51
1979	10.85	26.69	4.10	1.11	2.38	0.00	0.00	.	39.50
1980	11.11	39.05	3.00	0.76	8.67	0.00	0.00	.	52.37
1981	13.48	21.14	2.54	0.92	7.22	0.00	0.00	.	38.88
1982	11.59	25.60	2.75	1.09	7.10	0.00	0.00	.	41.22
1983	11.72	12.46	2.41	0.89	3.75	0.00	0.00	.	28.06
1984	10.21	23.56	2.48	1.05	2.57	0.00	0.00	0.95	36.09
1985	11.17	39.05	3.38	1.23	6.67	0.00	0.00	1.86	52.67
1986	13.81	19.91	2.83	1.08	6.29	0.00	0.03	1.69	38.89
1987	8.01	20.79	3.57	1.36	2.84	0.00	0.00	0.98	33.32
1988	12.80	31.77	2.88	1.15	6.00	0.00	0.00	1.57	47.15
1989	13.48	6.17	2.57	1.01	4.50	0.00	0.00	0.99	25.96
1990	12.19	9.17	3.17	1.24	4.18	0.00	0.00	0.82	27.52
1991	11.76	11.07	2.66	0.88	5.73	0.00	0.03	0.98	29.34
1992	12.63	22.65	2.50	0.78	4.60	0.00	0.00	0.98	38.24
1993	9.01	5.16	1.56	0.44	2.17	0.00	0.00	0.78	17.90
1994	7.59	11.77	2.36	0.70	4.04	0.00	0.00	0.80	24.75
1995	11.39	10.58	2.10	0.85	5.56	0.00	0.02	1.58	28.53
1996	2.45	13.41	1.26	0.47	1.85	0.00	0.00	0.52	18.96
1997	0.97	18.07	2.41	1.11	2.71	0.00	0.00	0.71	24.37

Table X-23c.—Annual CMR values by year for Bay Anchovy for 13 Regions and 100% flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	5.00	7.31	0.05	0.04	7.95	0.00	0.01	.	19.03
1975	4.20	6.61	0.18	0.07	6.10	0.05	0.63	.	16.76
1976	3.67	3.45	0.20	0.07	3.41	0.00	0.06	.	10.47
1977	4.96	13.78	0.22	0.07	8.00	0.02	0.21	.	25.00
1978	6.00	12.54	0.48	0.14	7.86	0.00	0.00	.	24.71
1979	6.30	10.80	0.52	0.16	4.11	0.00	0.04	.	20.43
1980	6.35	18.44	0.21	0.09	9.07	0.00	0.02	.	30.77
1981	4.01	18.56	0.23	0.11	8.94	0.00	0.01	.	29.06
1982	1.82	4.19	0.31	0.14	5.29	0.00	0.02	.	11.32
1983	2.95	9.04	0.51	0.21	6.34	0.00	0.00	.	17.93
1984	3.01	6.26	0.43	0.20	4.63	0.00	0.01	0.82	14.55
1985	3.07	10.06	0.47	0.20	8.17	0.05	0.57	1.11	21.84
1986	1.84	5.07	0.13	0.06	4.52	0.00	0.01	0.71	11.84
1987	5.50	9.99	0.38	0.11	5.67	0.01	0.14	1.21	21.25
1988	5.21	17.73	0.76	0.29	6.83	0.02	0.25	1.13	29.11
1989	3.59	7.96	0.11	0.03	4.62	0.00	0.01	0.57	15.97
1990	5.24	20.85	1.07	0.40	8.48	0.00	0.03	1.10	33.12
1991	3.72	9.09	1.44	0.59	6.99	0.00	0.01	0.95	21.01
1992	3.55	7.12	0.20	0.08	6.82	0.01	0.20	0.74	17.54
1993	3.17	7.08	0.50	0.29	7.03	0.01	0.15	0.82	17.81
1994	2.69	5.94	0.09	0.04	6.85	0.01	0.07	0.85	15.66
1995	3.55	14.99	1.82	0.96	6.74	0.01	0.05	0.96	26.40
1996	1.27	15.55	0.07	0.05	7.19	0.00	0.00	0.94	23.44
1997	3.61	6.62	1.78	0.98	7.95	0.01	0.05	0.98	20.25

Table X-23d.—Annual CMR values by year for River Herring for 13 Regions and 100% flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	0.21	1.04	0.75	3.26	0.58	1.76	25.26	.	30.78
1975	0.23	1.78	13.54	13.31	0.55	1.53	22.03	.	43.92
1976	1.00	2.32	6.67	4.82	0.71	1.61	23.59	.	35.88
1977	0.62	3.05	6.95	9.04	0.52	1.57	21.25	.	37.11
1978	0.26	1.55	3.60	2.12	0.37	1.75	25.39	.	32.33
1979	0.11	2.72	4.85	3.47	0.13	1.85	21.42	.	31.26
1980	0.08	0.55	3.27	2.78	0.58	1.23	22.24	.	28.64
1981	0.02	0.70	2.85	2.90	0.26	0.30	8.19	.	14.51
1982	0.21	1.00	2.35	2.15	1.88	0.42	4.28	.	11.72
1983	0.37	3.80	5.38	5.81	1.18	0.91	9.58	.	24.37
1984	0.19	6.67	2.07	1.86	1.53	1.10	18.73	0.33	29.38
1985	0.00	0.02	1.27	2.15	0.01	1.16	13.25	0.00	17.20
1986	0.01	1.16	1.98	3.97	0.12	0.26	4.68	0.03	11.69
1987	0.01	0.05	3.20	2.28	0.06	3.82	31.35	0.02	37.63
1988	0.05	0.61	4.20	4.54	0.23	1.35	19.36	0.05	27.93
1989	0.52	1.47	5.54	3.40	1.28	1.74	27.96	0.24	37.64
1990	1.07	3.61	2.82	2.26	1.38	1.95	24.79	0.30	34.33
1991	0.10	0.50	1.89	1.16	0.27	1.31	21.37	0.05	25.45
1992	0.07	0.52	2.52	1.46	0.54	1.68	41.55	0.09	45.47
1993	0.05	0.28	1.06	0.77	0.48	0.95	10.15	0.12	13.44
1994	0.09	0.59	2.31	1.31	0.39	1.75	14.73	0.11	20.18
1995	0.03	0.15	4.63	4.05	0.16	1.37	6.68	0.04	16.09
1996	0.01	0.55	1.61	1.76	0.23	1.73	3.16	0.07	8.80
1997	0.27	0.74	5.28	6.42	1.50	2.08	11.07	0.29	24.96

Table X-23e.—Annual CMR values by year for Striped Bass for 13 Regions and 100% flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	2.51	18.16	1.28	7.02	7.28	0.00	0.05	.	32.13
1975	3.37	24.17	5.65	4.88	7.96	0.05	0.65	.	39.89
1976	4.96	15.31	8.54	7.28	4.90	0.05	0.76	.	35.60
1977	3.37	40.38	7.11	5.70	5.67	0.04	0.52	.	52.67
1978	4.53	25.94	4.84	3.48	6.30	0.00	0.03	.	39.17
1979	3.84	35.39	6.34	4.62	4.43	0.01	0.10	.	47.01
1980	3.32	28.59	10.30	8.32	7.24	0.02	0.27	.	47.49
1981	0.80	13.50	1.50	9.50	6.19	0.02	0.32	.	28.48
1982	2.41	22.30	9.78	11.99	9.06	0.01	0.14	.	45.32
1983	2.07	23.50	8.02	5.23	7.90	0.02	0.24	.	40.01
1984	9.47	41.32	6.12	4.09	5.37	0.01	0.12	1.28	55.37
1985	0.25	12.87	7.20	6.32	2.37	0.23	2.53	0.63	28.71
1986	3.36	46.33	13.29	12.02	5.48	0.01	0.15	1.26	63.13
1987	1.68	7.29	12.94	15.06	2.57	0.08	0.76	0.68	35.31
1988	3.32	34.50	8.93	9.25	7.44	0.02	0.22	1.39	52.34
1989	3.36	8.82	7.65	7.17	6.12	0.01	0.14	1.14	29.99
1990	2.42	18.42	11.95	11.36	6.78	0.02	0.26	0.91	42.77
1991	2.36	16.32	10.43	9.60	6.20	0.23	4.39	1.12	41.47
1992	2.73	20.02	8.69	7.20	8.50	0.01	0.50	1.52	40.90
1993	1.46	18.17	4.14	5.59	4.52	0.02	0.31	0.93	31.20
1994	2.47	21.87	5.19	3.33	7.29	0.02	0.12	1.32	36.20
1995	1.26	14.09	9.79	8.98	4.23	0.06	0.38	0.84	34.15
1996	0.36	34.28	4.78	6.25	4.96	0.02	0.05	1.01	45.04
1997	1.61	4.88	9.19	9.89	6.19	0.04	0.20	1.33	29.29

Table X-23f.—Annual CMR values by year for Spottail Shiner for 13 Regions and 100% flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	3.71	6.34	1.72	2.36	1.84	3.32	36.93	.	48.20
1975	4.27	7.73	4.95	2.78	2.06	5.98	56.28	.	67.14
1976	8.69	10.09	8.54	3.10	2.89	3.04	35.40	.	55.74
1977	3.26	10.23	4.51	1.82	1.27	8.80	71.62	.	79.19
1978	6.00	12.01	5.49	1.75	2.02	5.87	55.99	.	68.82
1979	4.85	10.64	10.74	3.81	1.26	3.74	40.74	.	58.88
1980	1.79	5.74	7.93	3.31	0.88	4.59	47.57	.	59.14
1981	2.74	12.24	6.06	2.91	2.09	2.00	34.97	.	51.43
1982	4.53	9.85	6.86	3.12	2.64	3.96	41.54	.	57.55
1983	3.19	8.77	8.30	3.50	1.69	4.72	48.17	.	62.06
1984	3.44	6.71	5.90	2.85	1.38	5.25	53.38	0.28	64.22
1985	2.43	8.88	6.93	3.14	2.00	5.41	40.55	0.36	55.99
1986	3.22	11.11	10.66	5.18	1.95	3.69	31.13	0.40	52.80
1987	3.28	6.33	8.03	2.90	1.04	6.22	49.55	0.28	62.22
1988	3.01	11.13	9.13	4.06	1.62	5.43	45.79	0.29	62.20
1989	5.27	13.94	6.98	2.77	2.32	4.12	43.72	0.35	61.28
1990	3.53	11.49	7.97	3.73	1.79	4.79	45.95	0.30	61.88
1991	4.69	13.50	8.54	3.82	2.66	3.46	50.14	0.45	66.17
1992	2.38	7.37	8.18	3.65	1.82	2.15	39.93	0.30	53.97
1993	2.15	6.11	6.04	3.28	1.62	2.82	32.56	0.28	46.32
1994	2.18	5.66	7.39	3.88	1.68	3.96	33.84	0.27	48.82
1995	1.61	6.61	5.09	3.19	1.20	2.90	19.65	0.19	35.05
1996	1.51	13.76	4.45	4.28	1.91	4.34	20.06	0.34	41.92
1997	1.91	4.85	6.45	3.48	1.81	4.69	22.04	0.34	38.73

Table X-23g.—Annual CMR values by year for White Perch for 13 Regions and 100% flow-through mortality (actual flow). See Tables X-2a and b for model used in CMR estimation.

YEAR	BOWLINE POINT	INDIAN POINT	ROSETON	DANSKAMMER	LOVETT	EMPIRE STATE PLAZA	ALBANY STEAM STATION	WESTCHESTER RESCO	RIVERWIDE
1974	9.60	11.09	1.25	5.66	3.79	0.27	1.16	.	28.99
1975	3.84	14.48	8.85	8.16	3.32	0.40	2.32	.	35.26
1976	2.85	5.51	8.24	7.88	1.24	0.47	2.66	.	25.75
1977	2.38	11.93	9.27	7.01	1.85	0.49	2.10	.	30.64
1978	1.73	8.96	6.98	3.84	1.08	0.93	2.81	.	23.78
1979	1.20	13.44	9.24	5.78	0.78	0.25	1.72	.	28.86
1980	0.56	5.14	9.10	7.62	1.44	0.39	2.85	.	24.46
1981	0.56	11.23	2.91	5.65	2.54	0.16	1.51	.	22.50
1982	0.28	7.50	4.31	3.17	2.39	0.50	2.57	.	19.13
1983	1.75	27.51	9.84	5.85	4.68	0.39	2.04	.	43.78
1984	1.13	15.10	6.67	4.94	1.84	0.50	2.87	0.44	29.67
1985	0.09	0.96	5.88	5.53	0.47	0.31	1.19	0.12	13.84
1986	0.54	7.13	16.85	19.47	1.15	0.08	0.47	0.28	39.38
1987	0.01	1.14	12.54	10.71	0.78	0.64	1.10	0.22	24.90
1988	0.93	13.50	8.05	6.80	3.45	0.57	1.95	0.65	31.32
1989	1.34	5.23	11.28	7.94	2.41	0.48	2.89	0.54	28.35
1990	0.65	5.81	8.83	7.50	2.14	0.89	3.54	0.35	26.44
1991	0.33	2.51	12.13	8.79	1.70	0.29	1.41	0.34	25.00
1992	0.49	4.78	10.41	7.07	2.54	0.21	2.27	0.54	25.42
1993	0.21	4.10	3.03	4.44	2.27	0.21	0.53	0.42	14.33
1994	0.50	5.44	7.54	3.35	1.61	0.42	0.85	0.39	18.64
1995	0.16	3.38	7.71	5.90	0.87	0.37	0.53	0.27	17.92
1996	0.13	8.28	4.82	4.08	0.88	0.58	0.39	0.23	18.09
1997	0.28	2.29	6.81	8.50	3.31	0.53	1.02	0.49	21.30

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Appendix 8B

TABLE IV-1 (Page 1 of 2)

WEEKLY EFFICIENT FLOWS AND FISH PROTECTION POINTS (FPPS) FOR ROSETON, INDIAN POINT, AND BOWLINE POINT GENERATING STATIONS

		ROSETON		INDIAN POINT		BOWLINE POINT	
WEEK	DATE	EFFICIENT FLOW (1000 GPM)	FPPS	EFFICIENT FLOW (1000 GPM)	FPPs	EFFICIENT FLOW (1000 GPM)	FPPs
1	5-Jan	418	0.0	1022	0.0	514	0.0
2	12-Jan	418	0.0	1014	0.0	514	0.0
3	19-Jan	418	0.0	1014	0.0	514	0.0
4	26-Jan	418	0.0	1008	0.0	514	0.0
5	2-Feb	418	0.0	1009	0.0	514	0.0
6	9-Feb	418	0.0	1005	0.0	514	0.0
7	16-Feb	418	0.0	1003	0.0	514	0.0
8	23-Feb	418	2.1	1006	13.3	514	6.1
9	1-Mar	418	4.8	1012	19.3	514	8.6
10	8-Mar	418	2.1	1014	25.9	514	13.5
11	15-Mar	418	2.1	1029	24.3	514	12.2
12	22-Mar	418	2.9	1100	16.6	514	8.9
13	29-Mar	418	1.9	1120	8.5	514	6.0
14	5-Apr	418	0.5	1204	3.8	514	3.7
15	12-Apr	418	0.1	1227	7.2	514	4.1
16	19-Apr	418	0.6	1318	5.1	514	3.9
17	26-Apr	418	1.2	1359	9.4	514	5.0
18	3-May	418	3.9	1509	8.0	514	3.8
19	10-May	459	11.6	1652	13.0	514	3.7
20	17-May	561	20.4	1682	18.0	514	3.1
21	24-May	561	23.2	1684	26.9	514	3.8
22	31-May	561	18.1	1687	35.2	514	3.4
23	7-Jun	561	15.9	1690	45.9	514	4.0
24	14-Jun	630	13.8	1692	42.0	598	5.0
25	21-Jun	641	9.8	1694	52.9	632	7.8
26	28-Jun	641	12.8	1697	41.0	632	8.3
27	5-Jul	641	10.0	1698	37.7	632	8.4

TABLE IV-1 (Page 2 of 2)

WEEKLY EFFICIENT FLOWS AND FISH PROTECTION POINTS (FPPS) FOR ROSETON, INDIAN POINT, AND BOWLINE POINT GENERATING STATIONS

WEEK	DATE	ROSETON		INDIAN POINT		BOWLINE POINT	
		EFFICIENT FLOW (1000 GPM)	FPPS	EFFICIENT FLOW (1000 GPM)	FPPs	EFFICIENT FLOW (1000 GPM)	FPPs
28	12-Jul	641	7.3	1700	24.3	632	6.6
29	19-Jul	641	4.1	1702	16.6	632	5.5
30	26-Jul	641	2.5	1703	10.8	632	4.2
31	2-Aug	641	2.0	1704	8.4	632	3.3
32	9-Aug	641	1.6	1704	5.9	632	2.2
33	16-Aug	641	1.0	1704	3.3	632	1.1
34	23-Aug	641	0.4	1703	1.6	632	0.6
35	30-Aug	641	0.1	1703	1.0	632	0.4
36	6-Sep	641	0.1	1702	0.7	632	0.3
37	13-Sep	641	0.1	1700	0.5	632	0.2
38	20-Sep	618	0.0	1698	0.2	632	0.1
39	27-Sep	561	0.0	1695	0.1	632	0.0
40	4-Oct	561	0.0	1692	0.0	632	0.0
41	11-Oct	541	0.0	1689	0.0	598	0.0
42	18-Oct	418	0.0	1687	0.0	514	0.0
43	25-Oct	418	0.0	1683	0.0	514	0.0
44	1-Nov	418	0.0	1680	0.0	514	0.0
45	8-Nov	418	0.0	1566	0.0	514	0.0
46	15-Nov	418	0.0	1439	0.0	514	0.0
47	22-Nov	418	0.0	1343	0.0	514	0.0
48	29-Nov	418	0.0	1248	0.0	514	0.0
49	6-Dec	418	0.0	1211	0.0	514	0.0
50	13-Dec	418	0.0	1118	0.0	514	0.0
51	20-Dec	418	0.0	1099	0.0	514	0.0
52	27-Dec	418	0.0	1026	0.0	514	0.0

Appendix 8C

TABLE VI-1

ENTRAINMENT CONDITIONAL MORTALITY RATES FOR SEVEN TAXA UNDER FOUR SCENARIOS FOR MEETING THE GUARANTEED LEVEL OF FISH PROTECTION POINTS. OUTAGES ARE LIMITED TO THE MINIMUM NECESSARY TO MEET THE GUARANTEE. CONDITIONAL MORTALITY RATES ARE BASED ON ESTIMATED THROUGH-PLANT MORTALITY RATES. BOLD TYPE INDICATES THE MINIMUM RATE FOR THE TAXON

	Scenario				
	Early	Design	[illegible]	Minimum Outage	Average
Bowline Point					
Striped Bass	0.0087	**0.0063**	0.0074	0.0086	0.0077
White Perch	0.0031	**0.0021**	0.0027	0.0031	0.0027
Atlantic Tomcod	**0.0618**	0.0787	0.0825	0.0623	0.0713
American Shad	0.0002	**0.0001**	0.0002	0.0002	0.0002
Bay Anchovy	0.0478	0.0339	**0.0281**	0.0474	0.0393
River Herring	0.0013	**0.0010**	0.0013	0.0013	0.0012
Spottail Shiner	0.0051	0.0041	**0.0034**	0.0051	0.0044
Indian Point					
Striped Bass	0.1160	0.1105	0.1150	**0.0995**	0.1069
White Perch	0.0475	0.0439	0.0458	**0.0429**	0.0435
Atlantic Tomcod	**0.1116**	0.1373	0.1439	0.1434	0.1395
American Shad	0.0020	**0.0016**	0.0018	0.0019	0.0018
Bay Anchovy	0.1462	0.1310	**0.1169**	0.1360	0.1322
River Herring	0.0089	**0.0079**	0.0087	0.0081	0.0081
Spottail Shiner	0.0372	0.0301	**0.0237**	0.0370	0.0316
Roseton					
Striped Bass	0.0353	**0.0301**	0.0344	0.0329	0.0332
White Perch	0.0656	0.0617	0.0669	**0.0616**	0.0639
Atlantic Tomcod	**0.0099**	0.0179	0.0181	0.0178	0.0159
American Shad	0.0047	**0.0039**	0.0045	0.0047	0.0045
Bay Anchovy	0.0113	0.0112	**0.0067**	0.0113	0.0101
River Herring	0.0341	0.0314	**0.0301**	0.0329	0.0321
Spottail Shiner	0.0130	0.0123	**0.0084**	0.0130	0.0117
Total*					
Striped Bass	0.1546	0.1427	0.1517	**0.1366**	0.1432
White Perch	0.1128	0.1048	0.1120	**0.1046**	0.1071
Atlantic Tomcod	**0.1748**	0.2194	0.2288	0.2110	0.2136
American Shad	0.0069	**0.0057**	0.0065	0.0068	0.0064
Bay Anchovy	0.1963	0.1698	**0.1475**	0.1863	0.1746
River Herring	0.0438	0.0400	**0.0397**	0.0421	0.0411
Spottail Shiner	0.0546	0.0459	**0.0353**	0.0544	0.0472

* $CMR_{Total} = 1 - (1 - CMR_{BP})(1 - CMR_{IP})(1 - CMR_{Ros})$

Appendix 8D

Table 3. Total number killed by entrainment based on in-plant sampling at Bowline Point 1 & 2 during 1981-1987

American Shad

Sum of Number Entrained	Year						
Lifestage	1981	1982	1983	1984	1986	1987	Grand Total
1		1.20E+05					1.20E+05
3	4.13E+04	8.68E+05	5.48E+04	3.94E+05	1.32E+04	2.21E+04	1.39E+06
4	7.88E+04	2.76E+04	2.95E+04		1.55E+04	2.92E+04	1.81E+05
Grand Total	1.20E+05	1.02E+06	8.43E+04	3.94E+05	2.87E+04	5.13E+04	1.69E+06

Bay Anchovy

Sum of Number Entrained	Year							
Lifestage	1981	1982	1983	1984	1985	1986	1987	Grand Total
1			3.25E+04	1.73E+05	3.82E+06	1.30E+05	8.05E+05	4.96E+06
2			8.59E+04			3.33E+05	4.25E+04	4.61E+05
3	5.21E+07	2.21E+05	2.38E+07	2.88E+08	3.07E+07	4.66E+07	9.46E+07	5.36E+08
4	1.35E+06	5.20E+04	1.14E+06	2.18E+06	7.17E+05	2.08E+05	7.78E+05	6.42E+06
Grand Total	5.35E+07	2.73E+05	2.51E+07	2.90E+08	3.52E+07	4.73E+07	9.62E+07	5.48E+08

River Herring

Sum of Number Entrained	Year							
Lifestage	1981	1982	1983	1984	1985	1986	1987	Grand Total
1	3.91E+04	1.12E+04	1.80E+04	1.47E+05	1.09E+04	1.23E+04		2.38E+05
2			2.33E+04		2.64E+05			2.87E+05
3	2.02E+06	6.78E+06	2.44E+07	4.25E+07	4.00E+04	8.64E+05	1.52E+05	7.67E+07
4	1.39E+05	3.49E+04	7.69E+04	1.45E+04		4.51E+04	5.46E+03	3.16E+05
Grand Total	2.20E+06	6.82E+06	2.45E+07	4.27E+07	3.15E+05	9.21E+05	1.57E+05	7.76E+07

Striped Bass

Sum of Number Entrained	Year							
Lifestage	1981	1982	1983	1984	1985	1986	1987	Grand Total
1			1.53E+03	2.17E+04	2.01E+03		1.02E+03	2.62E+04
2	1.92E+05	1.69E+06	1.26E+06	5.11E+05	2.50E+04	5.35E+06	2.44E+04	9.05E+06
3	3.36E+06	1.16E+06	1.78E+06	4.27E+06	3.28E+05	9.64E+06	2.32E+06	2.29E+07
4	1.32E+05	8.69E+04	1.17E+05	3.60E+04		3.18E+04	3.10E+05	7.13E+05
Grand Total	3.69E+06	2.94E+06	3.16E+06	4.84E+06	3.55E+05	1.50E+07	2.65E+06	3.27E+07

White Perch

Sum of Number Entrained	Year							
Lifestage	1981	1982	1983	1984	1985	1986	1987	Grand Total
1	1.36E+06	3.73E+06	3.84E+06	3.75E+06	1.90E+05	1.67E+05	1.12E+03	1.30E+07
2		6.95E+04	9.03E+05	6.97E+05	2.87E+05	4.52E+05		2.41E+06
3	8.76E+06	3.63E+06	1.15E+07	1.01E+07	7.26E+05	5.56E+06	1.71E+05	4.05E+07
4	2.50E+05	4.95E+04	5.84E+04	1.14E+04	4.72E+04	6.70E+04	2.46E+04	5.08E+05
Grand Total	1.04E+07	7.48E+06	1.63E+07	1.46E+07	1.25E+06	6.25E+06	1.96E+05	5.65E+07

Life Stages: 1 = eggs; 2 = yolk-sac larvae; 3 = post yolk-sac larvae; 4 = juveniles

Table 3. Total numbers entrained based on in-plant abundance sampling at Bowline Point 1 & 2 during 1981-1987.

American Shad

Sum of Number Entrained	Year						
Lifestage	1981	1982	1983	1984	1986	1987	Grand Total
1		1.20E+05					1.20E+05
3	5.16E+04	1.09E+06	6.73E+04	4.96E+05	1.66E+04	2.78E+04	1.75E+06
4	8.87E+04	3.47E+04	3.15E+04		1.91E+04	3.68E+04	2.11E+05
Grand Total	1.40E+05	1.25E+06	9.88E+04	4.96E+05	3.57E+04	6.46E+04	2.08E+06

Bay Anchovy

Sum of Number Entrained	Year							
Lifestage	1981	1982	1983	1984	1985	1986	1987	Grand Total
1			3.25E+04	1.73E+05	3.85E+06	1.30E+05	8.05E+05	4.99E+06
2			3.48E+05			3.33E+05	4.25E+04	7.23E+05
3	5.21E+07	2.21E+05	4.16E+07	2.88E+08	3.21E+07	4.66E+07	9.46E+07	5.55E+08
4	1.35E+06	5.20E+04	1.14E+06	2.18E+06	7.17E+05	2.08E+05	7.78E+05	6.42E+06
Grand Total	5.35E+07	2.73E+05	4.32E+07	2.90E+08	3.67E+07	4.73E+07	9.62E+07	5.67E+08

River Herring

Sum of Number Entrained	Year							
Lifestage	1981	1982	1983	1984	1985	1986	1987	Grand Total
1	3.91E+04	1.12E+04	1.80E+04	1.73E+05	1.42E+04	1.23E+04		2.68E+05
2			2.93E+04		3.32E+05			3.61E+05
3	2.54E+06	8.54E+06	2.97E+07	5.36E+07	5.03E+04	1.09E+06	1.91E+05	9.57E+07
4	1.47E+05	3.70E+04	7.95E+04	1.50E+04		5.68E+04	6.88E+03	3.43E+05
Grand Total	2.73E+06	8.58E+06	2.98E+07	5.38E+07	3.97E+05	1.16E+06	1.98E+05	9.67E+07

Striped Bass

Sum of Number Entrained	Year							
Lifestage	1981	1982	1983	1984	1985	1986	1987	Grand Total
1			1.53E+03	2.43E+04	2.01E+03		1.02E+03	2.88E+04
2	5.46E+05	6.25E+06	2.84E+06	1.57E+06	6.77E+04	1.42E+07	9.17E+04	2.56E+07
3	1.17E+07	4.04E+06	6.26E+06	1.57E+07	1.15E+06	3.36E+07	8.08E+06	8.06E+07
4	5.20E+05	3.42E+05	4.78E+05	1.42E+05		1.25E+05	1.22E+06	2.83E+06
Grand Total	1.28E+07	1.06E+07	9.58E+06	1.74E+07	1.22E+06	4.79E+07	9.39E+06	1.09E+08

White Perch

Sum of Number Entrained	Year							
Lifestage	1981	1982	1983	1984	1985	1986	1987	Grand Total
1	1.36E+06	3.73E+06	3.84E+06	4.10E+06	1.98E+05	1.67E+05	1.12E+03	1.34E+07
2		1.23E+05	1.60E+06	1.28E+06	5.07E+05	7.98E+05		4.31E+06
3	1.55E+07	6.41E+06	2.04E+07	2.02E+07	1.29E+06	9.83E+06	3.02E+05	7.40E+07
4	5.38E+05	1.07E+05	1.42E+05	2.45E+04	1.02E+05	1.44E+05	5.29E+04	1.11E+06
Grand Total	1.74E+07	1.04E+07	2.60E+07	2.56E+07	2.10E+06	1.09E+07	3.56E+05	9.28E+07

Life Stages: 1 = eggs; 2 = yolk-sac larvae; 3 = post yolk-sac larvae; 4 = juveniles

Appendix 8E

WHITE PERCH-CASE 1(design) Unit 3 Flow (MGD) = 6.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	13000000	0.2304229147
YSL	2410000	0.0427168634
PYSL	40500000	0.7178560034
Juv	508000	0.0090042185
Total	56418000	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	0.21	0.0021000000
CMR (m)	1.0605	
CMR (b)	0.2471	
CMR 100	0.469805	0.0046980500

FLOW WEIGHT THE DIFFERENCE (CMR100-CMREST)

CMR egg 100	0.0010825384
CMR YSL 100	0.0002006860
CMR PYSL 100	0.0033725234
CMR Juv 100	0.0000423023
CMR egg est	0.0004838881
CMR YSL est	0.0000897054
CMR PYSL est	0.0015074976
CMR Juv est	0.0000189089

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (Screen)	Fraction Captured GB
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	100	1.0000000000	1.00
% capture Juv	100	1.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	780.0
Unit 1,2 Q YSL (MGD)	780.0
Unit 1,2 Q PYSL (MGD)	810.0
Unit 1,2 Q Juv (MGD)	870.0
CMR eggs	0.0000049888
CMR YSL	0.0000009248
CMR PYSL	0.0000149663
CMR Juv	0.0000001748

CMR TOTAL Fraction of Population 0.0000210545

WHITE PERCH-CASE 1(design) Unit 3 Flow (MGD) = 7.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	13000000	0.2304229147
YSL	2410000	0.0427168634
PYSL	40500000	0.7178560034
Juv	508000	0.0090042185
Total	56418000	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	0.21	0.0021000000
CMR (m)	1.0605	
CMR (b)	0.2471	
CMR 100	0.469805	0.0046980500

FLOW WEIGHT THE DIFFERENCE (CMR100-CMREST)

CMR egg 100	0.0010825384
CMR YSL 100	0.0002006860
CMR PYSL 100	0.0033725234
CMR Juv 100	0.0000423023
CMR egg est	0.0004838881
CMR YSL est	0.0000897054
CMR PYSL est	0.0015074976
CMR Juv est	0.0000189089

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (Screen)	Fraction Captured GB
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	100	1.0000000000	1.00
% capture Juv	100	1.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	780.0
Unit 1,2 Q YSL (MGD)	780.0
Unit 1,2 Q PYSL (MGD)	810.0
Unit 1,2 Q Juv (MGD)	870.0
CMR eggs	0.0000057563
CMR YSL	0.0000010671
CMR PYSL	0.0000172688
CMR Juv	0.0000002017

CMR TOTAL Fraction of Population 0.0000242937

WHITE PERCH-CASE 2 Unit 3 Flow (MGD) = 7.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	13000000	0.2304229147
YSL	2410000	0.0427168634
PYSL	40500000	0.7178560034
Juv	508000	0.0090042185
Total	56418000	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	0.21	0.0021000000
CMR (m)	1.0605	
CMR (b)	0.2471	
CMR 100	0.469805	0.0046980500

FLOW WEIGHT CMR100

CMR egg 100	0.0010825384
CMR YSL 100	0.0002006860
CMR PYSL 100	0.0033725234
CMR Juv 100	0.0000423023

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (screen)	Fraction Captured (GB)
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	50	0.5000000000	1.00
% capture Juv	0	0.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	780.0
Unit 1,2 Q YSL (MGD)	780.0
Unit 1,2 Q PYSL (MGD)	810.0
Unit 1,2 Q Juv (MGD)	870.0

CMR eggs	0.0000104090
CMR YSL	0.0000019297
CMR PYSL	0.0000156135
CMR Juv	0.0000000000

CMR TOTAL Fraction of Population 0.0000279520

WHITE PERCH-CASE 2 Unit 3 Flow (MGD) = 6.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	13000000	0.2304229147
YSL	2410000	0.0427168634
PYSL	40500000	0.7178560034
Juv	508000	0.0090042185
Total	56418000	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	0.21	0.0021000000
CMR (m)	1.0605	
CMR (b)	0.2471	
CMR 100	0.469805	0.0046980500

FLOW WEIGHT CMR100

CMR egg 100	0.0010825384
CMR YSL 100	0.0002006860
CMR PYSL 100	0.0033725234
CMR Juv 100	0.0000423023

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (screen)	Fraction Captured (GB)
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	50	0.5000000000	1.00
% capture Juv	0	0.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	780.0
Unit 1,2 Q YSL (MGD)	780.0
Unit 1,2 Q PYSL (MGD)	810.0
Unit 1,2 Q Juv (MGD)	870.0

CMR eggs	0.0000090212
CMR YSL	0.0000016724
CMR PYSL	0.0000135317
CMR Juv	0.0000000000

CMR TOTAL Fraction of Population 0.0000242251

BAY ANCHOVY-CASE 1 Unit 3 Flow (MGD) = 6.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	4960000	0.0090537218
YSL	461000	0.0008414850
PYSL	536000000	0.9783860646
Juv	6420000	0.0117187286
Total	547841000	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	3.39	0.0339000000
CMR (m)	1	
CMR (b)		
CMR 100	3.39	0.0339000000

FLOW WEIGHT THE DIFFERENCE (CMR100-CMREST)

CMR egg 100	0.0003069212
CMR YSL 100	0.0000285263
CMR PYSL 100	0.0331672876
CMR Juv 100	0.0003972649
CMR egg est	0.0003069212
CMR YSL est	0.0000285263
CMR PYSL est	0.0331672876
CMR Juv est	0.0003972649

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (Screen)	Fraction Captured GB
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	100	1.0000000000	1.00
% capture Juv	100	1.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	861.4
Unit 1,2 Q YSL (MGD)	840.2
Unit 1,2 Q PYSL (MGD)	888.1
Unit 1,2 Q Juv (MGD)	882.1
CMR eggs	0.0000000000
CMR YSL	0.0000000000
CMR PYSL	0.0000000000
CMR Juv	0.0000000000

CMR TOTAL Fraction of Population 0.0000000000

BAY ANCHOVY-CASE 1 Unit 3 Flow (MGD) = 7.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	4960000	0.0090537218
YSL	461000	0.0008414850
PYSL	536000000	0.9783860646
Juv	6420000	0.0117187286
Total	547841000	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	3.39	0.0339000000
CMR (m)	1	
CMR (b)		
CMR 100	3.39	0.0339000000

FLOW WEIGHT THE DIFFERENCE (CMR100-CMREST)

CMR egg 100	0.0003069212
CMR YSL 100	0.0000285263
CMR PYSL 100	0.0331672876
CMR Juv 100	0.0003972649
CMR egg est	0.0003069212
CMR YSL est	0.0000285263
CMR PYSL est	0.0331672876
CMR Juv est	0.0003972649

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (Screen)	Fraction Captured GB
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	100	1.0000000000	1.00
% capture Juv	100	1.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	861.4
Unit 1,2 Q YSL (MGD)	840.2
Unit 1,2 Q PYSL (MGD)	888.1
Unit 1,2 Q Juv (MGD)	882.1
CMR eggs	0.0000000000
CMR YSL	0.0000000000
CMR PYSL	0.0000000000
CMR Juv	0.0000000000
CMR TOTAL Fraction of Population	0.0000000000

BAY ANCHOVY-CASE 2 Unit 3 Flow (MGD) = 7.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	4960000	0.0090537218
YSL	461000	0.0008414850
PYSL	5.36E+08	0.9783860646
Juv	6420000	0.0117187286
Total	5.48E+08	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	3.39	0.0339000000
CMR (m)	1	
CMR (b)		
CMR 100	3.39	0.0339000000

FLOW WEIGHT CMR100

CMR egg 100	0.0003069212
CMR YSL 100	0.0000285263
CMR PYSL 100	0.0331672876
CMR Juv 100	0.0003972649

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (WW)	Fraction Captured (GB)
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	100	1.0000000000	1.00
% capture Juv	0	0.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	861.4
Unit 1,2 Q YSL (MGD)	840.2
Unit 1,2 Q PYSL (MGD)	888.1
Unit 1,2 Q Juv (MGD)	882.1

CMR eggs	0.0000026723
CMR YSL	0.0000002546
CMR PYSL	0.0002800976
CMR Juv	0.0000000000

CMR TOTAL Fraction of Population 0.0002830237

BAY ANCHOVY-CASE 2 Unit 3 Flow (MGD) = 6.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	4960000	0.0090537218
YSL	461000	0.0008414850
PYSL	5.36E+08	0.9783860646
Juv	6420000	0.0117187286
Total	5.48E+08	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	3.39	0.0339000000
CMR (m)	1	
CMR (b)		
CMR 100	3.39	0.0339000000

FLOW WEIGHT CMR100

CMR egg 100	0.0003069212
CMR YSL 100	0.0000285263
CMR PYSL 100	0.0331672876
CMR Juv 100	0.0003972649

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (WW)	Fraction Captured (GB)
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	100	1.0000000000	1.00
% capture Juv	0	0.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	861.4
Unit 1,2 Q YSL (MGD)	840.2
Unit 1,2 Q PYSL (MGD)	888.1
Unit 1,2 Q Juv (MGD)	882.1

CMR eggs	0.0000023160
CMR YSL	0.0000002207
CMR PYSL	0.0002427512
CMR Juv	0.0000000000

CMR TOTAL Fraction of Population 0.0002452873

RIVER HERRING-CASE 1 Unit 3 Flow (MGD) = 6.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	238000	0.0030693440
YSL	287000	0.0037012677
PYSL	76700000	0.9891541249
Juv	316000	0.0040752634
Total	77541000	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	0.1	0.0010000000
CMR (m)	1.2622	
CMR (b)	0.0026	
CMR 100	0.12362	0.0012362000

FLOW WEIGHT THE DIFFERENCE (CMR100-CMREST)

CMR egg 100	0.0000037943
CMR YSL 100	0.0000045755
CMR PYSL 100	0.0012227923
CMR Juv 100	0.0000050378
CMR egg est	0.0000030693
CMR YSL est	0.0000037013
CMR PYSL est	0.0009891541
CMR Juv est	0.0000040753

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (Sc	Fraction Captured GB
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	100	1.0000000000	1.00
% capture Juv	100	1.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	769.2
Unit 1,2 Q YSL (MGD)	769.2
Unit 1,2 Q PYSL (MGD)	812.8
Unit 1,2 Q Juv (MGD)	882.1
CMR eggs	0.0000000061
CMR YSL	0.0000000074
CMR PYSL	0.0000018684
CMR Juv	0.0000000071

CMR TOTAL Fraction of Population 0.0000018890

RIVER HERRING-CASE 1 Unit 3 Flow (MGD) = 7.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	238000	0.0030693440
YSL	287000	0.0037012677
PYSL	76700000	0.9891541249
Juv	316000	0.0040752634
Total	77541000	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	0.1	0.0010000000
CMR (m)	1.2622	
CMR (b)	0.0026	
CMR 100	0.12362	0.0012362000

FLOW WEIGHT THE DIFFERENCE (CMR100-CMREST)

CMR egg 100	0.0000037943
CMR YSL 100	0.0000045755
CMR PYSL 100	0.0012227923
CMR Juv 100	0.0000050378
CMR egg est	0.0000030693
CMR YSL est	0.0000037013
CMR PYSL est	0.0009891541
CMR Juv est	0.0000040753

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (Sc	Fraction Captured GB
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	100	1.0000000000	1.00
% capture Juv	100	1.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	769.2
Unit 1,2 Q YSL (MGD)	769.2
Unit 1,2 Q PYSL (MGD)	812.8
Unit 1,2 Q Juv (MGD)	882.1
CMR eggs	0.0000000071
CMR YSL	0.0000000085
CMR PYSL	0.0000021559
CMR Juv	0.0000000082

CMR TOTAL Fraction of Population 0.0000021796

RIVER HERRING-CASE 2 Unit 3 Flow (MGD) = 7.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	238000	0.0030693440
YSL	287000	0.0037012677
PYSL	76700000	0.9891541249
Juv	316000	0.0040752634
Total	77541000	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	0.1	0.0010000000
CMR (m)	1.2622	
CMR (b)	0.0026	
CMR 100	0.12362	0.0012362000

FLOW WEIGHT CMR100

CMR egg 100	0.0000037943
CMR YSL 100	0.0000045755
CMR PSYL 100	0.0012227923
CMR Juv 100	0.0000050378

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (WW)	Fraction Captured (GB)
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	50	0.5000000000	1.00
% capture Juv	0	0.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	769.2
Unit 1,2 Q YSL (MGD)	769.2
Unit 1,2 Q PYSL (MGD)	812.8
Unit 1,2 Q Juv (MGD)	882.1
CMR eggs	0.0000000370
CMR YSL	0.0000000446
CMR PSYL	0.0000056416
CMR Juv	0.0000000000
CMR TOTAL Fraction of Population	0.0000057232

RIVER HERRING-CASE 2 Unit 3 Flow (MGD) = 6.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	238000	0.0030693440
YSL	287000	0.0037012677
PYSL	76700000	0.9891541249
Juv	316000	0.0040752634
Total	77541000	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	0.1	0.0010000000
CMR (m)	1.2622	
CMR (b)	0.0026	
CMR 100	0.12362	0.0012362000

FLOW WEIGHT CMR100

CMR egg 100	0.0000037943
CMR YSL 100	0.0000045755
CMR PSYL 100	0.0012227923
CMR Juv 100	0.0000050378

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (WW)	Fraction Captured (GB)
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	50	0.5000000000	1.00
% capture Juv	0	0.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	769.2
Unit 1,2 Q YSL (MGD)	769.2
Unit 1,2 Q PYSL (MGD)	812.8
Unit 1,2 Q Juv (MGD)	882.1

CMR eggs	0.0000000321
CMR YSL	0.0000000387
CMR PSYL	0.0000048894
CMR Juv	0.0000000000

CMR TOTAL Fraction of Population 0.0000049601

AMERICAN SHAD-CASE 1 Unit 3 Flow (MGD) = 6.5

RELATIVE FRACTION KILLED

	No. Killed	**Frac. Of Total**
eggs	120000	0.0709639267
YSL	0	0.0000000000
PSYL	1390000	0.8219988173
Juv	181000	0.1070372561
Total	1691000	

REGRESSION ANALYSIS

	%	**Fraction**
CMR est:	0.01	0.0001000000
CMR (m)	1.2525	
CMR (b)	0.001	
CMR 100	0.011525	0.0001152500

FLOW WEIGHT THE DIFFERENCE (CMR100-CMREST)

CMR egg 100	0.0000081786
CMR YSL 100	0.0000000000
CMR PYSL 100	0.0000947354
CMR Juv 100	0.0000123360
CMR egg est	0.0000070964
CMR YSL est	0.0000000000
CMR PYSL est	0.0000821999
CMR Juv est	0.0000107037

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (Screen)	Fraction Captured GB
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	100	1.0000000000	1.00
% capture Juv	100	1.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	753.5
Unit 1,2 Q YSL (MGD)	772.4
Unit 1,2 Q PYSL (MGD)	812.8
Unit 1,2 Q Juv (MGD)	869.1
CMR eggs	0.0000000093
CMR YSL	0.0000000000
CMR PYSL	0.0000001002
CMR Juv	0.0000000122

CMR TOTAL Fraction of Population 0.0000001218

AMERICAN SHAD-CASE 1 Unit 3 Flow (MGD) = 7.5

RELATIVE FRACTION KILLED

	No. Killed	**Frac. Of Total**
eggs	120000	0.0709639267
YSL	0	0.0000000000
PSYL	1390000	0.8219988173
Juv	181000	0.1070372561
Total	1691000	

REGRESSION ANALYSIS

	%	**Fraction**
CMR est:	0.01	0.0001000000
CMR (m)	1.2525	
CMR (b)	0.001	
CMR 100	0.011525	0.0001152500

FLOW WEIGHT THE DIFFERENCE (CMR100-CMREST)

CMR egg 100	0.0000081786
CMR YSL 100	0.0000000000
CMR PYSL 100	0.0000947354
CMR Juv 100	0.0000123360
CMR egg est	0.0000070964
CMR YSL est	0.0000000000
CMR PYSL est	0.0000821999
CMR Juv est	0.0000107037

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (Screen)	Fraction Captured GB
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	100	1.0000000000	1.00
% capture Juv	100	1.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	753.5
Unit 1,2 Q YSL (MGD)	772.4
Unit 1,2 Q PYSL (MGD)	812.8
Unit 1,2 Q Juv (MGD)	869.1
CMR eggs	0.0000000108
CMR YSL	0.0000000000
CMR PYSL	0.0000001157
CMR Juv	0.0000000141
CMR TOTAL Fraction of Population	0.0000001405

AMERICAN SHAD-CASE 2 Unit 3 Flow (MGD) = 7.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	120000	0.0709639267
YSL	0	0.0000000000
PYSL	1390000	0.8219988173
Juv	181000	0.1070372561
Total	1691000	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	0.01	0.0001000000
CMR (m)	1.2525	
CMR (b)	0.001	
CMR 100	0.011525	0.0001152500

FLOW WEIGHT CMR100

CMR egg 100	0.0000081786
CMR YSL 100	0.0000000000
CMR PYSL 100	0.0000947354
CMR Juv 100	0.0000123360

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (screen)	Fraction Captured (GB)
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	25	0.2500000000	1.00
% capture Juv	0	0.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	780.0
Unit 1,2 Q YSL (MGD)	780.0
Unit 1,2 Q PYSL (MGD)	810.0
Unit 1,2 Q Juv (MGD)	870.0

CMR eggs	0.0000000786
CMR YSL	0.0000000000
CMR PYSL	0.0000002193
CMR Juv	0.0000000000

CMR TOTAL Fraction of Population 0.0000002979

AMERICAN SHAD-CASE 2 Unit 3 Flow (MGD) = 6.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	120000	0.0709639267
YSL	0	0.0000000000
PYSL	1390000	0.8219988173
Juv	181000	0.1070372561
Total	1691000	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	0.01	0.0001000000
CMR (m)	1.2525	
CMR (b)	0.001	
CMR 100	0.011525	0.0001152500

FLOW WEIGHT CMR100

CMR egg 100	0.0000081786
CMR YSL 100	0.0000000000
CMR PYSL 100	0.0000947354
CMR Juv 100	0.0000123360

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (screen)	Fraction Captured (GB)
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	25	0.2500000000	1.00
% capture Juv	0	0.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	780.0
Unit 1,2 Q YSL (MGD)	780.0
Unit 1,2 Q PYSL (MGD)	810.0
Unit 1,2 Q Juv (MGD)	870.0
CMR eggs	0.0000000682
CMR YSL	0.0000000000
CMR PYSL	0.0000001901
CMR Juv	0.0000000000

CMR TOTAL Fraction of Population 0.0000002582

STRIPED BASS-CASE 1 Unit 3 Flow (MGD) = 7.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	26200	0.0008014880
YSL	9050000	0.2768498464
PYSL	22900000	0.7005371805
Juv	713000	0.0218114851
Total	32689200	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	0.63	0.0063000000
CMR (m)	3.4457	
CMR (b)	0.0314	
CMR 100	2.202191	0.0220219100

FLOW WEIGHT THE DIFFERENCE (CMR100-CMREST)

CMR egg 100	0.0000176503
CMR YSL 100	0.0060967624
CMR PYSL 100	0.0154271667
CMR Juv 100	0.0004803306
CMR egg est	0.0000050494
CMR YSL est	0.0017441540
CMR PYSL est	0.0044133842
CMR Juv est	0.0001374124

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (Sc	Fraction Captured GB
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	100	1.0000000000	1.00
% capture Juv	100	1.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	776.0
Unit 1,2 Q YSL (MGD)	776.0
Unit 1,2 Q PYSL (MGD)	776.0
Unit 1,2 Q Juv (MGD)	869.0
CMR eggs	0.0000001218
CMR YSL	0.0000420677
CMR PYSL	0.0001064476
CMR Juv	0.0000029596

CMR TOTAL Fraction of Population 0.0001515918

STRIPED BASS-CASE 1 Unit 3 Flow (MGD) = 6.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	26200	0.0008014880
YSL	9050000	0.2768498464
PYSL	22900000	0.7005371805
Juv	713000	0.0218114851
Total	32689200	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	0.63	0.0063000000
CMR (m)	3.4457	
CMR (b)	0.0314	
CMR 100	2.202191	0.0220219100

FLOW WEIGHT THE DIFFERENCE (CMR100-CMREST)

CMR egg 100	0.0000176503
CMR YSL 100	0.0060967624
CMR PYSL 100	0.0154271667
CMR Juv 100	0.0004803306
CMR egg est	0.0000050494
CMR YSL est	0.0017441540
CMR PYSL est	0.0044133842
CMR Juv est	0.0001374124

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (Sc	Fraction Captured GB
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	100	1.0000000000	1.00
% capture Juv	100	1.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	776.0
Unit 1,2 Q YSL (MGD)	776.0
Unit 1,2 Q PYSL (MGD)	776.0
Unit 1,2 Q Juv (MGD)	869.0
CMR eggs	0.0000001055
CMR YSL	0.0000364587
CMR PYSL	0.0000922546
CMR Juv	0.0000025650
CMR TOTAL Fraction of Population	0.0001313801

STRIPED BASS-CASE 2 Unit 3 Flow (MGD) = 7.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	26200	0.0008014880
YSL	9050000	0.2768498464
PYSL	22900000	0.7005371805
Juv	713000	0.0218114851
Total	32689200	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	0.63	0.0063000000
CMR (m)	3.4457	
CMR (b)	0.0314	
CMR 100	2.202191	0.0220219100

FLOW WEIGHT CMR100

CMR egg 100	0.0000176503
CMR YSL 100	0.0060967624
CMR PYSL 100	0.0154271667
CMR Juv 100	0.0004803306

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (Screen)	Fraction Captured GB
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	25	0.2500000000	1.00
% capture Juv	0	0.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	776.0
Unit 1,2 Q YSL (MGD)	776.0
Unit 1,2 Q PYSL (MGD)	776.0
Unit 1,2 Q Juv (MGD)	869.0
CMR eggs	0.0000001706
CMR YSL	0.0000589249
CMR PYSL	0.0000372757
CMR Juv	0.0000000000

CMR TOTAL Fraction of Population 0.0000963690

STRIPED BASS-CASE 2 Unit 3 Flow (MGD) = 6.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	26200	0.0008014880
YSL	9050000	0.2768498464
PYSL	22900000	0.7005371805
Juv	713000	0.0218114851
Total	32689200	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	0.63	0.0063000000
CMR (m)	3.4457	
CMR (b)	0.0314	
CMR 100	2.202191	0.0220219100

FLOW WEIGHT CMR100

CMR egg 100	0.0000176503
CMR YSL 100	0.0060967624
CMR PYSL 100	0.0154271667
CMR Juv 100	0.0004803306

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (Screen)	Fraction Captured GB
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	25	0.2500000000	1.00
% capture Juv	0	0.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	776.0
Unit 1,2 Q YSL (MGD)	776.0
Unit 1,2 Q PYSL (MGD)	776.0
Unit 1,2 Q Juv (MGD)	869.0

CMR eggs	0.0000001478
CMR YSL	0.0000510682
CMR PYSL	0.0000323056
CMR Juv	0.0000000000

CMR TOTAL Fraction of Population 0.0000835200

SPOTTAIL SHINER-CASE 1 Unit 3 Flow (MGD) = 6.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	na	0.0000000000
YSL	na	0.0000000000
PYSL	na	0.5000000000
Juv	na	0.5000000000
Total	0	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	0.41	0.0041000000
CMR (m)	7.6452	
CMR (b)	0.1369	
CMR 100	2.997632	0.0299763200

FLOW WEIGHT THE DIFFERENCE (CMR100-CMREST)

CMR egg 100	0.0000000000
CMR YSL 100	0.0000000000
CMR PYSL 100	0.0149881600
CMR Juv 100	0.0149881600
CMR egg est	0.0000000000
CMR YSL est	0.0000000000
CMR PYSL est	0.0020500000
CMR Juv est	0.0020500000

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (Screen)	Fraction Captured GB
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	100	1.0000000000	1.00
% capture Juv	100	1.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	na
Unit 1,2 Q YSL (MGD)	na
Unit 1,2 Q PYSL (MGD)	818.9
Unit 1,2 Q Juv (MGD)	869.1
CMR eggs	0.0000000000
CMR YSL	0.0000000000
CMR PYSL	0.0001026963
CMR Juv	0.0000967645

CMR TOTAL Fraction of Population 0.0001994509

SPOTTAIL SHINER-CASE 1 Unit 3 Flow (MGD) = 7.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	na	0.0000000000
YSL	na	0.0000000000
PYSL	na	0.5000000000
Juv	na	0.5000000000
Total	0	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	0.41	0.0041000000
CMR (m)	7.6452	
CMR (b)	0.1369	
CMR 100	2.997632	0.0299763200

FLOW WEIGHT THE DIFFERENCE (CMR100-CMREST)

CMR egg 100	0.0000000000
CMR YSL 100	0.0000000000
CMR PYSL 100	0.0149881600
CMR Juv 100	0.0149881600
CMR egg est	0.0000000000
CMR YSL est	0.0000000000
CMR PYSL est	0.0020500000
CMR Juv est	0.0020500000

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (Screen)	Fraction Captured GB
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	100	1.0000000000	1.00
% capture Juv	100	1.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	na
Unit 1,2 Q YSL (MGD)	na
Unit 1,2 Q PYSL (MGD)	818.9
Unit 1,2 Q Juv (MGD)	869.1
CMR eggs	0.0000000000
CMR YSL	0.0000000000
CMR PYSL	0.0001184958
CMR Juv	0.0001116514

CMR TOTAL Fraction of Population 0.0002301339

SPOTTAIL SHINER-CASE 2 Unit 3 Flow (MGD) = 6.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	na	0.0000000000
YSL	na	0.0000000000
PYSL	na	0.9000000000
Juv	na	0.1000000000
Total	0	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	0.41	0.0041000000
CMR (m)	7.6452	
CMR (b)	0.1369	
CMR 100	2.997632	0.0299763200

FLOW WEIGHT CMR100

CMR egg 100	0.0000000000
CMR YSL 100	0.0000000000
CMR PYSL 100	0.0269786880
CMR Juv 100	0.0029976320

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (Screen)	Fraction Captured GB
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	100	1.0000000000	1.00
% capture Juv	0	0.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	na	
Unit 1,2 Q YSL (MGD)	na	
Unit 1,2 Q PYSL (MGD)		818.9
Unit 1,2 Q Juv (MGD)		869.1

CMR eggs	0.0000000000
CMR YSL	0.0000000000
CMR PYSL	0.0002141427
CMR Juv	0.0000000000

CMR TOTAL Fraction of Population 0.0002141427

SPOTTAIL SHINER-CASE 2 Unit 3 Flow (MGD) = 7.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	na	0.0000000000
YSL	na	0.0000000000
PYSL	na	0.9000000000
Juv	na	0.1000000000
Total	0	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	0.41	0.0041000000
CMR (m)	7.6452	
CMR (b)	0.1369	
CMR 100	2.997632	0.0299763200

FLOW WEIGHT CMR100

CMR egg 100	0.0000000000
CMR YSL 100	0.0000000000
CMR PYSL 100	0.0269786880
CMR Juv 100	0.0029976320

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (Screen)	Fraction Captured GB
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	100	1.0000000000	1.00
% capture Juv	0	0.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	na	
Unit 1,2 Q YSL (MGD)	na	
Unit 1,2 Q PYSL (MGD)		818.9
Unit 1,2 Q Juv (MGD)		869.1

CMR eggs	0.0000000000
CMR YSL	0.0000000000
CMR PYSL	0.0002470878
CMR Juv	0.0000000000

CMR TOTAL Fraction of Population 0.0002470878

ATLANTIC TOMCOD-CASE 1 Unit 3 Flow (MGD) = 6.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	na	0.0000000000
YSL	na	0.0000000000
PYSL	na	0.5000000000
Juv	na	0.5000000000
Total	0	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	7.87	0.0787000000
CMR (m)	1.8102	
CMR (b)	0.3673	
CMR 100	13.87897	0.1387897400

FLOW WEIGHT THE DIFFERENCE (CMR100-CMREST)

CMR egg 100	0.0000000000
CMR YSL 100	0.0000000000
CMR PYSL 100	0.0693948700
CMR Juv 100	0.0693948700
CMR egg est	0.0000000000
CMR YSL est	0.0000000000
CMR PYSL est	0.0393500000
CMR Juv est	0.0393500000

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (Screen)	Fraction Captured GB
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	100	1.0000000000	1.00
% capture Juv	100	1.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	na	
Unit 1,2 Q YSL (MGD)	na	
Unit 1,2 Q PYSL (MGD)		740.0
Unit 1,2 Q Juv (MGD)		820.0
CMR eggs		0.0000000000
CMR YSL		0.0000000000
CMR PYSL		0.0002639076
CMR Juv		0.0002381606

CMR TOTAL Fraction of Population 0.0005020053

ATLANTIC TOMCOD-CASE 1 Unit 3 Flow (MGD) = 7.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	na	0.0000000000
YSL	na	0.0000000000
PYSL	na	0.5000000000
Juv	na	0.5000000000
Total	0	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	7.87	0.0787000000
CMR (m)	1.8102	
CMR (b)	0.3673	
CMR 100	13.87897	0.1387897400

FLOW WEIGHT THE DIFFERENCE (CMR100-CMREST)

CMR egg 100	0.0000000000
CMR YSL 100	0.0000000000
CMR PYSL 100	0.0693948700
CMR Juv 100	0.0693948700
CMR egg est	0.0000000000
CMR YSL est	0.0000000000
CMR PYSL est	0.0393500000
CMR Juv est	0.0393500000

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (Screen)	Fraction Captured GB
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	100	1.0000000000	1.00
% capture Juv	100	1.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	na	
Unit 1,2 Q YSL (MGD)	na	
Unit 1,2 Q PYSL (MGD)		740.0
Unit 1,2 Q Juv (MGD)		820.0
CMR eggs		0.0000000000
CMR YSL		0.0000000000
CMR PYSL		0.0003045088
CMR Juv		0.0002748006
CMR TOTAL Fraction of Population		0.0005792258

ATLANTIC TOMCOD-CASE 2 Unit 3 Flow (MGD) = 6.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	NA	0.0000000000
YSL	NA	0.0000000000
PYSL	NA	0.5000000000
Juv	NA	0.5000000000
Total	0	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	7.87	0.0787000000
CMR (m)	1.8102	
CMR (b)	0.3673	
CMR 100	13.87897	0.1387897400

FLOW WEIGHT CMR100

CMR egg 100	0.0000000000
CMR YSL 100	0.0000000000
CMR PYSL 100	0.0693948700
CMR Juv 100	0.0693948700

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (Screen)	Fraction Captured GB
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	50	0.5000000000	1.00
% capture Juv	0	0.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	NA	
Unit 1,2 Q YSL (MGD)	NA	
Unit 1,2 Q PYSL (MGD)		740.0
Unit 1,2 Q Juv (MGD)		820.0

CMR eggs	0.0000000000
CMR YSL	0.0000000000
CMR PYSL	0.0003047748
CMR Juv	0.0000000000

CMR TOTAL I Fraction of Population 0.0003047748

ATLANTIC TOMCOD-CASE 2 Unit 3 Flow (MGD) = 7.5

RELATIVE FRACTION KILLED

	No. Killed	Frac. Of Total
eggs	NA	0.0000000000
YSL	NA	0.0000000000
PYSL	NA	0.5000000000
Juv	NA	0.5000000000
Total	0	

REGRESSION ANALYSIS

	%	Fraction
CMR est:	7.87	0.0787000000
CMR (m)	1.8102	
CMR (b)	0.3673	
CMR 100	13.87897	0.1387897400

FLOW WEIGHT CMR100

CMR egg 100	0.0000000000
CMR YSL 100	0.0000000000
CMR PYSL 100	0.0693948700
CMR Juv 100	0.0693948700

FLOW WEIGHT AND ADJUST FOR % CAPTURE

	%	Fraction Captured (Screen)	Fraction Captured GB
% capture eggs	100	1.0000000000	1.00
% capture YSL	100	1.0000000000	1.00
% capture PYSL	50	0.5000000000	1.00
% capture Juv	0	0.0000000000	1.00

FLOW DURING CORRESPONDING LIFE STAGE

Unit 1,2 Q eggs (MGD)	NA
Unit 1,2 Q YSL (MGD)	NA
Unit 1,2 Q PYSL (MGD)	740.0
Unit 1,2 Q Juv (MGD)	820.0

CMR eggs	0.0000000000
CMR YSL	0.0000000000
CMR PYSL	0.0003516632
CMR Juv	0.0000000000

CMR TOTAL I Fraction of Population 0.0003516632

Bowline Unit 3 Article X Application
Appendix 8E (CMR Runs)
Errata Sheet

Article X Section	Items In Application Requiring Revision/Deletion	Project Change/Application Revision
Appendix 8E (CMR Runs)	Minor revision to estimated CMR for American shad following correction to spreadsheet input data ~~(see attached sheets).~~	

J:\DATA\Client1\08027\Errata Sheets\errata sheet Appendix 8.E.wpd

see sheets attached to section 8 errata sheet — (per letter of B. Brenner to Lynch and Casutto of 8/7/01)
JJI
8/13/01

Appendix 9A

United States Department of the Interior

FISH AND WILDLIFE SERVICE
3817 Luker Road
Cortland, NY 13045

U.S. Department of the Interior 1849•1999

December 6, 1999

Mr. Craig H. Wolfgang
Project Manager
TRC Environmental Corporation
1200 Wall Street West, 2nd Floor
Lyndhurst, NJ 07071

Dear Mr. Wolfgang:

This responds to your letter of November 23, 1999, requesting information on the presence of endangered or threatened species in the vicinity of the proposed construction of a 1.7-mile underground electrical transmission line and a 4.2-mile natural gas transmission pipeline in the Village of West Haverstraw and Towns of Clarkstown and Haverstraw, Rockland County, New York.

Except for occasional transient individuals, no Federally listed or proposed endangered or threatened species under our jurisdiction are known to exist in the project impact area. Therefore, no Biological Assessment or further Section 7 consultation under the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.) is required with the U.S. Fish and Wildlife Service (Service). Should project plans change, or if additional information on listed or proposed species becomes available, this determination may be reconsidered.

The above comments pertaining to endangered species under our jurisdiction are provided pursuant to the Endangered Species Act. This response does not preclude additional Service comments under the Fish and Wildlife Coordination Act or other legislation.

Federally listed endangered and threatened marine species may be found near the project area. These species are under the jurisdiction of the National Marine Fisheries Service. You should contact Mr. Stanley Gorski, Habitat and Protected Resources Division, Area Coordinator, National Marine Fisheries Service, James J. Howard Marine Sciences Laboratory, 74 Magruder Road, Highlands, NJ 07732, for additional information (telephone: [908] 872-3037).

For additional information on fish and wildlife resources or State-listed species, we suggest you contact:

New York State Department
of Environmental Conservation
Region 3
21 South Putt Corners Road
New Paltz, NY 12561-1676
(914) 256-3000

New York State Department
of Environmental Conservation
Wildlife Resources Center - Information Services
New York Natural Heritage Program
700 Troy-Schenectady Road
Latham, NY 12110-2400
(518) 783-3932

National Wetlands Inventory (NWI) maps may or may not be available for the project area. However, while the NWI maps are reasonably accurate, they should not be used in lieu of field surveys for determining the presence of wetlands or delineating wetland boundaries for Federal regulatory purposes. Copies of specific NWI maps can be obtained from:

Cornell Institute for Resource Information Systems
302 Rice Hall
Cornell University
Ithaca, NY 14853
(607) 255-4864

Work in certain waters and wetlands of the United States may require a permit from the U.S. Army Corps of Engineers (Corps). If a permit is required, in reviewing the application pursuant to the Fish and Wildlife Coordination Act, the Service may concur, with or without stipulations, or recommend denial of the permit depending upon the potential adverse impacts on fish and wildlife resources associated with project implementation. The need for a Corps permit may be determined by contacting Mr. Joseph Seebode, Chief, Regulatory Branch, U.S. Army Corps of Engineers, 26 Federal Plaza, New York, NY 10278 (telephone: [212] 264-3996).

If you require additional information please contact Michael Stoll at (607) 753-9334.

Sincerely,

Mark W. Clough

ACTING FOR
David A. Stilwell
Field Supervisor

cc: NYSDEC, New Paltz, NY (Environmental Permits)
NYSDEC, Latham, NY
NMFS, Highlands, NJ (Attn: S. Gorski)
NMFS, Milford, CT (Attn: M. Ludwig)
COE, New York, NY

New York State Department of Environmental Conservation
Division of Fish, Wildlife & Marine Resources
Wildlife Resources Center - New York Natural Heritage Program
700 Troy-Schenectady Road, Latham, New York 12110-2400
Phone: (518) 783-3932 FAX: (518) 783-3916

John P. Cahill
Commissioner

December 6, 1999

Craig H. Wolfgang
TRC Environmental Corp.
1200 Wall Street West, 2nd floor
Lyndhurst, NJ 07071

Dear Mr. Wolfgang:

In response to your recent request we have reviewed the New York Natural Heritage Program databases with respect to the proposed Electric Generating Facility (Bowline Unit 3), and A 4.2 mile gas pipeline, site as indicated on the maps you provided, located in Rockland County, New York State.

Enclosed is a report of rare or state-listed animals and plants, significant natural communities, and other significant habitats, which our databases indicate occur, or may occur, on your site or in the immediate vicinity of your site. The information contained in this report is considered sensitive and may not be released to the public without permission from the New York Natural Heritage Program.

Your project location is within, or adjacent to, a designated Significant Coastal Fish and Wildlife Habitat. This habitat is part of New York State's Coastal Management Program (CMP), which is administered by the NYS Department of State (DOS). Projects which may impact the habitat are reviewed by DOS for consistency with the CMP. For more information regarding this designated habitat and applicable consistency review requirements, please contact:

Greg Capobianco or Steven C. Resler - (518) 474-6000
NYS Department of State
Division of Coastal Resources and Waterfront Revitalization
162 Washington Avenue, Albany, NY 12231

For most sites, comprehensive field surveys have not been conducted; the enclosed report only includes records from our databases. We cannot provide a definitive statement on the presence or absence of all rare or state-listed species or significant natural communities. This information should not be substituted for on-site surveys that may be required for environmental impact assessment.

Our databases are continually growing as records are added and updated. If this proposed project is still under development one year from now, we recommend that you contact us again so that we may update this response with the most current information.

This response applies only to known occurrences of rare or state-listed animals and plants, of significant natural communities, and of other significant habitats. For information regarding regulated areas or permits that may be required under state law (e.g., regulated wetlands), please contact the appropriate NYS DEC Regional Office, Division of Environmental Permits, at the enclosed address.

Sincerely,

Betty Ketcham

Betty A. Ketcham
Information Services
NY Natural Heritage Program

Encs.

cc: Reg. 3, Wildlife Mgr.
Reg. 3, Fisheries Mgr.
Peter Nye, Endangered Species Unit, Delmar

ENCLOSURE INTENTIONALLY
OMITTED

CONFIDENTIAL

TRC

November 23, 1999

Ms. Betty Ketchum
NYS Department of Environmental Conservation
NY Natural Heritage Program
700 Troy-Schenectady Road
Latham, New York 12110-2400

Subject: **Bowline Unit 3 Combined Cycle Project**
Proposed Gas and Electric Interconnections

Dear Ms. Ketchum:

Southern Energy of New York proposes to construct a 750 MW combined-cycle, electric generating facility (Bowline Unit 3) at the existing Bowline Point Generating Facility located in the Town of Haverstraw, Rockland County, NY. In addition to the proposed electric generating facility, a 1.7-mile 345 kV underground electric transmission line and a 4.2-mile gas pipeline are also proposed to be constructed within an existing electric and gas transmission corridor through the Towns of Haverstraw and Clarkstown and the Village of West Haverstraw, all in Rockland County. TRC Environmental, as the applicant's environmental consultants, would like to request information regarding the known occurrence or potential habitat for any threatened, endangered or rare species within the proposed transmission corridor.

The proposed electric and gas transmission lines will follow the same alignment from the Bowline Point facility to the West Haverstraw substation, a distance of approximately 1.7 miles, including approximately 1.2 miles parallel to Minisceongo Creek. The proposed 345 kV electric transmission line will terminate at the West Haverstraw substation. The proposed gas pipeline would continue past the substation along an existing transmission right-of-way over South Mountain (High Tor State Park) to the existing Buena Vista metering station, an additional distance of approximately 2.5 miles. The proposed alignments of the electric and gas transmission lines are shown on the enclosed portions of the Haverstraw , NY and Thiells, NY quadrangle maps.

If you have any questions concerning the proposed project or this request, please contact me at (201) 933-5541, ext.113. Thank you for your attention to this request.

Sincerely,
TRC Environmental Corporation

Craig H. Wolfgang
Project Manager

Enclosures
cc: B. Brenner, Esq., Couch White, LLP
E. Dorsett, Southern Energy, Inc.
L. Friscoe, Southern Energy, Inc.

1200 Wall Street West, 2nd Floor • Lyndhurst, New Jersey 07071
Telephone 201-933-5541 • Fax 201-933-5601

TRC

November 23, 1999

Mr. Mike Stoll
U. S. Fish and Wildlife Service
3817 Luker Road
Cortlandt, New York 13045

Subject: **Bowline Unit 3 Combined Cycle Project**
Proposed Gas and Electric Interconnections

Dear Mr. Stoll:

Southern Energy of New York proposes to construct a 750 MW combined-cycle, electric generating facility (Bowline Unit 3) at the existing Bowline Point Generating Facility located in the Town of Haverstraw, Rockland County, NY. In addition to the proposed electric generating facility, a 1.7-mile 345 kV underground electric transmission line and a 4.2-mile gas pipeline are also proposed to be constructed within an existing electric and gas transmission corridor through the Towns of Haverstraw and Clarkstown and the Village of West Haverstraw, all in Rockland County. TRC Environmental, as the applicant's environmental consultants, would like to request information regarding the known occurrence or potential habitat for any threatened, endangered or rare species within the proposed transmission corridor.

The proposed electric and gas transmission lines will follow the same alignment from the Bowline Point facility to the West Haverstraw substation, a distance of approximately 1.7 miles, including approximately 1.2 miles parallel to Minisceongo Creek. The proposed 345 kV electric transmission line will terminate at the West Haverstraw substation. The proposed gas pipeline would continue past the substation along an existing transmission right-of-way over South Mountain (High Tor State Park) to the existing Buena Vista metering station, an additional distance of approximately 2.5 miles. The proposed alignments of the electric and gas transmission lines are shown on the enclosed portions of the Haverstraw , NY and Thiells, NY quadrangle maps.

If you have any questions concerning the proposed project or this request, please contact me at (201) 933-5541, ext.113. Thank you for your attention to this request.

Sincerely,
TRC Environmental Corporation

Craig H. Wolfgang
Project Manager

Enclosures
cc: B. Brenner, Esq., Couch White, LLP
E. Dorsett, Southern Energy, Inc.
L. Friscoe, Southern Energy, Inc.

1200 Wall Street West, 2nd Floor • Lyndhurst, New Jersey 07071
Telephone 201-933-5541 • Fax 201-933-5601

Customer-Focused Solutions

Appendix 9B

Southern Energy Bowline Unit 3

Haverstraw, New York

Appendix 9B

VEGETATION SAMPLING DATA

	Plot	Species		Cover Class	Strata	Other
Plant Community 1 - Urban Vacant Lot						
	1	*Schizachyrium scoparium*		D	GC	
		Commelina communis		O	GC	
		Dauca carota		R	GC	
		Apocynum androsaemifolium		O	GC	
		Aster dumosus		C	GC	
		Erigeron philadelphicus		R	GC	
		Polygonum persicaria		O	GC	
		Populus deltoides		C	U	
		Melilotus alba		C	GC	
		Danthonia spicata		D	GC	
		Euphorbia sulpina		C	GC	
		Artemisia vulgaris		C	GC	
		Centaurea maculosa		C	GC	
		Taraxacum officinale		R	GC	
		Achillea millefolium		R	GC	
		Oeothera biennis		R	GC	
		Plantago major		R	GC	
		Plantago lanceolata		R	GC	
		Lythrum salicaria		R	GC	
		Senecio vulgaris		C	GC	
		Hieracium canadense		C	GC	
		Potentilla simplex		O	GC	
		Cladonia cristatella		O	GC	
Plant Community 6 - Dredge Spoil Wetland/Successional Southern Hardwoods						
E	2	*Populus deltoides*		D	C	
		Lythrum salicaria		C	GC	
		Phragmites australis		C	GC	
		Juncus bufonius		C	GC	
		Juncus effusus		O	GC	
E	3	*Scirpus cyperinus*		O	GC	
		Juniperus virginiana		R	C	
		Malus sp.		R	U	
		Platanus occidentalis		R	SC	
	4	*Populus deltoides*		D	O	
		Acer negundo		C	SC	
		Ailanthus altissima		C	SC	
		Cornus amomum		C	U	
		Malus sp.		R	SC	
		Acer rubrum		O	SC	
		Juniperus virginiana		R	SC	
		Lonicera tatarica		C	U	

Southern Energy Bowline Unit 3
Haverstraw, New York

Appendix 9B
VEGETATION SAMPLING DATA

	Plot	Species		Cover Class	Strata	Other
		Prunus sp.		R	U	
		Morus alba		C	SC	
		Ulmus americana		R	SC	
		Phragmites australis		D	GC	
		Solidago speciosa		C	GC	
		Parthenocissus quinquefolia		C	GC	
		Lonicera japonica		C	GC	
		Rhus radicans		C	GC	
		Aster patens		R	GC	
		Eleagnus augustifolia		R	U	
		Celastrus scandens		C	GC	
Plant Community 4 - Dredge Spoil Wetland/Shallow Emergent Marsh						
	5	UNKGRASS		C	GC	
		Achillea millefolium		C	GC	
		Artemisia vulgaris		C	GC	
		Rubus odoratus		O	GC	
		Lythrum salicaria		O	GC	
		Phragmites australis		D	GC	
		Aster patens		C	GC	
		Lonicera tatarica		R	U	
		Robinia pseudoacacia		O	O	
Plant Community 3 - Dredge Spoils/Successional Southern Hardwoods						
	6	*Alliaria officinalis*		O	GC	
		Acer negundo		D	O	
		Populus deltoides		D	O	
		Prunus serotina		O	SC	
	7	*Acer negundo*		C	SC	
		Cornus stolonifera		R	U	
		Lonicera japonica		D	GC	
		Parthenocissus quinquefolia		C	GC	
		Betula populifolia		O	SC	
		Acer saccharinum		R	C	
		Rhamnus cathartica		R	U	
		Rubus odoratus		O	GC	
		Alliaria officinalis		C	GC	
Plant Community 3 - Dredge Spoil Wetland/Successional Southern Hardwoods						
	8	*Populus deltoides*		D	C	
		Salix sp.		O	SC	
		Cornus amomum		O	U	

Southern Energy Bowline Unit 3
Haverstraw, New York

Appendix 9B
VEGETATION SAMPLING DATA

	Plot	Species		Cover Class	Strata	Other
		Phragmites australis		D	GC	
		Lythrum salicaria		C	GC	
F	9	*Salix fragilis*		D	C	
		Populus deltoides		C	O	
		Fraxinus americana		C	O	
		Cornus amomum		D	U	
		Ulmus americana		R	SC	
		Alliaria officinalis		C	GC	
		Phragmites australis		D	GC	
		Lonicera japonica		C	SC	
		Ribes americanum		C	SC	
Plant Community 3 - Dredge Spoils/Successional Southern Hardwoods						
	10	*Solanum dulcamara*		O	GC	
		Populus deltoides		D	C	
		Ulmus americana		C	C	
		Acer negundo		C	C	
		Fraxinus americana		C	SC	
		Morus alba		O	SC	
		Lonicera japonica		D	SC	
		Alliaria officinalis		C	GC	
		Acer negundo		C	SC	
		Cornus amomum		C	U	
		Parthenocissus quinquefolia		C	GC	
		Rhus radicans		C	GC	
		Celastrus scandens		C	GC	
		Juniperus virginiana		R	SC	
		Morus alba		R	C	
		Phytolacca americana		O	GC	
		Fraxinus americana		C	C	
		Acer platanoides		R	SC	
		Rubus allegheniensis		O	GC	
		Rhus typhina		R	SC	
		Phragmites australis		O	GC	
		Viburnum recognitum		R	U	
		Betula populifolia		O	SC	
		Geum sp.		O	GC	
		Ulmus americana		C	SC	
		Rubus odorata		O	GC	
		Artemisia vulgaris		C	GC	
		Vicia sp.		O	GC	
		Baptisia australis		R	GC	
		Acer saccharinum		O	C	
	11	*Vitus aestivalis*		R	GC	

Southern Energy Bowline Unit 3

Haverstraw, New York

Appendix 9B

VEGETATION SAMPLING DATA

	Plot	Species		Cover Class	Strata	Other
		Populus deltoides		D	C	
		Populus deltoides		D	SC	
		Baptisia australis		O	GC	
		Lythrum salicaria		C	GC	
		Solidago sp.		C	GC	
	12	*Fragaria virginiana*		C	GC	
		Carex lurida		R	GC	
		Solidago sp.		C	GC	
		Aster patens		R	GC	
		Verbascum thapsus		C	GC	
		Cornus amomum		C	U	
		Ailanthus altissima		C	C	
		Platanus occidentalis		R	C	
		Lonicera japonica		O	GC	
	13	*Cornus amomum*		C	U	
		Vitus aestivalus		C	SC	
		Phragmites australis		D	GC	
		Lythrum salicaria		C	GC	
		Cornus stolonifera		C	U	
		Eupatorium rugosum		R	GC	
Plant Community 2 - Dredge Spoils/Successional Old Field						
	14	*Artemisia vulgaris*		C	GC	
		Eupatorium perfoliatum		O	GC	
		Solidago sp.		C	GC	
		Melilotus alba		O	GC	
		Carex sp.		O	GC	
		Fragaria virginiana		O	GC	
		Verbascum thapsus		O	GC	
		Celastrus scandens		O	GC	
		Lonicera japonica		C	GC	
		Apocynum androsaemifolium		C	GC	
		Ailanthus altissima		R	SC	
		Populus deltoides		R	C	
Plant Community 3 - Dredge Spoils/Successional Southern Hardwoods						
	15	*Populus deltoides*		D	C	
		Acer saccharinum		R	C	
		Robinia pseudo-acacia		R	C	
		Celastrus scandens		D	SC	
		Juniperus virginiana		O	SC	
		Rhus typhina		O	SC	
		Cornus amomum		C	U	

Appendix 9C

Appendix 9-C: Potential Wildlife Species Present at the Proposed Bowline Unit 3 Development Site.

Family	Common Name	Scientific Name	Guild (a)	Forage Method	Breeding Substrate	Urban Lot	Old Field	Southern Hardwoods	Stream	Pond	Shallow Marsh	Shrub Swamp	Forested Wetland
Amphibians													
Bufonidae	Eastern American Toad	*Bufo a. americanus*	I	Ground Ambusher	Water	X	X	X		X	X	X	X
	Fowler's Toad	*Bufo woodhousei fowleri*	I	Ground Ambusher	Water					X			X
Hylidae	Gray Treefrog	*Hyla versicolor*	I	Bark Ambusher	Water					X			X
	Northern Spring Peeper	*Pseudacris c. crucifer*	I	Riparian Ambusher	Water					X	X	X	X
Plethodontidae	Redback Salamander	*Plethodon c. cinereus*	I	Ground Gleaner	Terrestrial Subsurface			X					X
Ranidae	Bullfrog	*Rana catesbeiana*	C	Water Ambusher	Water				X	X			
	Green Frog	*Rana clamitans melanota*	I	Riparian Ambusher	Water				X	X	X	X	
	Pickerel Frog	*Rana palustris*	I	Riparian Ambusher	Water				X	X			
	Wood Frog	*Rana sylvatica*	I	Ground Ambusher	Water			X					X
Salamandridae	N. Dusky Salamander	*Desmognathus fuscus*	I	Water Gleaner	Riparian Subsurface				X				
	N. Two-lined Salamander	*Eurycea bislineata*	I	Water Gleaner	Water				X				
	Red-spotted Newt	*Notophthalmus viridescens*	I	Water Gleaner	Water					X			
Birds													
Accipitridae	*Red-tailed Hawk	*Buteo jamaicensis*	C	Ground Pouncer	Tree-Branch	X	X	X					
	Sharp-shinned Hawk	*Accipiter striatus*	C	Air Hawker	Tree-Branch		X	X					X
Alcedinidae	Belted Kingfisher	*Ceryle alcyon*	P	Water Plunger	Riparian Subsurface			X	X	X			
Anatidae	American Black Duck	*Anas rubripes*	O	Water Forager	Riparian Ground				X	X			
	*Canada Goose	*Branta canadensis*	H	Ground Grazer	Riparian Ground	X			X	X	X		
	*Mallard	*Anas platyrhynchos*	G	Water Forager	Riparian Ground				X	X	X		
Apodidae	Chimney Swift	*Chaetura pelagica*	I	Air Screener	Buildings	X							
Ardeidae	Great Blue Heron	*Ardea herodias*	C	Water Ambusher	Riparian Twig-Branch				X	X			
	Green-backed Heron	*Butorides striatus*	C	Water Ambusher	Riparian Shrub				X	X			
Bombycillidae	Cedar Waxwing	*Bombycilla cedrorum*	F	Upper Canopy Gleaner	Tree-Twig		X					X	X
Certhiidae	Brown Creeper	*Certhia americana*	I	Bark Gleaner	Tree Cavity-Crevice			X					X
Charadriidae	Killdeer	*Charadrius vociferus*	I	Ground Gleaner	Ground-Herb	X							
Columbidae	*Mourning Dove	*Zenaida macroura*	G	Ground Gleaner	Tree-Branch	X	X	X					X
	*Rock Dove	*Columba livia*	O	Ground Gleaner	Buildings	X							
Corvidae	*American Crow	*Corvus brachyrhynchos*	O	Ground Gleaner	Tree-Branch	X	X	X					X
	*Blue Jay	*Cyanocitta cristata*	O	Ground Gleaner	Tree-Branch		X	X					X
Cuculidae	Black-billed Cuckoo	*Coccyzus erythropthalmus*	I	Lower Canopy Gleaner	Tree-Branch		X	X				X	
	Yellow-billed Cuckoo	*Coccyzus americanus*	I	Lower Canopy Gleaner	Tree-Branch		X	X					
Falconidae	American Kestrel	*Falco sparverius*	C	Ground Pouncer	Tree Cavity-Crevice	X							
Fringillidae	*American Goldfinch	*Carduelis tristis*	O	Ground Gleaner	Shrub		X				X	X	X
	American Tree Sparrow	*Spizella arborea*	O	Ground Gleaner		X	X				X	X	
	Chipping Sparrow	*Spizella passerina*	O	Ground Gleaner	Shrub	X							
	Dark-eyed Junco	*Junco hyemalis*	G	Ground Gleaner		X	X	X					X
	Evening Grosbeak	*Coccothraustes vespertinus*	G	Ground Gleaner			X						X
	Field Sparrow	*Spizella pusilla*	O	Ground Gleaner	Ground-Herb		X						
	Fox Sparrow	*Passerella iliaca*	O	Ground Gleaner			X						

Appendix 9-C: Potential Wildlife Species Present at the Proposed Bowline Unit 3 Development Site.

Family	Common Name	Scientific Name	Guild (a)	Forage Method	Breeding Substrate	Urban Lot	Old Field	Southern Hardwoods	Stream	Pond	Shallow Marsh	Shrub Swamp	Forested Wetland
	Indigo Bunting	*Passerina cyanea*	I	Lower Canopy Gleaner	Ground-Herb		X						X
	*Northern Cardinal	*Cardinalis cardinalis*	O	Ground Gleaner	Shrub				X			X	X
	Pine Siskin	*Carduelis pinus*	G	Ground Gleaner		X	X						X
	Rose-breasted Grosbeak	*Pheucticus ludovicianus*	O	Lower Canopy Gleaner	Tree-Twig		X	X					X
	*Song Sparrow	*Melospiza melodia*	O	Ground Gleaner	Ground-Herb	X	X				X	X	X
Fringillidae	Swamp Sparrow	*Melospiza georgiana*	I	Ground Gleaner	Riparian Ground						X	X	
	*White-throated Sparrow	*Zonotrichia albicollis*	G	Ground Gleaner		X	X						
Hirundinidae	*Barn Swallow	*Hirundo rustica*	I	Air Screener	Buildings	X	X						
	*Cliff Swallow	*Hirundo pyrrhonota*	I	Air Screener	Buildings	X	X						
	Tree Swallow	*Tachycineata bicolor*	I	Air Screener	Tree Cavity-Crevice	X	X		X	X	X		
Icteridae	Baltimore Oriole	*Icterus galbula*	O	Upper Canopy Gleaner	Tree-Twig			X					X
	*Brown-headed Cowbird	*Molothrus ater*	O	Ground Gleaner	Nest Parasite	X	X	X			X		X
	*Common Grackle	*Quiscalus quiscula*	O	Ground Gleaner	Tree-Branch	X				X	X	X	X
	*Red-winged Blackbird	*Agelaius phoeniceus*	O	Ground Gleaner	Shrub					X	X	X	
Laridae	Herring Gull	*Larus argentatus*	C	Coastal Scavenger	Beach-Rock-Dune	X				X			
Mimidae	Brown Thrasher	*Toxostoma rufum*	O	Ground Gleaner	Shrub		X						X
	*Gray Catbird	*Dumetella carolinensis*	O	Ground Gleaner	Shrub		X					X	X
	*Northern Mockingbird	*Mimus polyglottos*	O	Ground Gleaner	Shrub		X						
Paridae	*Black-capped Chickadee	*Parus atricapillus*	I	Lower Canopy Gleaner	Tree Cavity-Crevice		X	X				X	X
	*Tufted Titmouse	*Parus bicolor*	I	Lower Canopy Gleaner	Tree Cavity-Crevice			X					X
Parulidae	American Redstart	*Setophaga ruticilla*	I	Lower Canopy Gleaner	Tree-Twig			X					X
	*Black-and-White Warbler	*Mniotilta varia*	I	Bark Gleaner	Ground-Herb			X					X
	Blue-winged Warbler	*Vermivora pinus*	I	Lower Canopy Gleaner	Ground-Herb		X						
	Chestnut-sided Warbler	*Dendroica pensylvanica*	I	Lower Canopy Gleaner	Shrub		X						
	*Common Yellowthroat	*Geothlypis trichas*	I	Lower Canopy Gleaner	Ground-Herb		X		X		X	X	X
	Ovenbird	*Seiurus aurocapillus*	I	Ground Gleaner	Ground-Herb			X					X
	*Palm Warbler	*Dendroica palmarum*	I	Ground Gleaner	Ground-Herb							X	
	Prairie Warbler	*Dendroica discolor*	I	Lower Canopy Gleaner	Shrub		X						
	*Yellow Warbler	*Dendroica petechia*	I	Lower Canopy Gleaner	Shrub		X		X			X	
	*Yellow-rumped Warbler	*Dendroica coronata*	I	Lower Canopy Gleaner	Tree-Branch		X					X	X
Phasianidae	Ring-necked Pheasant	*Phasianus colchicus*	O	Ground Gleaner	Ground-Herb		X				X		
Picidae	*Downy Woodpecker	*Picoides pubescens*	I	Bark Gleaner	Tree Cavity-Crevice			X					X
	Hairy Woodpecker	*Picoides villosus*	I	Bark Gleaner	Tree Cavity-Crevice			X					
	*Northern Flicker	*Colaptes auratus*	I	Ground Gleaner	Tree Cavity-Crevice	X	X	X					X
	Pileated Woodpecker	*Dryocopus pileatus*	I	Bark Excavator	Tree Cavity-Crevice			X					
	*Red-bellied Woodpecker	*Melanerpes carolinus*	I	Bark Gleaner	Tree Cavity-Crevice			X					
	Yellow-bellied Sapsucker	*Sphyrapicus varius*	I	Bark Gleaner				X					X
Ploceidae	*House Sparrow	*Passer domesticus*	G	Ground Gleaner	Buildings	X	X						
Scolopacidae	Spotted Sandpiper	*Actitis macularia*	O	Riparian Gleaner	Ground-Herb				X	X			
Sittidae	*White-breasted Nuthatch	*Sitta carolinensis*	I	Bark Gleaner	Tree Cavity-Crevice			X					X
Strigidae	Eastern Screech-Owl	*Otus asio*	C	Ground Pouncer	Tree Cavity-Crevice		X	X					X
	Great Horned Owl	*Bubo virginianus*	C	Ground Pouncer	Tree-Branch		X	X					X

Appendix 9-C: Potential Wildlife Species Present at the Proposed Bowline Unit 3 Development Site.

Family	Common Name	Scientific Name	Guild (a)	Forage Method	Breeding Substrate	Urban Lot	Old Field	Southern Hardwoods	Stream	Pond	Shallow Marsh	Shrub Swamp	Forested Wetland
Sturnidae	European Starling	*Sturnus vulgaris*	O	Ground Gleaner	Buildings	X							
Sylviidae	*Blue-gray Gnatcatcher	*Polioptila caerulea*	I	Upper Canopy Gleaner	Tree-Branch		X					X	X
	*Golden-crowned Kinglet	*Regulus satrapa*	I	Lower Canopy Gleaner									X
Tetraonidae	Ruffed Grouse	*Bonasa umbellus*	O	Ground Gleaner	Ground-Herb			X					X
Thraupidae	Scarlet Tanager	*Piranga olivacea*	I	Upper Canopy Gleaner	Tree-Twig			X					X
Trochilidae	Ruby-throated Hummingbird	*Archilochus colubris*	O	Floral Hover-Gleaner	Tree-Branch		X	X					X
Troglodytidae	*Carolina Wren	*Thryothorus ludovicianus*	I	Lower Canopy Gleaner	Tree Cavity-Crevice		X						X
	House Wren	*Troglodytes aedon*	I	Lower Canopy Gleaner	Tree Cavity-Crevice		X	X					X
	Winter Wren	*Troglodytes troglodytes*	I	Ground Gleaner								X	
Turdidae	*American Robin	*Turdus migratorius*	O	Ground Gleaner	Tree-Branch	X	X	X					X
	Veery	*Catharus fuscescens*	O	Ground Gleaner	Ground-Herb			X					X
	*Wood Thrush	*Hylocichla mustelina*	O	Ground Gleaner	Tree-Branch			X					X
Tyrannidae	Eastern Kingbird	*Tyrannus tyrannus*	I	Air Sallier	Tree-Twig	X	X			X			
	*Eastern Phoebe	*Sayornis phoebe*	I	Air Sallier	Buildings		X	X				X	
	Eastern Wood-Pewee	*Contopus virens*	I	Air Sallier	Tree Branch			X					X
	Least Flycatcher	*Empidonax minimus*	I	Air Sallier	Tree-Branch			X					X
Vireonidae	Red-eyed Vireo	*Vireo olivaceus*	I	Upper Canopy Gleaner	Tree-Twig			X					X
	Warbling Vireo	*Vireo gilvus*	I	Upper Canopy Gleaner	Tree-Twig			X					
Mammals													
Canidae	Coyote	*Canis latrans*	O	Ground Forager	Terrestrial Subsurface		X	X			X	X	X
	Gray Fox	*Urocyon cinereoargenteus*	O	Ground Forager	Ground-Herb		X	X			X	X	X
	*Red Fox	*Vulpes vulpes*	O	Ground Forager	Terrestrial Subsurface	X	X	X			X	X	X
Cervidae	*White-tailed Deer	*Odocoileus virginianus*	H	Ground Grazer	Ground-Herb		X	X			X	X	X
Cricetidae	Deer Mouse	*Peromyscus maniculatus*	O	Ground Forager	Terrestrial Subsurface		X	X					X
	Meadow Vole	*Microtus pennsylvanicus*	H	Ground Grazer	Terrestrial Subsurface		X				X		
	*Muskrat	*Ondatra zibethicus*	H	Water Grazer	Riparian Subsurface				X	X			
	S. Red-backed Vole	*Clethrionomys gapperi*	H	Ground Grazer	Terrestrial Subsurface			X				X	X
	White-footed Mouse	*Peromyscus leucopus*	O	Ground Forager	Terrestrial Subsurface	X	X	X				X	X
	Woodland Vole	*Microtus pinetorum*	H	Ground Grazer	Terrestrial Subsurface			X					X
Didelphidae	Virginia Opossum	*Didelphis virginiana*	O	Ground Forager	Tree Cavity-Crevice	X	X	X			X	X	X
Leporidae	*Eastern Cottontail	*Sylvilagus floridanus*	H	Ground Grazer	Ground-Herb	X	X				X		
Muridae	House Mouse	*Mus musculus*	O	Ground Forager	Buildings	X	X						
	Norway Rat	*Rattus norvegicus*	O	Ground Forager	Terrestrial Subsurface	X	X						
Mustelidae	Ermine	*Mustela erminea*	C	Ground Pursuer	Ground-Herb		X	X				X	X
	Long-tailed Weasel	*Mustela frenata*	C	Ground Pursuer	Terrestrial Subsurface		X	X				X	X
	Mink	*Mustela vison*	P	Water Diver	Riparian Subsurface			X	X	X		X	X
	Striped Skunk	*Mephitis mephitis*	O	Ground Forager	Terrestrial Subsurface	X	X	X			X	X	X
Procyonidae	Raccoon	*Procyon lotor*	O	Ground Forager	Tree Cavity-Crevice	X	X	X	X	X	X	X	X
Sciuridae	Eastern Chipmunk	*Tamias striatus*	G	Ground Forager	Terrestrial Subsurface		X	X					
	*Gray Squirrel	*Sciurus carolinensis*	G	Ground Forager	Tree Cavity-Crevice			X					
	S. Flying Squirrel	*Glaucomys volans*	G	Ground Forager	Tree Cavity-Crevice			X					

Appendix 9-C: Potential Wildlife Species Present at the Proposed Bowline Unit 3 Development Site.

Family	Common Name	Scientific Name	Guild (a)	Forage Method	Breeding Substrate	Urban Lot	Old Field	Southern Hardwoods	Stream	Pond	Shallow Marsh	Shrub Swamp	Forested Wetland
	*Woodchuck	*Marmota monax*	H	Ground Grazer	Terrestrial Subsurface	X	X	X					
Soricidae	N. Short-tailed Shrew	*Blarina brevicauda*	I	Ground Gleaner	Terrestrial Subsurface		X	X				X	X
Vespertilionidae	Big Brown Bat	*Eptesicus fuscus*	I	Air Hawker	Buildings	X	X		X	X	X	X	
	Little Brown Bat	*Myotis lucifugus*	I	Air Hawker	Buildings	X	X		X	X	X	X	
	Red Bat	*Lasiurus borealis*	I	Air Hawker	Tree-Twig	X	X	X	X	X	X	X	
Zapodidae	Meadow Jumping Mouse	*Zapus hudsonius*	O	Ground Forager	Ground-Herb		X						
	Woodland Jumping Mouse	*Napaeozapus insignis*	O	Ground Forager	Ground-Herb		X	X					X
Reptiles													
Chelydridae	Snapping Turtle	*Chelydra serpentina*	O	Bottom Forager	Riparian Subsurface				X	X			
Colubridae	Black Rat Snake	*Elaphe o. obsoleta*	C	Ground Ambusher	Terrestrial Subsurface		X						
	E. Smooth Green Snake	*Opheodrys v. vernalis*	I	Ground Ambusher	Terrestrial Subsurface		X	X			X		
	*Eastern Garter Snake	*Thamnophia s. sirtalis*	C	Ground Ambusher	Terrestrial Subsurface	X	X	X		X	X	X	
Colubridae	Eastern Milk Snake	*Lampropeltis t. triangulum*	C	Ground Ambusher	Terrestrial Subsurface	X		X					
	Eastern Ribbon Snake	*Thamnophis s. sauritus*	C	Water Ambusher	Riparian Subsurface				X	X	X		
	Northern Brown Snake	*Storeria d. dekayi*	I	Ground Ambusher	Terrestrial Subsurface	X	X	X				X	
	Northern Redbelly Snake	*Storeria o. occipitomaculata*	I	Ground Ambusher	Terrestrial Subsurface			X				X	
	Northern Water Snake	*Nerodia s. sipedon*	C	Water Ambusher	Riparian Subsurface				X	X			
Emydidae	*Eastern Painted Turtle	*Chrysemys p. picta*	O	Bottom Forager	Terrestrial Subsurface				X	X			

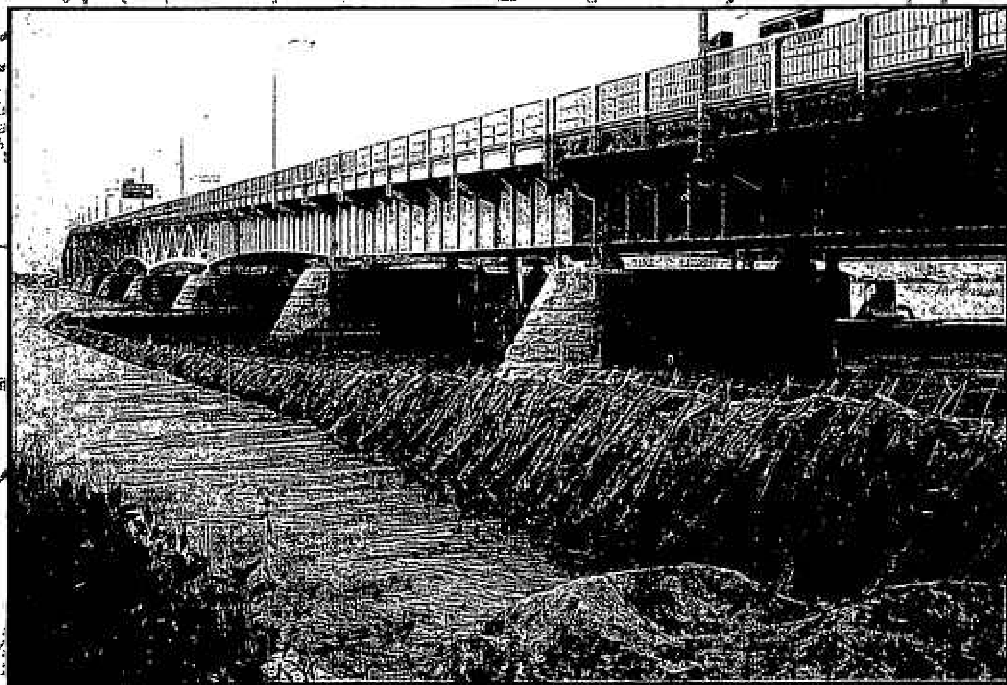
* Species (or sign) observed on the site during site visits by TRC Environmental.

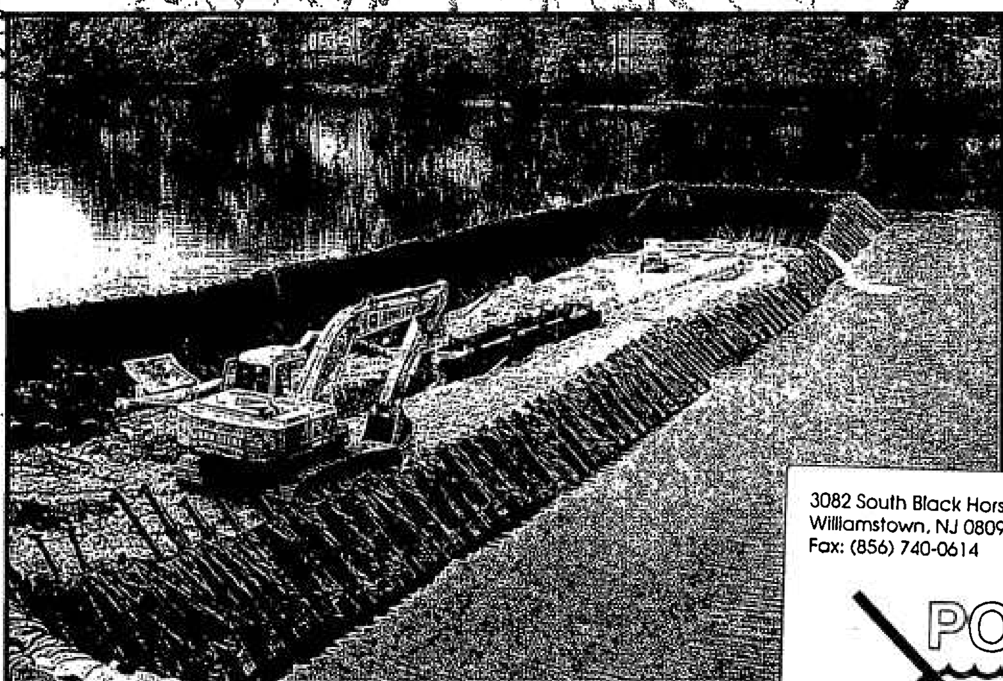
(a) Guilds include:
C: Carnivore G: Granivore I: Insectivore P: Piscivore
F: Frugivore H: Herbivore O: Omnivore

Appendix 9D

PORTADAM, INC.

DIVERSION AND COFFERDAM STRUCTURES





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WILLIAM H. STRE
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Phone: (856) 740-06C

PORTADAM, INC.

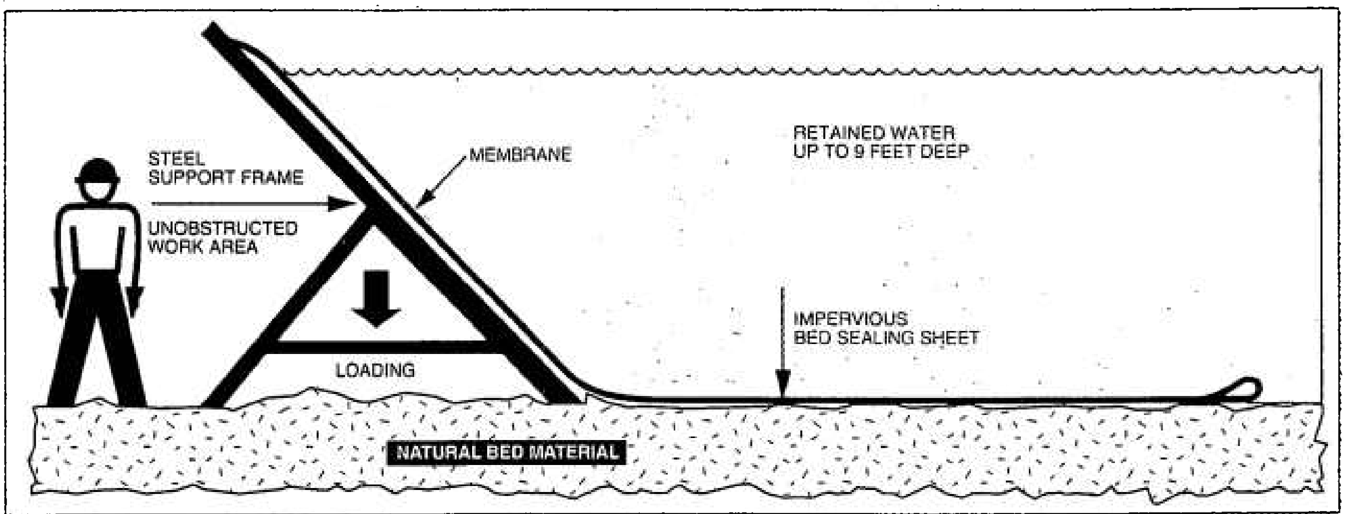
DIVERSION AND COFFERDAM STRUCTURES

E-Mail: portadam@eticomm.net

website:www.portadam.con
(800) 346-479

With today's ever growing concerns over environmental issues, Portadam, Inc. is equipped to provide you with approved technologies, recognized throughout the U.S. as the clean alternative to water diversion and cofferdamming.

We view each potential project with a plan to provide a clean, feasible, engineered product to assist agencies and contractors in a combined effort to keep our water ways pristine for future generations. We pride ourselves in finding solutions to complex water control problems.

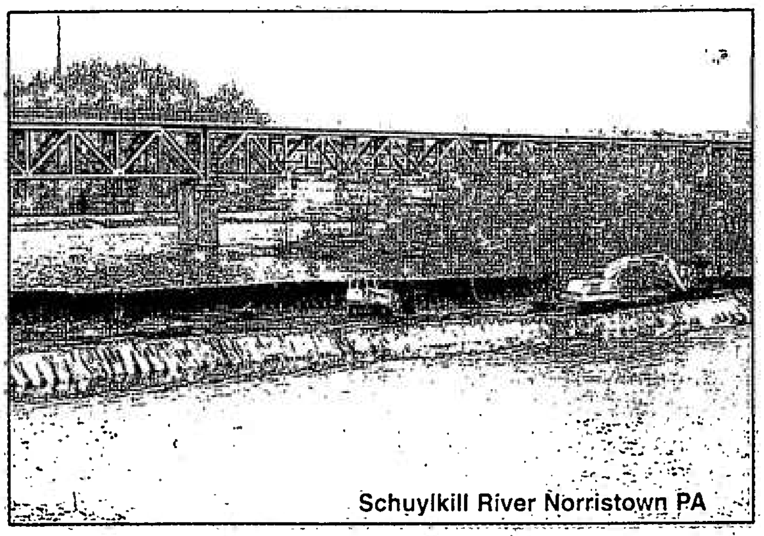


The **PORTADAM** concept utilizes a steel supporting structure with a continuous reinforced vinyl liner membrane to effectively provide a means of water diversion, retention or impoundment. The support structure is designed to transfer hydraulic loading to a near vertical load, thereby creating a free-standing structure with no back bracing to interfere with your work area. The liner system is very flexible, creating ease of sealing over most irregular contours. This system can be installed almost anywhere, in any configuration and to any length. The equipment is offered as a rental item in heights of **3', 5', 7' and 10'.**

If you have a need to control standing or flowing water, whether for construction, repair of structures, flood control, storage or diversion - let us help you. Portadam, Inc. offers free consultation, site surveys and budget pricing. We can handle your water control problems. Review a sampling of the various types of projects we have successfully handled in the past.

INDEX

On The Cover: Bridge Piers, Grand Island, NY; Pipeline Crossing, Christiansburg, VA.

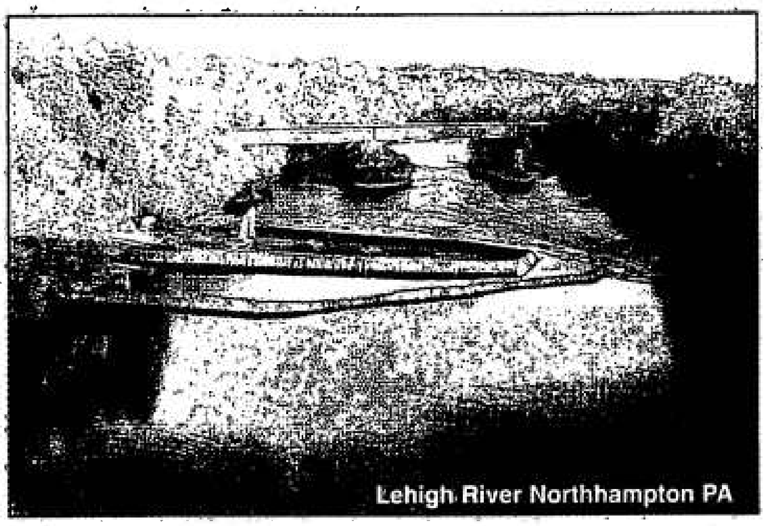


Schuylkill River Norristown PA

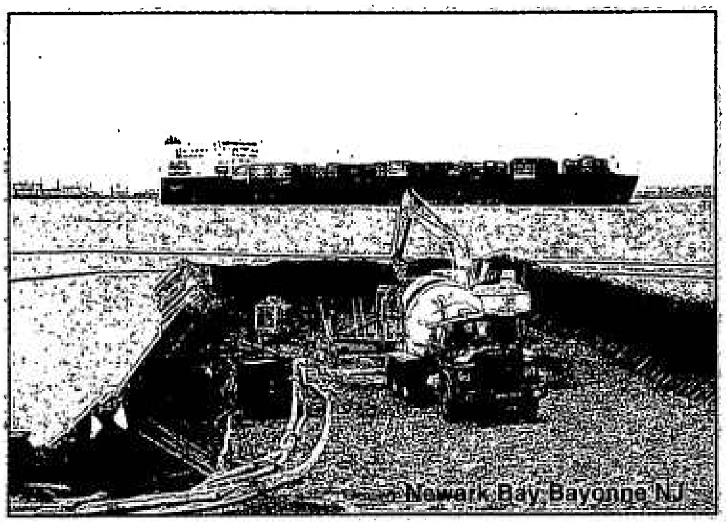
The PORTADAM system has proven to be a clean and effective method of performing open cut construction of pipelines across rivers and streams. A two phase operation allows for unimpeded flow of water around the work site while offering a clean cofferdam system with NO introduction of harmful materials to the water course.

Adjustment of the river or stream bed prior to installation is normally NOT required. Flexibility of the PORTADAM system equipment allows for installation over irregular contours and around obstructions.

PORTADAM, INC.
DIVERSION AND COFFERDAM STRUCTURES



Lehigh River Northhampton PA



Newark Bay Bayonne NJ

The "free-standing" characteristic of this system leaves the work area unobstructed, completely free of cross bracing, allowing the pipeline installation to proceed directly from the land portion directly to the river bed. Since no fill material is required, excavation depths are greatly reduced. Concrete encasement can be poured in the dry without fear of water course contamination.

DAM REHABILITATION

Low head dam rehabilitation and retrofit can easily be accomplished behind a PORTADAM cofferdam system. Water flow can be diverted to one side of the river in a two phase construction sequence or diverted through an alternate bypass channel.

Dennisville Lake Dennisville NJ

D & R Canal Trenton NJ

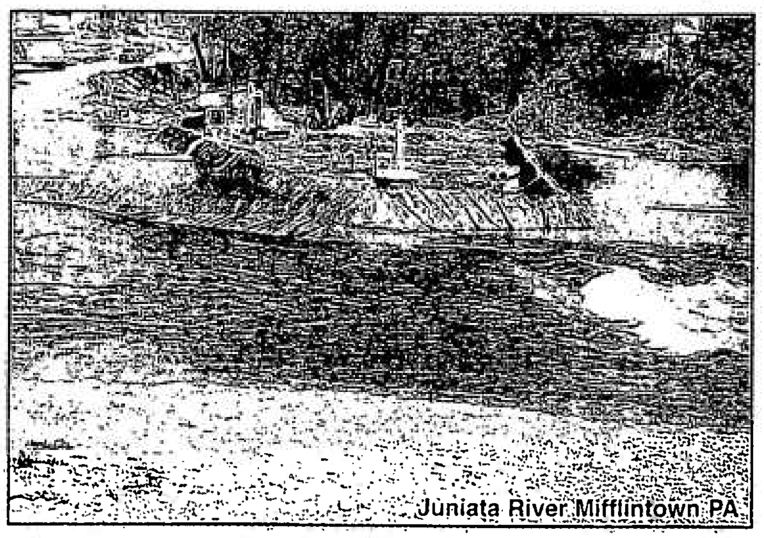
The PORTADAM equipment steel framework and liner components adapt easily to the spillway shape to construct a continuous cofferdam line, both upstream and downstream.

PORTADAM, INC.
DIVERSION AND COFFERDAM STRUCTURES

Dewatering upstream of a hydro plant intake structure could facilitate repair or replacement of old trash-racks. PORTADAM technology is also used for tailrace area de-watering, gate replacement and concrete spillway repairs. This equipment offers plant operators alternatives for dewatering areas without the problems associated with earthfill or the costs of sheet piling operations.

West Canada Creek
Herkimer NY

INTAKE & OUTFALL PIPELINES AND STRUCTURES



Juniata River Mifflintown PA

Concrete intake structures situated along the edge of a river or lake can be repaired or constructed in a dry work area behind a PORTADAM system. The system can be installed in a 3-sided configuration to provide access into the water body without adverse effects to the water system.

This cofferdam method produces an unobstructed work area for excavation and forming as required to construct a new intake structure.

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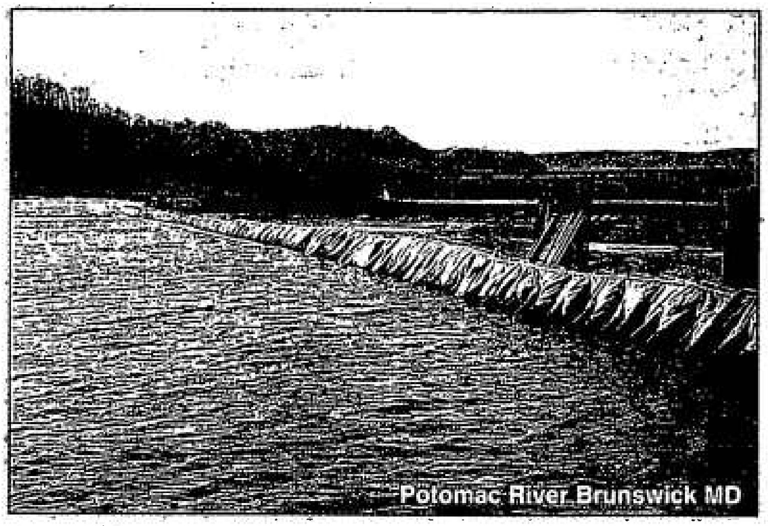
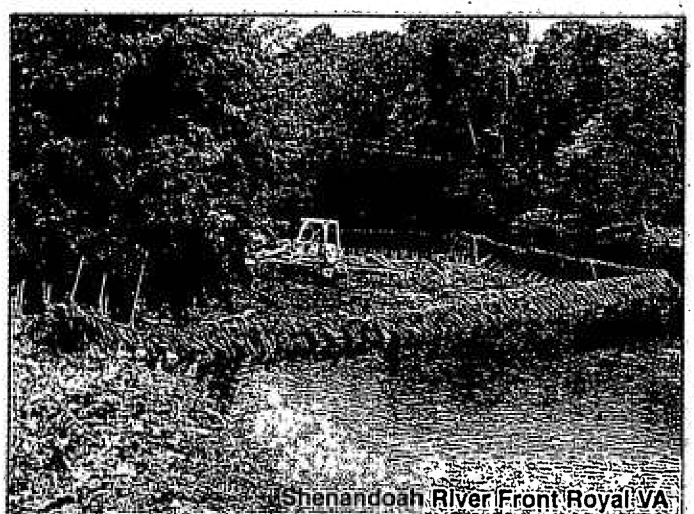
DIVERSION AND COFFERDAM STRUCTURES



Potomac River Brunswick MD

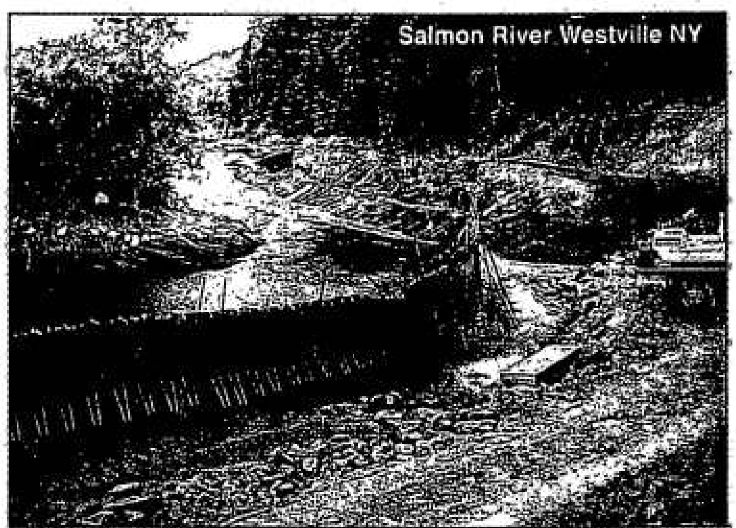


Shenandoah River Front Royal VA

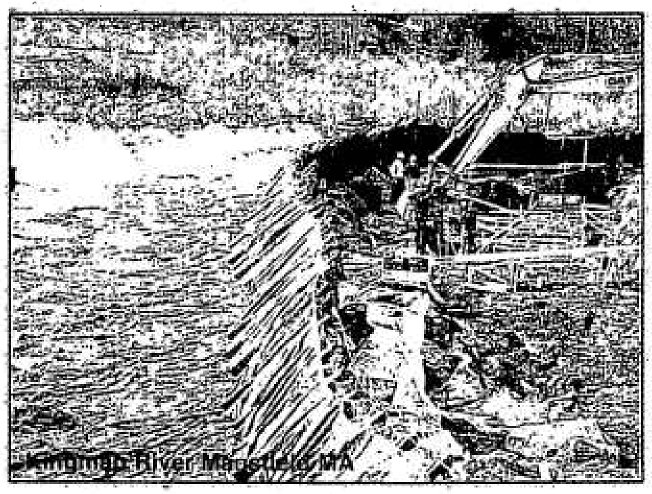
Outfall pipelines with diffuser sections are easily installed in the dry behind a PORTADAM structure. The Portadam system provides river bed access in an unobstructed work area for trench excavation, pipe assembly and concrete encasement. Typically, NO river bed preparation or fill material is required to install a PORTADAM system. NO costly fill removal or contour grade adjustments are required after removal of the PORTADAM system. The water course remains virtually unaffected.

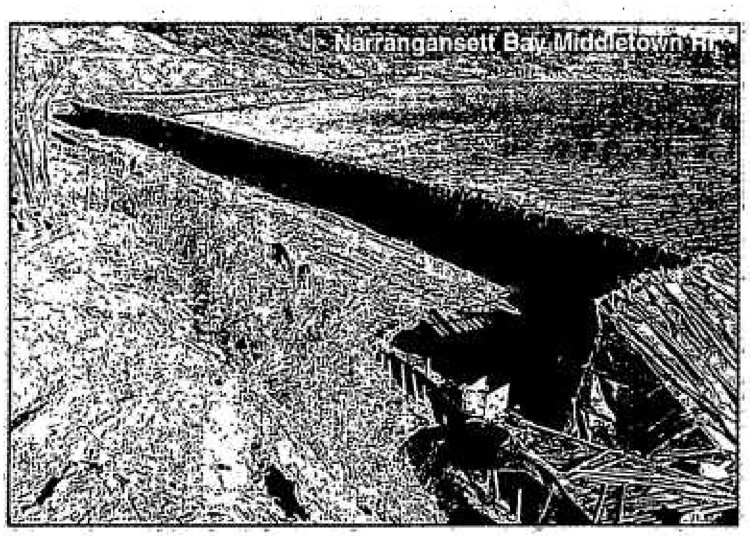
BANK RESTORATION AND STREAM CHANNELIZATION

The flexibility of the PORTADAM system equipment allows for installation in practically any configuration and over almost any contour. This feature permits installation along stream banks for restoration such as bulkheads, gabion structures, architectural walls and geoliners.


Salmon River Westville NY


Coeurd'Alene River Kellogg ID


Kingman River Mansfield MA


Narragansett Bay Middletown RI

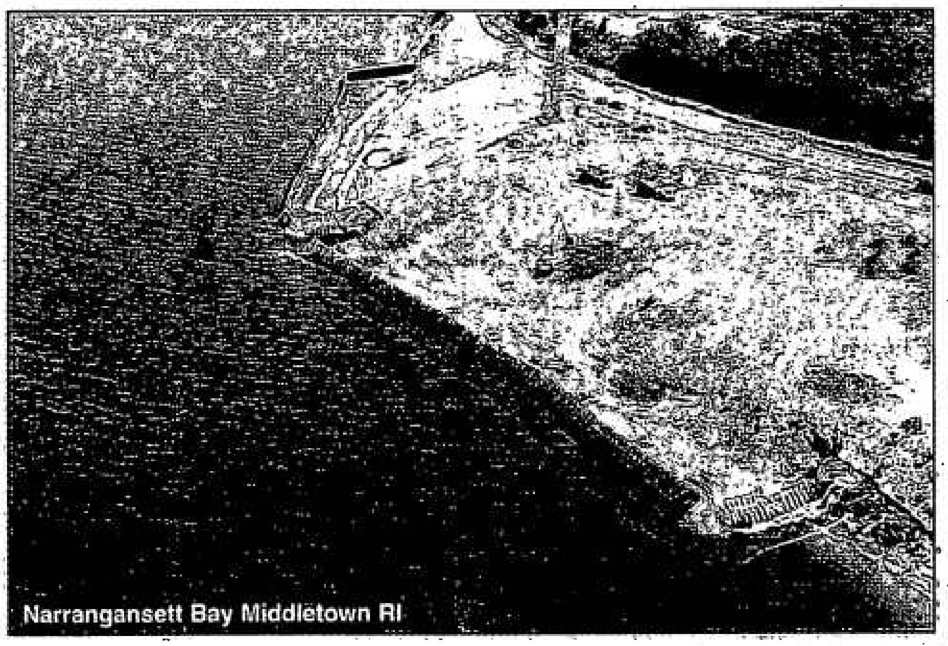
Dewatering these work areas allows for better control of excavation at toe of slope, so that proper "key-in" can be made to achieve the best possible construction techniques.

PORTADAM, INC.
DIVERSION AND COFFERDAM STRUCTURES


Raritan River Bound Brook NJ

Keeping the affected area separated from the clean area is a major consideration on all HazMat remediation sites. Especially in water, there is a great advantage to keeping the clean water from making contact with the contaminated materials.

The PORTADAM system offers an effective method of surrounding an in-water remediation site and separating the clean water from the work area while maintaining natural stream or river flow. In addition, by working in a dry area, excavated material de-watering is minimized.


Narragansett Bay Middletown RI

This cofferdam method is clean and re-usable. It can be utilized in a multi-phase remediation project while offering clear, unobstructed access to the work area (lake or river bed). No fill material is typically required, therefore the customer does not ADD more contaminated materials to the site to be remediated.

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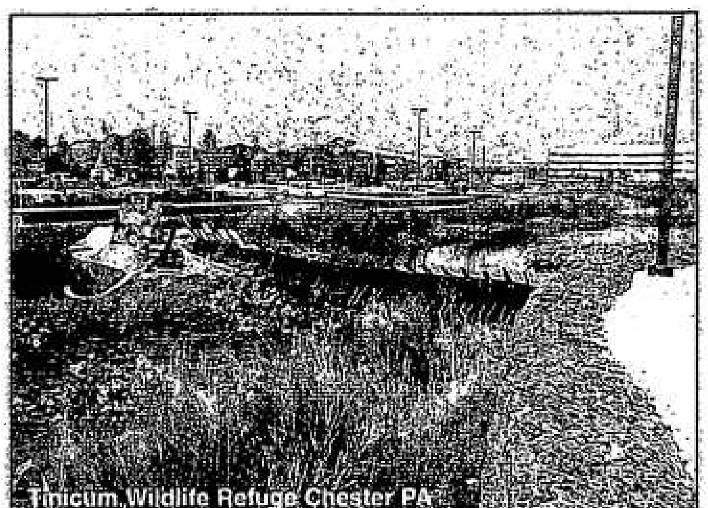
DIVERSION AND COFFERDAM STRUCTURES

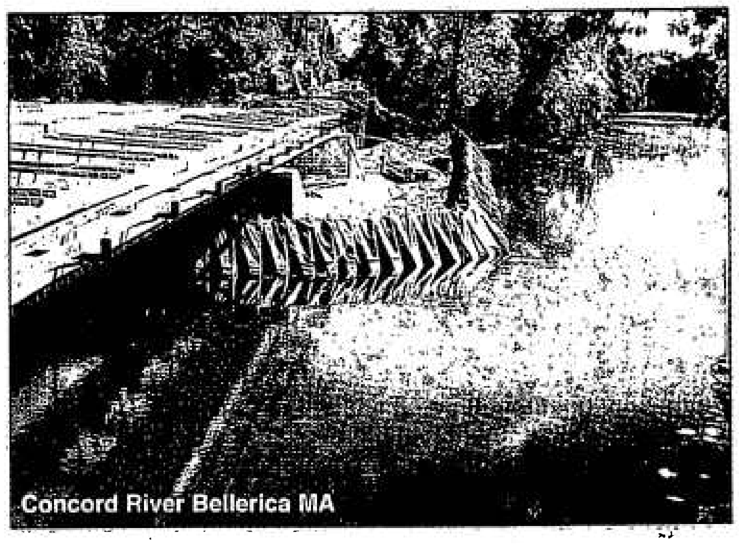

Tinicum Wildlife Refuge Chester PA

BRIDGE PIERS (Rehabilitation & New Construction)

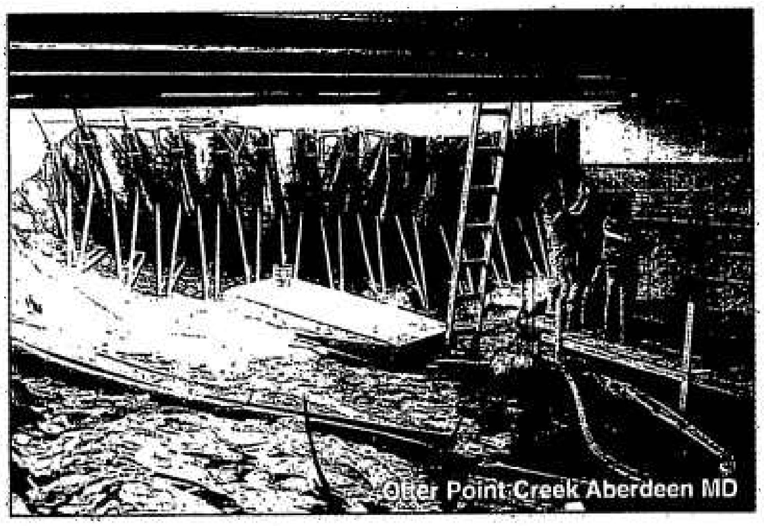
Portadam can be installed in virtually any configuration. Also, since it is a light weight system, it can be installed under existing spans, allowing for continued traffic flow. Span removal is not required as with driven sheeting methods.

Culvert rehabilitation is made easy by de-watering or diverting stream flows with the Portadam system.

If the bridge pier work area is close to shore, the customer might opt for a 3-sided cofferdam structure so that they can access the pier directly from the shore. This configuration will allow for construction equipment and supplies to be utilized directly from the river bed (fill material is not required). Excavation is made easy because the equipment operator is closer to the work (not digging through added fill) and can readily see the entire work area (not digging underwater).



Concord River Bellerica MA

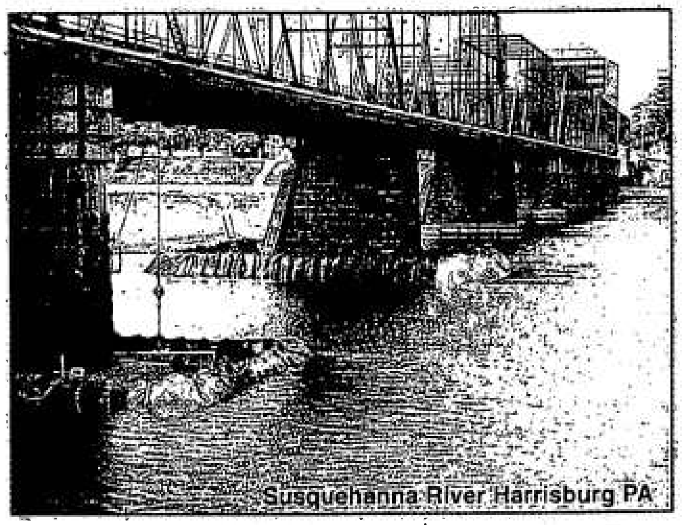


Otter Point Creek Aberdeen MD

PORTADAM, INC.
DIVERSION AND COFFERDAM STRUCTURES

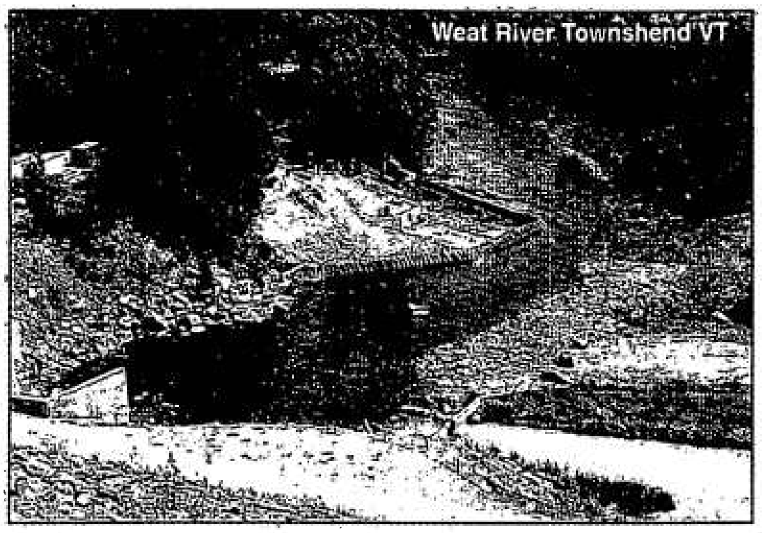
If the bridge pier is away from shore, as in large multi-span bridges, the PORTADAM system can be installed in a box or rectangular configuration. Again, fill material is not normally required. The cofferdam is positioned directly on the river or lake bed. Access to the work area is either from the bridge deck or from floating equipment.

Because the system is "free-standing", the pier work area is unobstructed by cross-bracing or tie-backs to the pier face. This open space allows for clear access to excavate, assemble form-work and place protective measures. Also, with the area dry, concrete pours become more visible, controllable, non-polluting and successful.



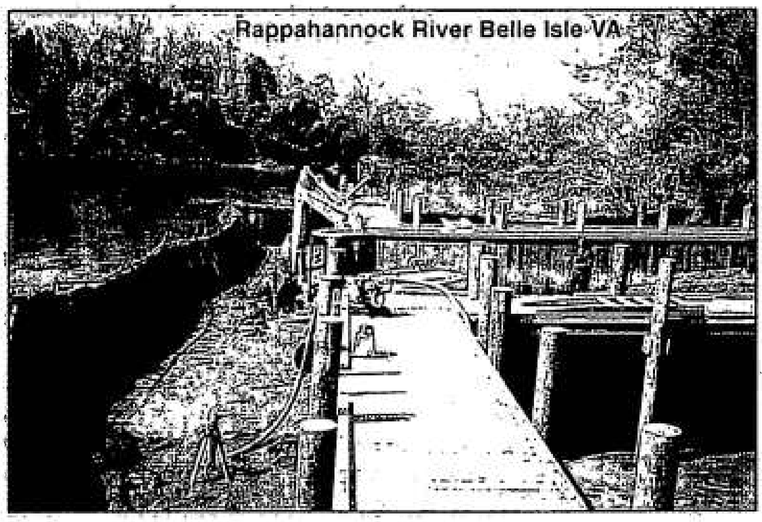
Susquehanna River Harrisburg PA

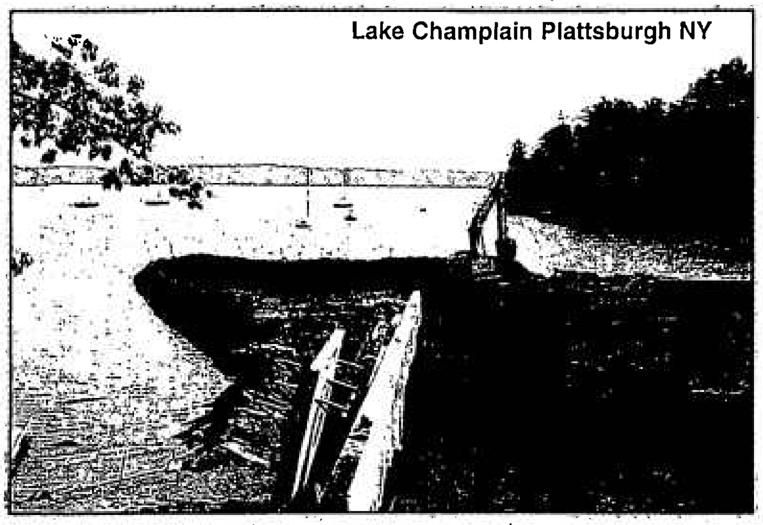
BOAT RAMPS (Rehabilitation & New Construction)



Installation or repair of boat ramps becomes an easy, land based operation with the use of the PORTADAM system cofferdam. A 3-sided structure, open to the shore, allows full, open access to the boat ramp work area. No cross bracing is required, leaving the entire work area free of obstruction.

Since the main component of the PORTADAM system is a nylon reinforced vinyl liner, the water body is completely protected from the work area. All excavation and concrete work is conducted behind a barrier that keeps the lake, river or stream completely free of siltation, turbidity and pollution.



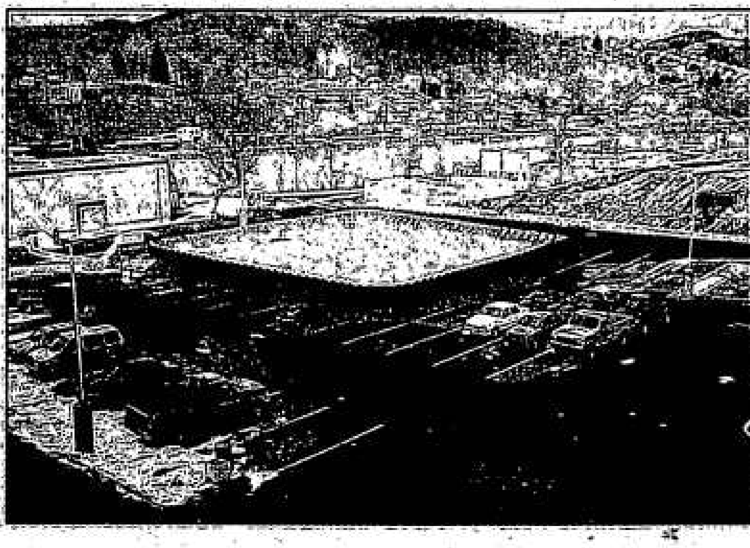


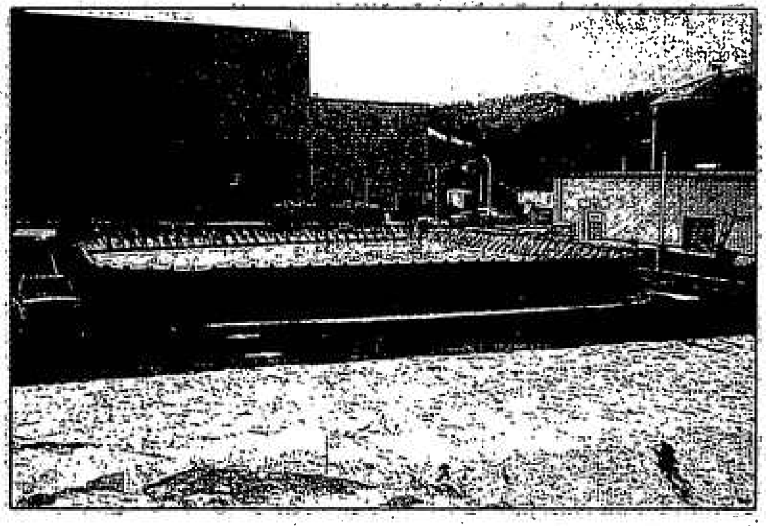
No floating equipment or heavy pile driving machinery is needed to install a PORTADAM.

PORTADAM, INC.
DIVERSION AND COFFERDAM STRUCTURES

HOLDING BASINS

Adaptibility of the PORTADAM system equipment has made it very useful as a temporary holding basis on land. By inverting the equipment installation procedure, the PORTADAM can be used to produce a holding basin of almost any size and configuration. Installation over irregular, unprepared contours makes it far superior to other, less flexible, equipment.

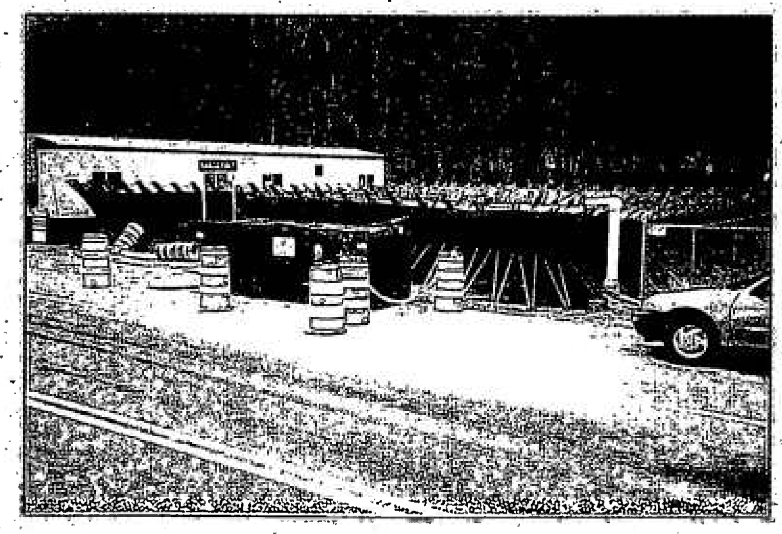




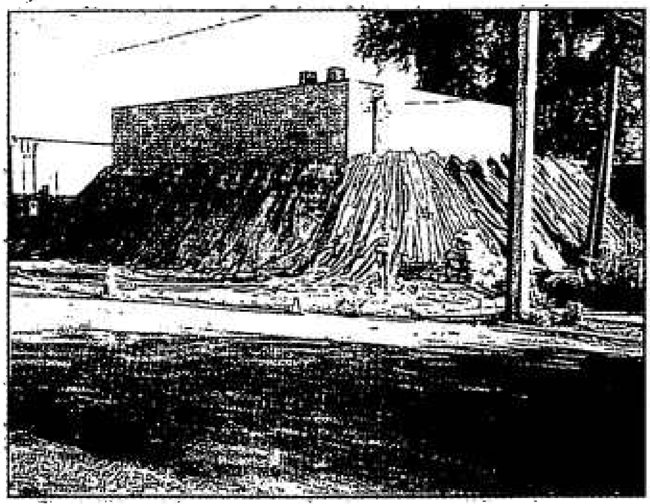
Thru-wall connection fittings are easily made with "boots" attached to the vinyl liner. Inlet and outlet pipes of any size can be added prior to shipping or in the field.

PORTADAM, INC.
DIVERSION AND COFFERDAM STRUCTURES

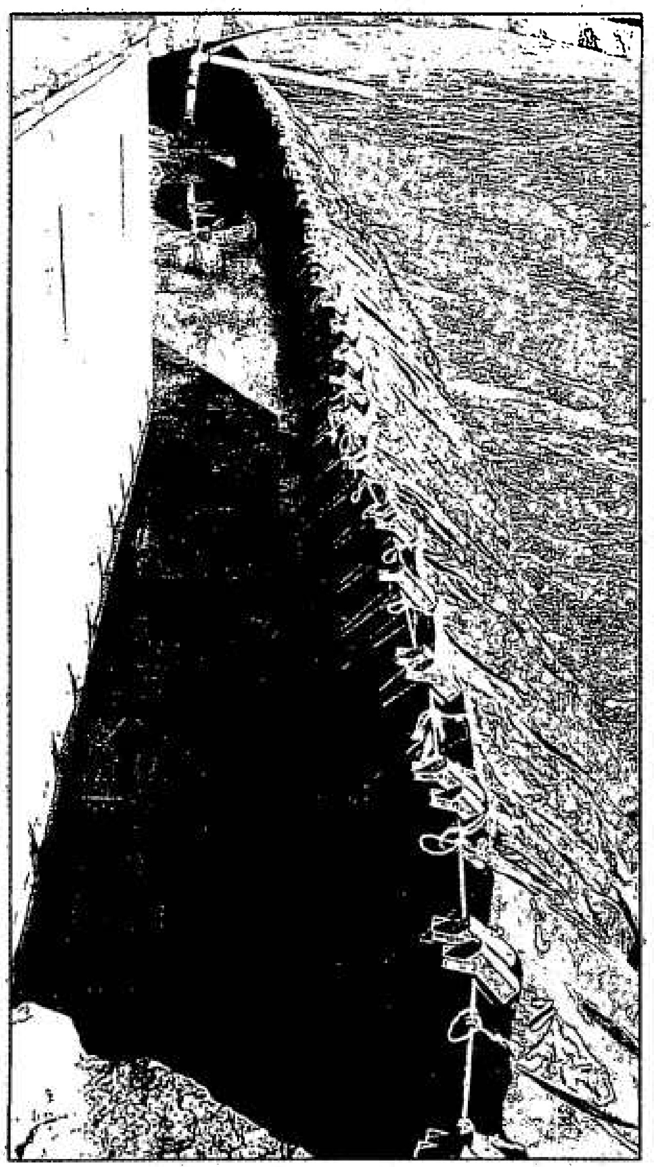
The unique structural steel wall configuration of the PORTADAM holding basin keeps the bracing system inside of the overall basin "footprint", eliminating external bracing. Containment of most fluids can be achieved with the standard VCN liners, but the PORTADAM holding basin can be easily fitted with special liners to accommodate various hazardous liquids.



The PORTADAM system can be used to divert flood waters away from buildings, treatment plants, reservoirs, even entire towns. The flexibility of the equipment permits quick installation on unprepared surfaces and along almost any desired line.



Raise the height of existing levees with PORTADAM which is 1/10 the weight of standard sandbag extensions, installs in less than 1/10 the amount of time and can achieve an added height of up to 9 feet over top of the existing levee. In addition, the long sealing apron used with the standard PORTADAM equipment will extend down the river-side face of the levee, effectively reducing saturation of the levee soils.

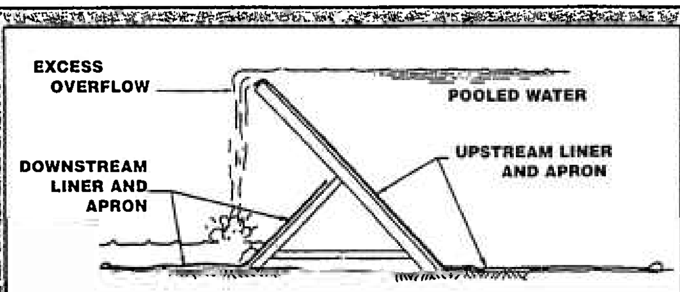


Anyone who has ever endured a flood fight realizes that clean-up after the flood waters recede is very difficult. Not only is there a major disposal (sandbags) problem, but volunteers are not as easily found for the cleanup operation. The PORTADAM system equipment is completely RE-USABLE. All of the equipment is easily removed from the site and stored for the next flood fight. No need to re-purchase and dispose of thousands of sandbags all over again.

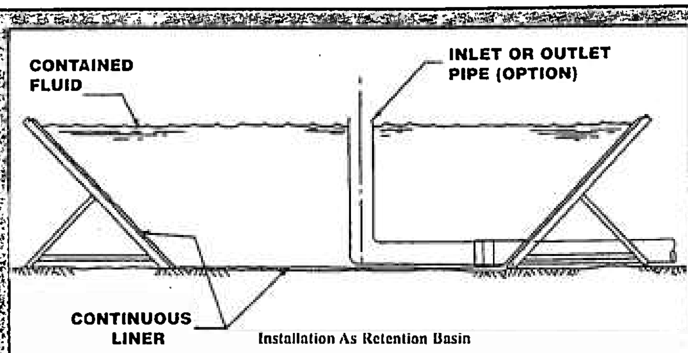
Protection of buildings, treatment plants and reservoirs can be accomplished with a system that is installed and removed more quickly and easily than sandbags and which does not produce an eye-sore for the community. Normal plant operations can continue during installation. The skeletal steel framework system can be pre-installed, with access gaps, with the liner being placed only at the final moments. The equipment is offered in various heights from 3' high to 10' high to allow for the desired measure of protection.

PORTADAM, INC.
DIVERSION AND COFFERDAM STRUCTURES

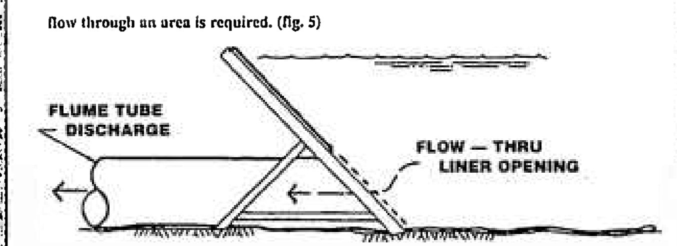
INSTALLATION VARIATIONS AND ATTACHMENTS



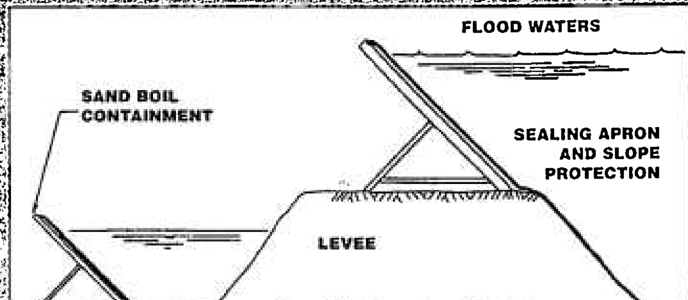
Installation As Overflow Weir



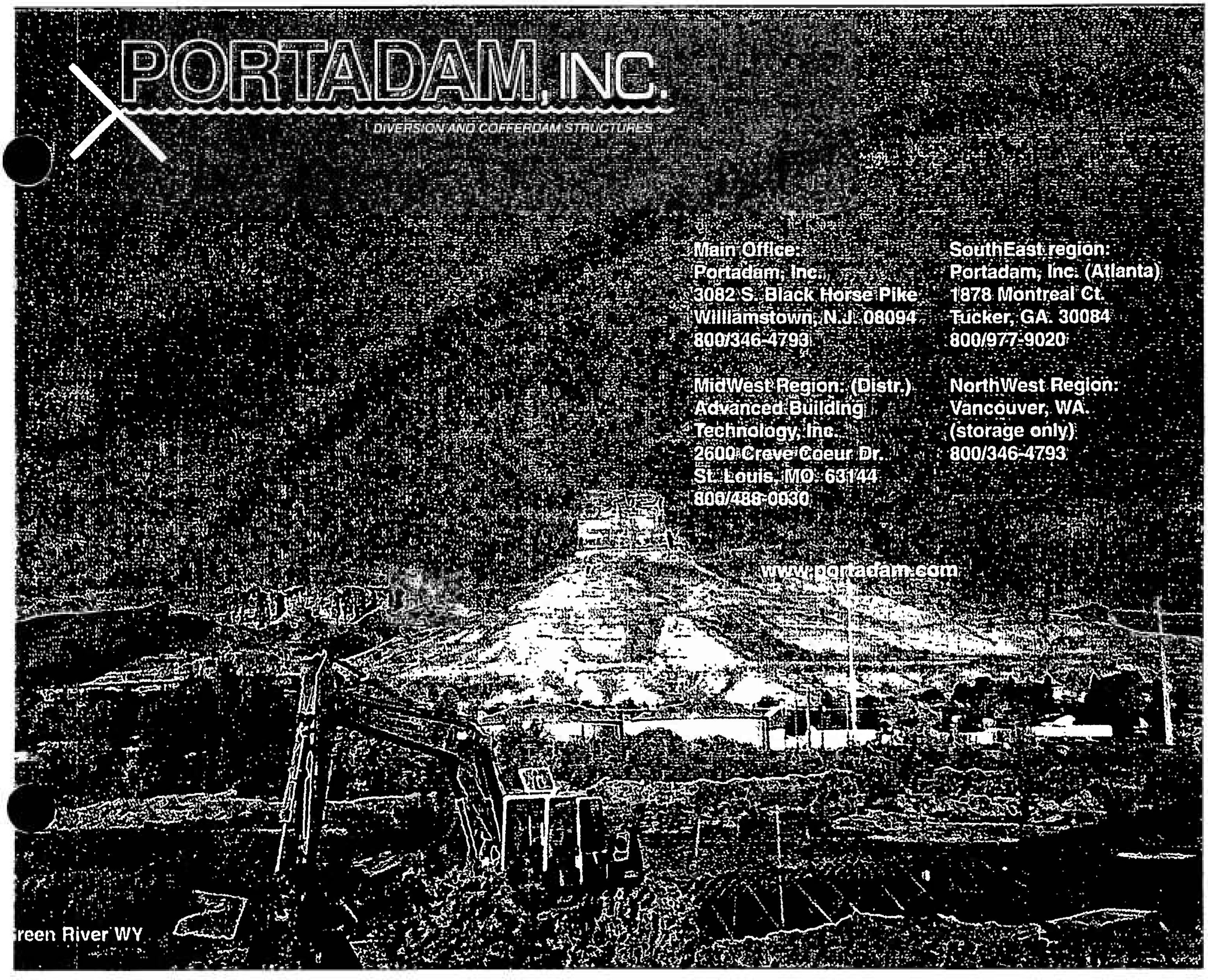
Installation As Retention Basin



Thru-wall Tube Connections



Levee Height Extension and Protection



Appendix 9E

SUBJECT SPDES PERMIT APPLICATION — SITE SHEET NO. 1 OF 4 JOB NO. G499

BY E. BRISBANE DATE 24 JUNE 99 CHKD. BY ________ DATE ________

PRELIMINARY CALCULATIONS — NOT FOR CONSTRUCTION

ESTIMATE OF TOTAL AREA OF THE SITE

MAIN SITE AREA

SECTION						
1	N 8160 → N 8900	×	E 3400 → E 3600	= 740 × 200	=	148,000 FT^2
2	+ N 8160 → N 8960	×	E 3600 → E 3700	= 800 × 100	=	80,000
3	+ N 8160 → N 8870	×	E 3700 → E 3800	= 710 × 100	=	71,000
4	+ N 8130 → N 8760	×	E 3800 → E 3900	= 630 × 100	=	63,000
5	+ N 8120 → N 8700	×	E 3900 → E 4000	= 580 × 100	=	58,000
6	+ N 8120 → N 8680	×	E 4000 → E 4300	= 560 × 300	=	168,000
7	+ N 8120 → N 8580	×	E 4300 → E 4400	= 460 × 100	=	46,000
8	+ N 8120 → N 8460	×	E 4400 → E 4500	= 340 × 100	=	34,000
					TOT. =	668,000 FT^2
					=	15.33 ACRES

COOLING TOWER AREA

9	N 8060 → N 8280	×	E 4500 → E 4600	= 220 × 100	=	22,000 FT^2
10	+ N 8060 → N 8300	×	E 4600 → E 4700	= 240 × 100	=	24,000
11	+ N 7800 → N 8250	×	E 4700 → E 4800	= 450 × 100	=	45,000
12	+ N 7800 → N 8250	×	E 4800 → E 4900	= 450 × 100	=	45,000
13	+ N 7780 → N 8250	×	E 4900 → E 5000	= 470 × 100	=	47,000
14	+ N 7570 → N 8250	×	E 5000 → E 5200	= 680 × 200	=	136,000
15	+ N 7600 → N 8200	×	E 5200 → E 5300	= 600 × 100	=	60,000
					TOT. =	379,000 FT^2
					=	8.7 ACRES

TOTAL AREA OF SITE = 15.33 + 8.7 = 24.03 ACRES

AREA OF SITE TO BE DISTURBED BY CONSTRUCTION ACTIVITIES = 15.33 + 8.7 = 24.03 ACRES.

SUBJECT SPDES PERMIT APPLICATION - SITE SHEET NO. 2 OF 4 JOB NO. 9499

BY E. BRISBANE DATE 24 JUNE 99 CHKD. BY ______ DATE ______

PRELIMINARY CALCULATIONS - NOT FOR CONSTRUCTION

AREA OF SITE DRAINING TO SEDIMENTATION POND 1

SECTION			
1			= 148,000 FT^2
2			= 80,000
3			= 71,000
4 × 0.6	63000 × 0.6		= 37,800
		TOTAL	= 336,800 FT^2
			= 7.73 ACRES

AREA OF SITE DRAINING TO SEDIMENTATION POND 2

SECTION			
4 × 0.4	63,000 × 0.4		= 25,200 FT^2
5			= 58,000
6			= 168,000
7			= 46,000
8			= 34,000
		TOTAL	= 331,200 FT^2
			= 7.6 ACRES

AREA OF SITE DRAINING TO SEDIMENTATION POND 3

SECTION		
9		= 22,000 FT^2
10		= 24,000
11		= 45,000
12		= 45,000
13		= 47,000
14		= 136,000
15		= 60,000
	TOTAL	= 379,000 FT^2
		= 8.7 ACRES

SUBJECT SPDES PERMIT APPLICATION – SITE SHEET NO. 3 OF 4 JOB NO. 649

BY E. BRISBANE DATE 24 JUNE 99 CHKD. BY ______ DATE ______

PRELIMINARY CALCULATIONS – NOT FOR CONSTRUCTION

STORAGE REQUIRED FOR FIRST FLUSH – SEDIMENTATION POND 1

CONSTRUCTION STAGE = 0.5"/12 × 336800 FT^2 = 14,033 FT^3

POND 170 FT LG × 60 FT WIDE AT CREST 9.5 FT 1:1.5 SLOPES

VOLUME OF POND BETWEEN 9.0 FT AND 4.0 FT

LENGTH AT 9 FT ELEV = 170 − 2 × 1.5 × 0.5 = 168.5

WIDTH AT 9 FT ELEV = 60 − 2 × 1.5 × 0.5 = 58.5

APPROX VOL = (168.5 − 7.5) × (58.5 − 7.5) × 5 = 41,055 FT^3

STORAGE REQUIRED FOR FIRST FLUSH – SEDIMENTATION POND 2

CONSTRUCTION STAGE = 0.5"/12 × 331,200 FT^2 = 13,800 FT^3

POND 160 FT LG × 60 FT WIDE AT CREST 9.5 FT 1:1.5 SLOPES

VOLUME OF POND BETWEEN 9.0 FT AND 4.0 FT

LENGTH AT 9.0 FT ELEV. = 160 − 2 × 1.5 × 0.5 = 158.5

WIDTH AT 9.0 FT ELEV. = 60 − 2 × 1.5 × 0.5 = 58.5

APPROX VOL = (158.5 − 7.5) × (58.5 − 7.5) × 5 = 38505 FT^3

STORAGE REQUIRED FOR FIRST FLUSH – SEDIMENTATION POND 3

CONSTRUCTION STAGE = 0.5"/12 × 379,000 FT^2 = 15,792 FT^3

POND 300 FT LG × 40 FT WIDE AT CREST 9.5 FT 1:1.5 SLOPE

VOLUME OF POND BETWEEN 9.0 FT AND 4.0 FT

LENGTH AT 9.0 FT ELEV = 300 − 2 × 1.5 × 0.5 = 298.5

WIDTH AT 9.0 FT ELEV = 40 − 2 × 1.5 × 0.5 = 38.5

APPROX VOL = (298.5 − 7.5) × (38.5 − 7.5) × 5 = 45,105 FT^3

SUBJECT SPDES PERMIT APPLICATION - SITE SHEET NO. 4 OF 4 JOB NO. 6499

BY E. BRISBANE DATE 24 JUNE 99 CHKD. BY DATE

PRELIMINARY CALCULATIONS - NOT FOR CONSTRUCTION

AREA OF WETLANDS ON THE SITE

AREA			
1	130 × 40	=	5200 FT^2
2	140 × 70	=	9,800
3	150 × 25	=	3,750
4	50 × 20	=	1,000
5	50 × 20	=	1,000
6	90 × 90	=	8,100

TOTAL = 28,850 FT^2

= 0.66 ACRES

AREA OF NEW IMPERVIOUS SURFACE

1.	TURBINE BUILDING	490 FT × 140 FT	=	68,600 FT^2
2.	MOTOR CONTROL CENTRE	70 × 40	=	2,800
3.	TRANSFORMERS	70 × 30	=	2,100
4.	HEAT RECOVERY STEAM GEN	3 × 120 × 50	=	18,000
5.	ROADS	1220 × 30	=	36,600
6.	COOLING TOWERS	$600 \times 70 - 10 \times \frac{\pi \times 45^2}{4}$	=	26,095

TOTAL = 154,195 FT^2

= 3.54 ACRES

Appendix 10A

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: H-1

Date: 2/3/00

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform				✓	
Vegetation			✓		
Water					✓
Man-made Modifications		✓			
Unity			✓		

Overall Landscape Quality Rating: M

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers					✓
Mobile viewers	✓				
Competing Tasks				✓	
Competing Visual Elements					
Structures			✓		
Transportation				✓	
Human activities				✓	

Overall Viewer Rating: MH

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility			✓		
Distance		✓			
Locational factors		✓			
Scale		✓			

Overall Visibility Rating: M

Comments: Stony Point lighthouse - view to the south encompasses the full width of Haverstraw Bay. Bowline visible behind U.S. Gypsum (numerous plumes). Views to the east and north partially blocked by mature, deciduous trees.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: H-4
Date: 12/9/99
By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform					
Vegetation					
Water					
Man-made Modifications					
Unity					

Overall Landscape Quality Rating: ________

	Low	L/M	Moderate	M/H	High
Viewer Analysis					
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ________

	Low	L/M	Moderate	M/H	High
Visibility Analysis					
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ________

Comments: Fowler Library (Kings Daughter Library)
Bowline not visible due to intervening structures

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: H-5

Date: 12/9/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform					
Vegetation					
Water					
Man-made Modifications					
Unity					

Overall Landscape Quality Rating: ________

Viewer Analysis

	Low	L/M	Moderate	M/H	High
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ________

Visibility Analysis

	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ________

Comments: U.S. Post Office, Haverstraw (NRHP). Bowline not visible due to intervening structures (Fowler Library)

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: H-6

Date: 12/9/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform	✓				
Vegetation		✓			
Water	✓				
Man-made Modifications			✓		
Unity		✓			

Overall Landscape Quality Rating: LM

Viewer Analysis

	Low	L/M	Moderate	M/H	High
Stationary viewers	✓				
Mobile viewers	✓				
Competing Tasks	✓				
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: L

Visibility Analysis

	Low	L/M	Moderate	M/H	High
Degree of visibility		✓			
Distance		✓			
Locational factors	✓				
Scale			✓		

Overall Visibility Rating: LM

Comments: Homestead, 143 Hudson Ave, Haverstraw (NRHP) Mature conifers behind house screen view of Bowline. Scenic view is not integral to historic significance of the property. Older street of architecturally individual homes.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: H-7

Date: 12/9/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform	✓				
Vegetation		✓			
Water	✓				
Man-made Modifications			✓		
Unity		✓			

Overall Landscape Quality Rating: LM

Viewer Analysis

	Low	L/M	Moderate	M/H	High
Stationary viewers	✓				
Mobile viewers	✓				
Competing Tasks	✓				
Competing Visual Elements					
Structures	✓				
Transportation	✓				
Human activities	✓				

Overall Viewer Rating: L

Visibility Analysis

	Low	L/M	Moderate	M/H	High
Degree of visibility			✓		
Distance			✓		
Locational factors		✓			
Scale		✓			

Overall Visibility Rating: LM

Comments: Central Presbyterian Church (NRHP). Existing Bowline Plant visible through the trees (w/ plume) predominantly screened during leaf-out season

VAP#: H-9
Date: 12/9/99
By: CHW

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform					
Vegetation					
Water					
Man-made Modifications					
Unity					

Overall Landscape Quality Rating: ________

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ________

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ________

Comments: Fraser-Hoyer House (NRHP). Stand of mature conifers blocks view of the Hudson River and Bowline plant. Structure is boarded up and in declining condition. Adjacent to Helen Hayes Hospital

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: H-11

Date: 12/8/99

By: CHW

	Low	L/M	Moderate	M/H	High
	Low Impact →				High Impact
	Common		Noteworthy		Distinctive
Landscape Quality Assessment					
Landform					
Vegetation					
Water					
Man-made Modifications					
Unity					

Overall Landscape Quality Rating: ________

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ________

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ________

Comments: Drum Hill High School, Peekskill (NRHP) under renovation - future home of Drum Hill Senior Living Community. Bowline not visible due to intervening structures and vegetation.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: H-12

Date: 12/8/99

By: CHW

	Low Impact →			High Impact
Common		Noteworthy		Distinctive
Low	L/M	Moderate	M/H	High

Landscape Quality Assessment	Low	L/M	Moderate	M/H	High
Landform					
Vegetation					
Water					
Man-made Modifications					
Unity					

Overall Landscape Quality Rating: ________

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ________

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ________

Comments: Villa Loretto, Peekskill (NRHP) - Villa in the Woods. Converted to condominiums w/ surrounding townhouse development. Bowline not visible due to intervening development and vegetation

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: H-15

Date: 12/8/99

By: CHW

	Low Impact →			High Impact
Common		Noteworthy		Distinctive
Low	L/M	Moderate	M/H	High

Landscape Quality Assessment	Low	L/M	Moderate	M/H	High
Landform					
Vegetation					
Water					
Man-made Modifications					
Unity					

Overall Landscape Quality Rating: ________

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ________

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ________

Comments: Mt. Florence, Peekskill (NRHP) Chapel Hill Estates. Former school complex now abandoned. Adjacent residential development. Bowline not visible due to intervening vegetation.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: H-17

Date: 2/3/00

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform				✓	
Vegetation			✓		
Water	✓				
Man-made Modifications			✓		
Unity		✓			

Overall Landscape Quality Rating: M

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers		✓			
Mobile viewers	✓				
Competing Tasks				✓	
Competing Visual Elements					
Structures	✓				
Transportation			✓		
Human activities			✓		

Overall Viewer Rating: LM

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ______

Comments: St. Patrick's Church, Verplanck (NRHP) Church sits on a high point w/ cleared view west toward Lovett Station and aerial T-line crossing. View toward Bowline blocked by vegetation and residences.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: H-18

Date: 12/8/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform					
Vegetation					
Water					
Man-made Modifications					
Unity					

Overall Landscape Quality Rating: ________

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ________

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ________

Comments: Old Croton Aqueduct - NHL. Footpath and ventilator shaft near southern intersection w/ Quaker Bridge Road. Bowline and Hudson River not visible due to intervening vegetation and topography.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: H-20

Date: 12/8/99

By: CHW

	Low	L/M	Moderate	M/H	High
	Low Impact →				High Impact
	Common		Noteworthy		Distinctive
Landscape Quality Assessment					
Landform				✓	
Vegetation			✓		
Water					✓
Man-made Modifications			✓		
Unity				✓	

Overall Landscape Quality Rating: MH

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ________

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ________

Comments: Quaker Bridge. Historic, single lane steel-truss bridge over scenic stream. Enclosed landscape.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: H-21

Date: 12/1/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform			✓		
Vegetation			✓		
Water			✓		
Man-made Modifications		✓			
Unity		✓			

Overall Landscape Quality Rating: M

Viewer Analysis					
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ______

Visibility Analysis					
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ______

Comments: Van Cortlandt Manor - Bowline not visible due to intervening topography and vegetation

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: H-22

Date: 12/8/99

By: CHW

	Low	L/M	Moderate	M/H	High
	Low Impact →				High Impact
	Common		Noteworthy		Distinctive
Landscape Quality Assessment					
Landform	✓				
Vegetation	✓				
Water	✓				
Man-made Modifications				✓	
Unity			✓		

Overall Landscape Quality Rating: LM

Viewer Analysis					
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ______

Visibility Analysis					
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ______

Comments: Asbury Methodist Church, Croton - NRHP. Bowline and Hudson River not visible due to intervening buildings and vegetation.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: H-23

Date: 12/8/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform			✓		
Vegetation		✓			
Water				✓	
Man-made Modifications	✓				
Unity	✓				

Overall Landscape Quality Rating: M

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers	✓				
Mobile viewers	✓				
Competing Tasks			✓		
Competing Visual Elements					
Structures	✓				
Transportation	✓				
Human activities	✓				

Overall Viewer Rating: L

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility			✓		
Distance		✓			
Locational factors		✓			
Scale		✓			

Overall Visibility Rating: LM

Comments: Croton North RR Station - NRHP (now F.A. Burchetta, Electrical Contractors, 1 Senasqua Road) View limited by trees along shoreline and diminished by MetroNorth RR. Not accessible to the public.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: H-24

Date: 12/1/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform					
Vegetation					
Water					
Man-made Modifications					
Unity					

Overall Landscape Quality Rating: ________

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ________

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ________

Comments: Jug Tavern (NRHP) Bowline (and Hudson River) not visible due to intervening topography.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: H-26

Date: 12/1/99

By: CHW

	Low	L/M	Moderate	M/H	High
	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
Landscape Quality Assessment					
Landform	✓				
Vegetation	✓				
Water		✓			
Man-made Modifications	✓				
Unity		✓			

Overall Landscape Quality Rating: L

Viewer Analysis

	Low	L/M	Moderate	M/H	High
Stationary viewers	✓				
Mobile viewers	✓				
Competing Tasks	✓				
Competing Visual Elements					
Structures	✓				
Transportation	✓				
Human activities	✓				

Overall Viewer Rating: L

Visibility Analysis

	Low	L/M	Moderate	M/H	High
Degree of visibility	✓				
Distance	✓				
Locational factors	✓				
Scale	✓				

Overall Visibility Rating: L

Comments: Squire House (NRHP - 36 So. Highland Ave) Ossining. Bowline barely visible in the background. Not a focal point due to surrounding structures, vegetation and major roadway.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: H-27

Date: 12/1/99

By: CHW

	Low	L/M	Moderate	M/H	High
	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
Landscape Quality Assessment					
Landform					
Vegetation					
Water					
Man-made Modifications					
Unity					

Overall Landscape Quality Rating: ________

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ________

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ________

Comments: St. Paul's Episcopal Church, Ossining (NRHP) Bowline not visible due to intervening buildings in Downtown Ossining.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: H-28

Date: 12/1/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform					
Vegetation					
Water					
Man-made Modifications					
Unity					

Overall Landscape Quality Rating: ________

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ________

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ________

Comments: First Baptist Church, Ossining (NRHP). Bowline not visible due to intervening buildings in Downtown Ossining.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: H-29

Date: 12/8/99

By: CHW

Low Impact → High Impact				
Common		Noteworthy		Distinctive
Low	L/M	Moderate	M/H	High

Landscape Quality Assessment

	Low	L/M	Moderate	M/H	High
Landform		✓			
Vegetation		✓			
Water	✓				
Man-made Modifications	✓				
Unity	✓				

Overall Landscape Quality Rating: L

Viewer Analysis

	Low	L/M	Moderate	M/H	High
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ______

Visibility Analysis

	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ______

Comments: Richard Austin House (NRHP), Ossining. Located along major roadway. Bowline and Hudson River not visible due to intervening vegetation and buildings

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: H-30

Date: 12/8/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform		✓			
Vegetation		✓			
Water	✓				
Man-made Modifications	✓				
Unity	✓				

Overall Landscape Quality Rating: L

Viewer Analysis

	Low	L/M	Moderate	M/H	High
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ________

Visibility Analysis

	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ________

Comments: Washington School (NRHP), Ossining. Located on major roadway across from a strip mall. Hudson River and Bowline not visible.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: H-31

Date: 12/8/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform			✓		
Vegetation	✓				
Water		✓			
Man-made Modifications				✓	
Unity			✓		

Overall Landscape Quality Rating: M

Viewer Analysis

	Low	L/M	Moderate	M/H	High
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ______

Visibility Analysis

	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ______

Comments: Downtown Ossining Historic District. Architecturally cohesive downtown of 2- and 3-story commercial buildings. Hudson River views are limited.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-1
Date: 1/6/00
By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform				✓	
Vegetation			✓		
Water					✓
Man-made Modifications		✓			
Unity		✓			

Overall Landscape Quality Rating: M

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers	✓				
Mobile viewers				✓	
Competing Tasks		✓			
Competing Visual Elements					
Structures		✓			
Transportation			✓		
Human activities			✓		

Overall Viewer Rating: M

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility					✓
Distance				✓	
Locational factors				✓	
Scale				✓	

Overall Visibility Rating: MH

Comments: Hudson River – Composite assessment from a boat on the river between Bowline Point and Stony Point.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-2

Date: 12/9/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform					
Vegetation					
Water					
Man-made Modifications					
Unity					

Overall Landscape Quality Rating: ________

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ________

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ________

Comments: Lowland Park, Stony Point. Bowline not visible due to dense intervening (deciduous) vegetation. Ballfield, playground, picnic pavillion.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-3

Date: 12/8/99

By: CHW

	Low Impact →				High Impact
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform				✓	
Vegetation		✓			
Water					✓
Man-made Modifications		✓			
Unity			✓		

Overall Landscape Quality Rating: M

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers			✓		
Mobile viewers	✓				
Competing Tasks			✓		
Competing Visual Elements					
Structures	✓				
Transportation	✓				
Human activities		✓			

Overall Viewer Rating: LM

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility				✓	
Distance			✓		
Locational factors	✓				
Scale			✓		

Overall Visibility Rating: M

Comments: Willow Cove Yacht Club and Marina. View from the dock diminished by U.S. Gypsum in the foreground. Summer views would be intermittent w/ boats in the water.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-4

Date: 12/8/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform			✓		
Vegetation			✓		
Water					✓
Man-made Modifications	✓				
Unity	✓				

Overall Landscape Quality Rating: LM

Viewer Analysis

	Low	L/M	Moderate	M/H	High
Stationary viewers			✓		
Mobile viewers	✓				
Competing Tasks		✓			
Competing Visual Elements					
Structures	✓				
Transportation	✓				
Human activities	✓				

Overall Viewer Rating: L

Visibility Analysis

	Low	L/M	Moderate	M/H	High
Degree of visibility				✓	
Distance			✓		
Locational factors		✓			
Scale			✓		

Overall Visibility Rating: M

Comments: Vincent Clark River View Park, Stony Point. Picnic ground, playground. Bowline partially backdropped.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-5

Date: 12/8/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform					
Vegetation					
Water					
Man-made Modifications					
Unity					

Overall Landscape Quality Rating: ________

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ________

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ________

Comments: Minisceongo Yacht Club (private security gate). Orientation is to the north. Bowline not visible due to U.S. Gypsum plant.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-6

Date: 12/8/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform					
Vegetation					
Water					
Man-made Modifications					
Unity					

Overall Landscape Quality Rating: ________

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ________

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ________

Comments: Penny Bridge Marina. Orientation to the north. Bowline not visible due to U.S. Gypsum plant.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-7

Date: 12/8/99

By: CHW

	Low	L/M	Moderate	M/H	High
	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
Landscape Quality Assessment					
Landform				✓	
Vegetation		✓			
Water					✓
Man-made Modifications	✓				
Unity	✓				

Overall Landscape Quality Rating: LM

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers			✓		
Mobile viewers	✓				
Competing Tasks			✓		
Competing Visual Elements					
Structures	✓				
Transportation	✓				
Human activities	✓				

Overall Viewer Rating: L

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility			✓		
Distance			✓		
Locational factors		✓			
Scale			✓		

Overall Visibility Rating: M

Comments: Grassy Point playground - view oriented east and north. View south towards Bowline diminished by conveyor structure & homes. Bowline backdropped.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-8

Date: 12/9/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform			✓		
Vegetation			✓		
Water	✓				
Man-made Modifications		✓			
Unity			✓		

Overall Landscape Quality Rating: M

Viewer Analysis					
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ______

Visibility Analysis					
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ______

Comments: Philip Rotella Golf Course. Bowline and Hudson River not visible due to intervening topography and vegetation.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-9

Date: 12/9/99

By: CHW

	Low Impact →			High Impact
Common		Noteworthy		Distinctive
Low	L/M	Moderate	M/H	High

Landscape Quality Assessment	Low	L/M	Moderate	M/H	High
Landform	✓				
Vegetation	✓				
Water	✓				
Man-made Modifications	✓				
Unity	✓				

Overall Landscape Quality Rating: L

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers				✓	
Mobile viewers	✓				
Competing Tasks	✓				
Competing Visual Elements					
Structures	✓				
Transportation		✓			
Human activities	✓				

Overall Viewer Rating: L

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility				✓	
Distance				✓	
Locational factors				✓	
Scale					✓

Overall Visibility Rating: MH

Comments: School athletic fields. Bowline plant and stacks are skylined behind residential structures. Baseball field, soccer, track.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-10

Date: 12/8/99

By: CHW

	Low	L/M	Moderate	M/H	High
	Low Impact →				High Impact
	Common		Noteworthy		Distinctive
Landscape Quality Assessment					
Landform				✓	
Vegetation			✓		
Water				✓	
Man-made Modifications		✓			
Unity			✓		

Overall Landscape Quality Rating: M

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers				✓	
Mobile viewers	✓				
Competing Tasks			✓		
Competing Visual Elements					
Structures		✓			
Transportation	✓				
Human activities			✓		

Overall Viewer Rating: M

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility					✓
Distance				✓	
Locational factors				✓	
Scale				✓	

Overall Visibility Rating: MH

Comments: Haverstraw Marina. Mature vegetation obscures base of Bowline plant. Summer view likely obstructed by boats in the water.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-11

Date: 12/9/99

By: CHW

	Low	L/M	Moderate	M/H	High
	Low Impact →				High Impact
	Common		Noteworthy		Distinctive
Landscape Quality Assessment					
Landform			✓		
Vegetation			✓		
Water					✓
Man-made Modifications	✓				
Unity		✓			

Overall Landscape Quality Rating: LM

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers					✓
Mobile viewers	✓				
Competing Tasks			✓		
Competing Visual Elements					
Structures		✓			
Transportation		✓			
Human activities			✓		

Overall Viewer Rating: M

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility					✓
Distance				✓	
Locational factors			✓		
Scale				✓	

Overall Visibility Rating: MH

Comments: Bowline Point Park - developed town park w/ tennis courts, picnic area, pool/waterslide, playgrounds. Mature deciduous trees provide partial screening during summer (December - closed for the season)

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-12

Date: 12/9/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform				✓	
Vegetation			✓		
Water					✓
Man-made Modifications		✓			
Unity			✓		

Overall Landscape Quality Rating: M

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers				✓	
Mobile viewers	✓				
Competing Tasks			✓		
Competing Visual Elements					
Structures		✓			
Transportation				✓	
Human activities			✓		

Overall Viewer Rating: M

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility		✓			
Distance		✓			
Locational factors	✓				
Scale	✓				

Overall Visibility Rating: L

Comments: Emeline Park - 3 acre riverfront park (co-owned by Scenic Hudson and Village of Haverstraw) Bowline not visible due to intervening structures and topography. Plume visible above residences.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-13

Date: 12/9/99

By: CHW

	Low	L/M	Moderate	M/H	High
	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
Landscape Quality Assessment					
Landform				✓	
Vegetation		✓			
Water					✓
Man-made Modifications		✓			
Unity		✓			

Overall Landscape Quality Rating: M

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers				✓	
Mobile viewers	✓				
Competing Tasks			✓		
Competing Visual Elements					
Structures	✓				
Transportation			✓		
Human activities			✓		

Overall Viewer Rating: M

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility					✓
Distance				✓	
Locational factors				✓	
Scale					✓

Overall Visibility Rating: H

Comments: Rose Nelson Memorial Park - basketball, handball, playground. Located on a bluff overlooking the Hudson River. Bowline plant skylined.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-14

Date: 12/8/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform		✓			
Vegetation		✓			
Water		✓			
Man-made Modifications	✓				
Unity	✓				

Overall Landscape Quality Rating: LM

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers				✓	
Mobile viewers	✓				
Competing Tasks				✓	
Competing Visual Elements					
Structures	✓				
Transportation			✓		
Human activities			✓		

Overall Viewer Rating: M

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility					✓
Distance					✓
Locational factors				✓	
Scale					✓

Overall Visibility Rating: H

Comments: Pecks Pond Park. Bowline dominates the view. Traffic, noise, other structures. Walking path around pond and ballfields.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-16

Date: 12/1/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform					
Vegetation					
Water					
Man-made Modifications					
Unity					

Overall Landscape Quality Rating: ________

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ________

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ________

Comments: Charles Point Pier Park (Local Waterfront Revitalization Program) Small path and waterfront viewing area w/ benches. Oriented north toward Dunderberg Mtn. Bowline not visible.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-18

Date: 12/8/99

By: CHW

	Low	L/M	Moderate	M/H	High
	Low Impact →				High Impact
	Common		Noteworthy		Distinctive
Landscape Quality Assessment					
Landform			✓		
Vegetation			✓		
Water		✓			
Man-made Modifications					✓
Unity				✓	

Overall Landscape Quality Rating: M

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ______

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ______

Comments: Blue Mountain Reservation - Westchester County. Large, undeveloped tract, traversed by Station Road (unpaved). Bowline and Hudson River not visible due to intervening topography and dense vegetation.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-19

Date: 12/1/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform	✓				
Vegetation		✓			
Water	✓				
Man-made Modifications	✓				
Unity	✓				

Overall Landscape Quality Rating: L

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ______

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ______

Comments: Sunset Park (Town of Cortlandt) Playground, ballfields. Bowline not visible. Large conifers screen view toward project. Adjacent church.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-20

Date: 12/1/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform			✓		
Vegetation		✓			
Water					✓
Man-made Modifications	✓				
Unity		✓			

Overall Landscape Quality Rating: M

	Low	L/M	Moderate	M/H	High
Viewer Analysis					
Stationary viewers		✓			
Mobile viewers	✓				
Competing Tasks			✓		
Competing Visual Elements					
Structures	✓				
Transportation	✓				
Human activities	✓				

Overall Viewer Rating: L

	Low	L/M	Moderate	M/H	High
Visibility Analysis					
Degree of visibility				✓	
Distance		✓			
Locational factors			✓		
Scale			✓		

Overall Visibility Rating: M

Comments: Cortlandt Yacht Club. Existing plant clearly visible across Hudson River but plant and stack are backdropped by higher topography to SW. Bowline viewed in conjunction w/ gypsum plant. Plumes visible.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-21

Date: 12/1/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform				✓	
Vegetation		✓			
Water					✓
Man-made Modifications		✓			
Unity			✓		

Overall Landscape Quality Rating: M

Viewer Analysis

	Low	L/M	Moderate	M/H	High
Stationary viewers			✓		
Mobile viewers	✓				
Competing Tasks					✓
Competing Visual Elements					
Structures				✓	
Transportation			✓		
Human activities				✓	

Overall Viewer Rating: MH

Visibility Analysis

	Low	L/M	Moderate	M/H	High
Degree of visibility				✓	
Distance			✓		
Locational factors			✓		
Scale			✓		

Overall Visibility Rating: M

Comments: Oscawana Park/Nature Preserve - footpath through the woods (Oscawana Island). Benches along path and shoreline. Bowline plainly visible but backdropped by South Mountain (High Tor Ridge)

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-22

Date: 12/1/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform				✓	
Vegetation		✓			
Water					✓
Man-made Modifications		✓			
Unity			✓		

Overall Landscape Quality Rating: M

Viewer Analysis

	Low	L/M	Moderate	M/H	High
Stationary viewers					✓
Mobile viewers	✓				
Competing Tasks				✓	
Competing Visual Elements					
Structures			✓		
Transportation			✓		
Human activities			✓		

Overall Viewer Rating: M

Visibility Analysis

	Low	L/M	Moderate	M/H	High
Degree of visibility				✓	
Distance			✓		
Locational factors			✓		
Scale			✓		

Overall Visibility Rating: M

Comments: Georges Island Park - picnic grounds and boat launch. 180° view of Hudson River and mountains to the west. Bowline clearly visible from footpath around promontory. Bowline backdropped by higher terrain.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-23

Date: 12/1/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform			✓		
Vegetation	✓				
Water					✓
Man-made Modifications		✓			
Unity			✓		

Overall Landscape Quality Rating: M

Viewer Analysis

	Low	L/M	Moderate	M/H	High
Stationary viewers			✓		
Mobile viewers	✓				
Competing Tasks			✓		
Competing Visual Elements					
Structures				✓	
Transportation	✓				
Human activities		✓			

Overall Viewer Rating: LM

Visibility Analysis

	Low	L/M	Moderate	M/H	High
Degree of visibility				✓	
Distance		✓			
Locational factors			✓		
Scale			✓		

Overall Visibility Rating: M

Comments: Croton Yacht Club - separated from the community by Route 9. (high speed, high volume) and R.R. Bowline clearly visible but backdropped.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-24

Date: 12/8/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform			✓		
Vegetation		✓			
Water					✓
Man-made Modifications		✓			
Unity		✓			

Overall Landscape Quality Rating: M

	Low	L/M	Moderate	M/H	High
Viewer Analysis					
Stationary viewers			✓		
Mobile viewers	✓				
Competing Tasks			✓		
Competing Visual Elements					
Structures		✓			
Transportation	✓				
Human activities		✓			

Overall Viewer Rating: LM

	Low	L/M	Moderate	M/H	High
Visibility Analysis					
Degree of visibility				✓	
Distance		✓			
Locational factors			✓		
Scale			✓		

Overall Visibility Rating: M

Comments: Senasqua Park, Town of Croton. Waterfront park w/ picnic pavillion, playground. 180° Hudson River views. Bowline clearly visible but backdropped by higher terrain. Summer view likely mitigated by boating activity from nearby Croton Yacht Club.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-25
Date: 12/1/99
By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform				✓	
Vegetation			✓		
Water					✓
Man-made Modifications		✓			
Unity			✓		

Overall Landscape Quality Rating: M

Viewer Analysis

	Low	L/M	Moderate	M/H	High
Stationary viewers					✓
Mobile viewers	✓				
Competing Tasks				✓	
Competing Visual Elements					
Structures				✓	
Transportation		✓			
Human activities			✓		

Overall Viewer Rating: M

Visibility Analysis

	Low	L/M	Moderate	M/H	High
Degree of visibility				✓	
Distance		✓			
Locational factors			✓		
Scale			✓		

Overall Visibility Rating: M

Comments: Croton Point Park - picnic grounds, beach, nature center - panoramic views of highlands to the west - Bowline clearly visible but backdropped. Middleground views across open water - gypsum plant and Lovett also visible. Man-made features not the focal point due to backdrop.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-26

Date: 12/8/99

By: CHW

	Low Impact →			High Impact
Common		Noteworthy		Distinctive
Low	L/M	Moderate	M/H	High

Landscape Quality Assessment

	Low	L/M	Moderate	M/H	High
Landform					
Vegetation					
Water					
Man-made Modifications					
Unity					

Overall Landscape Quality Rating: ________

Viewer Analysis

	Low	L/M	Moderate	M/H	High
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ________

Visibility Analysis

	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ________

Comments: Crotonville Park (Herbert Gerlach Park) Playground, ballfields. Bowline not visible due to intervening vegetation.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-27

Date: 12/8/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform					
Vegetation					
Water					
Man-made Modifications					
Unity					

Overall Landscape Quality Rating: ________

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ________

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ________

Comments: Veterans Memorial Park, Ossining. Bowline not visible due to intervening structures (residences) and topography. Ballfields, playground

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-28

Date: 12/1/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform					
Vegetation					
Water					
Man-made Modifications					
Unity					

Overall Landscape Quality Rating: ________

	Low	L/M	Moderate	M/H	High
Viewer Analysis					
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ________

	Low	L/M	Moderate	M/H	High
Visibility Analysis					
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ________

Comments: Snowden Park - Ossining. Playground, ballfields, basketball courts. Bowline not visible

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-29

Date: 12/1/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform					
Vegetation					
Water					
Man-made Modifications					
Unity					

Overall Landscape Quality Rating: ________

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ________

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ________

Comments: Shattemuc Yacht Club, Ossining. Bowline not visible due to intervening topography and vegetation at Croton Point Park.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-30

Date: 12/1/99

By: CHW

	Low Impact →				High Impact
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform					
Vegetation					
Water					
Man-made Modifications					
Unity					

Overall Landscape Quality Rating: ________

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ________

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ________

Comments: Ossining town park (near Nelson Park) Open lawn area w/ benches. Old Croton Aqueduct vent structure located nearby (NHL). Bowline not visible due to intervening buildings

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: R-31

Date: 12/1/99

By: CHW

	Low Impact →			High Impact
Common		Noteworthy		Distinctive
Low	L/M	Moderate	M/H	High

Landscape Quality Assessment	Low	L/M	Moderate	M/H	High
Landform					
Vegetation					
Water					
Man-made Modifications					
Unity					

Overall Landscape Quality Rating: ________

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ________

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ________

Comments: Nelson Park, Ossining. Large, open park w/ ballfields. Bowline not visible due to intervening topography, vegetation and structures.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: S-1

Date: 12/5/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform				✓	
Vegetation			✓		
Water					✓
Man-made Modifications	✓				
Unity		✓			

Overall Landscape Quality Rating: M

Viewer Analysis

	Low	L/M	Moderate	M/H	High
Stationary viewers			✓		
Mobile viewers	✓				
Competing Tasks			✓		
Competing Visual Elements					
Structures	✓				
Transportation		✓			
Human activities		✓			

Overall Viewer Rating: LM

Visibility Analysis

	Low	L/M	Moderate	M/H	High
Degree of visibility	✓				
Distance	✓				
Locational factors	✓				
Scale	✓				

Overall Visibility Rating: L

Comments: View south from rock outcrop - wide expanse of the Hudson River - numerous industrial facilities (w/ plumes) visible (Georgia Pacific, US Gypsum, Lovett Station, aerial T-line crossing of Hudson River. Bowline not discernible due to hazy sun and distance.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: S-2

Date: 12/5/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform				✓	
Vegetation			✓		
Water					✓
Man-made Modifications	✓				
Unity		✓			

Overall Landscape Quality Rating: M

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers			✓		
Mobile viewers	✓				
Competing Tasks			✓		
Competing Visual Elements					
Structures	✓				
Transportation	✓				
Human activities	✓				

Overall Viewer Rating: L

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility	✓				
Distance	✓				
Locational factors	✓				
Scale	✓				

Overall Visibility Rating: L

Comments: Viewpoint along Tump-Torne trail. View south diminished by industrial facilities on both sides of the river. Bowline not discernible (plumes visible w/ binoculars) Occasional noise from freight train along west shoreline

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: S-3

Date: 12/5/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform					✓
Vegetation			✓		
Water					✓
Man-made Modifications	✓				
Unity		✓			

Overall Landscape Quality Rating: M

	Low	L/M	Moderate	M/H	High
Viewer Analysis					
Stationary viewers			✓		
Mobile viewers	✓				
Competing Tasks					✓
Competing Visual Elements					
Structures	✓				
Transportation	✓				
Human activities	✓				

Overall Viewer Rating: L

	Low	L/M	Moderate	M/H	High
Visibility Analysis					
Degree of visibility	✓				
Distance	✓				
Locational factors	✓				
Scale	✓				

Overall Visibility Rating: L

Comments: Viewpoint along Timp-Torne trail. Rock outcrop. Scenic overlook oriented east toward Indian Point nuclear plant. 180° view of Hudson River diminished by numerous industrial facilities. Bowline not discernible through the haze.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: S-4

Date: 12/5/99

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform					✓
Vegetation				✓	
Water	✓				
Man-made Modifications		✓			
Unity				✓	

Overall Landscape Quality Rating: MH

	Low	L/M	Moderate	M/H	High
Viewer Analysis					
Stationary viewers					
Mobile viewers					
Competing Tasks					
Competing Visual Elements					
Structures					
Transportation					
Human activities					

Overall Viewer Rating: ________

	Low	L/M	Moderate	M/H	High
Visibility Analysis					
Degree of visibility None					
Distance					
Locational factors					
Scale					

Overall Visibility Rating: ________

Comments: Viewpoint along Timp-Torne trail. Scenic overlook oriented south-southwest. Hudson River and Bowline not visible due to intervening vegetation. TV tower visible in the distance.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: S-5

Date: 12/5/95

By: CHW

	Low Impact →			High Impact
Common		Noteworthy		Distinctive
Low	L/M	Moderate	M/H	High

Landscape Quality Assessment

	Low	L/M	Moderate	M/H	High
Landform					✓
Vegetation			✓		
Water					✓
Man-made Modifications	✓				
Unity		✓			

Overall Landscape Quality Rating: M

Viewer Analysis

	Low	L/M	Moderate	M/H	High
Stationary viewers			✓		
Mobile viewers	✓				
Competing Tasks					✓
Competing Visual Elements					
Structures	✓				
Transportation	✓				
Human activities	✓				

Overall Viewer Rating: LM

Visibility Analysis

	Low	L/M	Moderate	M/H	High
Degree of visibility			✓		
Distance	✓				
Locational factors	✓				
Scale	✓				

Overall Visibility Rating: LM

Comments: Viewpoint along Timp-Torne trail. Bowline visible in the background beyond Lovett Station, T-line U.S. Gypsum. Dominant features are the Lovett stack and lattice T-line structure. Bowline backdropped by South Mountain. Indian Point, Ga Pacific, Verplanck visible.

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: S-6

Date: 12/1/99

By: CHW

	Low	L/M	Moderate	M/H	High
	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
Landscape Quality Assessment					
Landform				✓	
Vegetation			✓		
Water					✓
Man-made Modifications	✓				
Unity		✓			

Overall Landscape Quality Rating: M

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers	✓				
Mobile viewers	✓				
Competing Tasks	✓				
Competing Visual Elements					
Structures	✓				
Transportation	✓				
Human activities	✓				

Overall Viewer Rating: L

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility	✓				
Distance	✓				
Locational factors	✓				
Scale	✓				

Overall Visibility Rating: L

Comments: Pull off area on Route 9 South in Peekskill. Hudson River and Dunderberg Mountain dominate the view - along with industrial developments - Bowline stack & plume barely visible in the background (verified w/ binoculars)

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: S-8

Date: 3/6/00

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform					✓
Vegetation			✓		
Water					✓
Man-made Modifications		✓			
Unity		✓			

Overall Landscape Quality Rating: M/H

Viewer Analysis

	Low	L/M	Moderate	M/H	High
Stationary viewers				✓	
Mobile viewers	✓				
Competing Tasks					✓
Competing Visual Elements					
Structures	✓				
Transportation	✓				
Human activities	✓				

Overall Viewer Rating: L/M

Visibility Analysis

	Low	L/M	Moderate	M/H	High
Degree of visibility					✓
Distance				✓	
Locational factors			✓		
Scale			✓		

Overall Visibility Rating: M/H

Comments: High Tor - Spectacular 360° views. Bowline clearly visible but elevated view causes Bowline to be backdropped. No single focal point. Views south and west are less cluttered (Manhattan skyline visible)

VISUAL ASSESSMENT WORKSHEET

Bowline Point Unit 3 - Article X Application

VAP#: S-9

Date: 3/4/00

By: CHW

	Low Impact → High Impact				
	Common		Noteworthy		Distinctive
	Low	L/M	Moderate	M/H	High
Landscape Quality Assessment					
Landform					✓
Vegetation		✓			
Water				✓	
Man-made Modifications	✓				
Unity		✓			

Overall Landscape Quality Rating: M

Viewer Analysis	Low	L/M	Moderate	M/H	High
Stationary viewers			✓		
Mobile viewers	✓				
Competing Tasks					✓
Competing Visual Elements					
Structures	✓				
Transportation	✓				
Human activities	✓				

Overall Viewer Rating: L

Visibility Analysis	Low	L/M	Moderate	M/H	High
Degree of visibility					✓
Distance				✓	
Locational factors					✓
Scale					✓

Overall Visibility Rating: H

Comments: Little Tor - Scenic overlook along Long Path. 180° view of Haverstraw and mountains to the north and west. Bowline stands out against background of the Hudson River. Focal point due to mass and scale. Community provides visual interest different from Natural landscape views. Unit 3 will be highly visible.

Appendix 10B

BOWLINE UNIT 3
COOLING TOWER PLUME ANALYSIS

1.01 Introduction

Bowline Unit 3 will employ a mechanical draft, evaporative cooling tower to remove waste heat from the condenser circulating cooling water. Mechanical-draft evaporative cooling towers can produce a number of potentially adverse environmental effects having to do with condensed water, either ejected directly into the atmosphere at tower level or formed by condensation within the moist, buoyant plume. These impacts can include: local shading of the sun by the plume, deposition of dissolved salt particles contained in plume water droplets, (drift) fogging at ground level under special circumstances, and, if the weather is sufficiently cold, ice buildup ("icing") on objects with which the plume cloud comes into contact.

A cooling tower analysis was performed using the Electric Power Research Institute (EPRI) Seasonal and Annual Cooling Tower Impact (SACTI) cooling tower model. The SACTI model was developed especially for modeling utility cooling towers. The model is widely recognized as being the most comprehensive and validated cooling tower plume model available for modeling power plant cooling tower plumes. This document discusses the structure of the SACTI model and the modeling methodology employed by TRC in the analysis.

2.0 Evaporative Cooling Tower Impacts

There are two sources of liquid water contained in the plume from a mechanical draft cooling tower:

1) relatively large directly-entrained droplets (called "drift droplets", "tower drift", or simply "drift") in the exhaust plume from the cooling tower, and;

2) water vapor that condenses into small droplets as the plume cools to ambient temperatures. The fundamental differences in the average sizes of these two droplet distributions are significant in producing different potential plume environmental impacts (Policastro, et. al., 1984).

The large drift droplets contain dissolved minerals and have significant settling velocities; in contrast, the very fine condensation droplets do not contain dissolved minerals and have negligible settling velocities.

All the potential environmental impacts typically associated with cooling tower plumes occur because of water (both droplets and vapor) contained in the plume. Visible plumes occur when small water droplets produce an opaque cloud. Plume shadowing occurs when the visible cloud attenuates direct sunlight. Fogging can occur when the plume containing liquid water droplets comes into contact with the ground. Icing can occur as water vapor within the plume contacts and forms a frost on objects whose surface temperature is below freezing. This form of icing occurs by sublimation of water vapor directly to ice, and is essentially identical to frost formation seen on winter mornings. Rime icing occurs when the super-cooled liquid water droplets in the cooling tower plume contact a subfreezing surface. The droplets may freeze on contact. Icing can also occur as directly emitted drift droplets fall onto exposed objects that are at temperatures below freezing. This form of icing occurs as "glaze" ice, which is different from "rime" ice. However, glaze ice is a very localized concern, since modern cooling towers use very high efficiency drift eliminators, and drift is kept to a minimum. The directly emitted-droplets contain some dissolved minerals (including common salt, in the case of the Bowline Unit 3 tower). Deposition of the minerals can also occur in areas where the drift droplets fall.

Two of the cooling tower plume impacts that have significant potential to produce adverse environmental effects are plume fogging and icing. Cooling tower plume fogging and icing can potentially impact vehicular traffic if the fog or ice occurs on a roadway. Cooling tower icing can be a potential safety hazard to structures or other objects due to the weight of the ice on the structure, or if the ice clogs vents or air intakes. Considering these potential environmental impacts, the factors leading to cooling tower fogging and icing are discussed in more detail in the following sections.

2.1 Fogging Potential of Cooling Tower Plumes

A fog is nothing more than a ground level cloud (Huschke, 1959). The same physical processes governing cloud formation and dissipation also govern fog. In general, fog occurs when the air becomes saturated with moisture and microscopic water droplets condense on particles in the air. If the air temperature is less than freezing, icing can develop on objects immersed within the fog. Under normal meteorological conditions, fog does not form if the difference between the air temperature (dry bulb) and the dew point temperature is greater than approximately 4° Fahrenheit (F) (2.2° Celsius (C) (Huschke, 1959). This temperature difference is called the dew point temperature depression, or simply dew point depression.

Cooling tower fog occurs when a plume from the cooling tower is transported to ground, usually by aerodynamic downwash effects in the lee of the tower. The extent of the cooling tower-induced fogging is therefore determined (and limited) by the horizontal and longitudinal extent of the cooling tower plume. Because a cooling tower fog is produced by an emitted plume, rather than by natural cloud (or fog) formation processes, the conditions that result in cooling tower fog are significantly different than those which result in a natural fog. Whereas natural fog formation occurs only with a dew point depression of approximately 2° C or less, cooling tower plume fogging conditions can occur with dew point depressions of 6° C or larger (Policastro, et.al., 1984). The difference is that a mechanical device, the cooling tower, is providing a significant amount of energy to drive the formation and maintenance of a visible plume saturated with moisture. In contrast, low-energy natural processes that operate over large areas typically produce naturally occurring fogs. Additionally, wide area natural fogs are typically associated with light or calm winds, while cooling tower ground fog events are usually the result of downwash under strong winds.

It is unlikely that the moisture or energy released by a cooling tower can induce a fog to occur over wide areas through normal atmospheric processes (Policastro, et.al., 1984). While locally very significant in terms of heat or moisture released, the amount of energy or moisture associated with a cooling tower is minuscule when compared to that contained in the surrounding atmosphere over wide areas.

As stated above, cooling tower fogging at ground levels is produced when a cooling tower plume is transported to the ground. The most common physical process that transports a plume to the ground is aerodynamic wake turbulence (also called downwash). As the name implies, wake turbulence refers to the increased mixing (turbulence) that occurs in the wakes of buildings or structures. The cooling tower housing is a primary cause of this wake turbulence.

Wake turbulence produces two effects on a plume. First, the eddy turbulence and low-pressure area in the lee of the structure cause the physical transport of the plume to the ground. Second, these same processes cause an increase in the entrainment of colder, usually unsaturated ambient air into the plume. This increased mixing causes the plume to cool more rapidly with the rapid condensation of moisture in the plume to form a cloud. Ultimately, all the condensation droplets will evaporate due to the entrainment of typically dryer ambient air into the plume. However, if the ambient air is nearly saturated, the plume can travel for long distances downwind before the water droplets evaporate, and the visible plume eventually disappears.

The primary meteorological parameter affecting wake turbulence is the horizontal wind speed at the level of the plume. As wind speeds increase, the amount of wake turbulence and the size of the area affected by the aerodynamic wake of the structure becomes larger. Of comparable importance in determining the amount of downwash is the size of the cooling tower and any other structures near the cooling tower. The larger the cooling tower housing and adjacent structures or buildings, the larger the resulting wake turbulence will be (for given horizontal wind speed).

Also of importance is the mass flow (momentum) and buoyancy (heat release) of the plume from the cooling tower. A large buoyancy and momentum flux of the plume means that the plume will rise above the wake region of the obstacle for a given situation. As the plume rises and cools due to entrainment of ambient air, further condensation occurs, but plume contact with the ground is not made if the buoyancy and momentum flux is sufficient to loft it above the wake region.

2.2 Icing Potential of Cooling Tower Plumes

As discussed previously, icing formed by a cooling tower plume typically would be rime icing. Rime icing is formed as the super-cooled plume water droplets freeze when in contact with a subfreezing surface.

However, there are two potential sources of water droplets that can lead to icing from the cooling tower plume. These droplets are either directly emitted drift, or water entrained by airflow through the tower, and condensation drops formed in the plume by condensation of water vapor. This section discusses the potential icing from each of these two types of droplets.

2.2.1 Glaze Icing From Drift Droplets

The relatively large drift drops, if present in sufficient number and mass, can pose an icing threat as they settle to the ground. However, with modern drift eliminators installed within the towers, the quantity of liquid water introduced into the surroundings in this way is quite small. In fact, it ranges between about 1 gallon per minute (gpm) to 10 gpm (out of over 180,000 gpm circulated in the cooling tower) for the varieties of towers being considered by Southern Energy. Modern designs of mechanical-draft towers do not appear to pose a significant glaze icing threat from tower drift (Policastro, et.al., 1984).

2.2.2 Rime Icing from Plume Droplets

The icing potential posed by the very small plume droplets is much more complicated. Essentially, however, for airstreams containing liquid water droplets (i.e. a cloud), the potential for icing exists when super-cooled droplets collect and freeze on exposed objects if the surface temperature of the objects is below freezing.

As an airstream's flow splits to go around an obstruction in the airflow, most of the droplets will simply follow the flow and not impact on the object. Some droplets, though, will impact on the obstruction and freeze, producing rime icing if the freezing occurs almost instantaneously. The collection efficiency is defined as the fraction of the total condensed water flux (moving with the undisturbed flow through an area of the same cross-section as the obstruction) which is collected-on the obstruction. Collection efficiency ranges in value between 0.0 and 1.0.

For newly formed, very small droplets in a cooling tower plume, the value of collection efficiency is small, normally 0.05 or less. For still smaller droplets, the collection efficiency approaches zero. These small collection efficiencies generally result in low icing rates. On the other hand, the concentration of condensed water in the plume can be quite large at close-in distances compared to that of natural clouds. Thus, there can still be some icing potential in a cooling tower plume near the tower.

The same conditions that bring the plume to ground level, as described in Section 2.1 for fogging, will allow potential ground-level icing to occur when the surface temperature is below freezing. There may be a higher frequency of occurrence of potential icing on elevated structures because the plume may still come in contact with the elevated structures, while not being sufficiently bent over to reach the ground.

3.0 SACTI Model Description

The EPRI SACTI cooling tower model calculates the seasonal and annual impacts of cooling tower vapor plumes. Various environmental impacts simulated in the SACTI model include:

- visible plume length and radius,
- deposition of minerals (salt) contained in cooling tower plume drift (water droplets entrained in the plume during plume exhaust),
- plume-induced fogging and icing downwind of the cooling tower, and,
- plume shadowing (the amount and duration of plume shadows at a given location).

The SACTI model is a multiple-source model that predicts cooling tower plume impacts from any number of identical natural draft, linear mechanical draft, or circular mechanical draft cooling towers. The SACTI model was designed to provide predictions that can be used in the licensing of power plants with cooling towers. The model developers validated the model with field and laboratory data in all situations where good quality data existed.

The seasonal/annual modeling methodology employed by the SACTI model is a parameterization scheme that reduces the available hourly meteorological data to between 30 and 100 categories of unique meteorological conditions (from a cooling tower plume dispersion perspective). Potential fogging and icing cases are reduced to 10 categories. Each category is modeled separately and the modeling results of the category are assumed to apply for all occurrences of the category for the period for which modeling is performed. The number of specific categories for a given situation is dependent upon the cooling tower geometry, tower emission parameters, and the meteorological conditions experienced at the site. The categorization scheme used in the SACTI model allows a user to analyze multiple years of meteorological data without the need to model every hour of every year to determine plume impacts. The representative scenarios are assumed to apply for multiple hours, thereby greatly reducing computer execution time.

The SACTI model is composed of four separate programs: a meteorological preprocessing program (PREP); a plume dispersion program (MULT); a program to produce tabular summaries of the modeling results (TABLES); and a graphical postprocessor program (PAGE).

To begin a SACTI modeling analysis, the PREP program reads a sequential hourly meteorological data file and generates a set of meteorological scenarios that produce significant plume dispersion effects. The MULT program then computes the expected plume dispersion for each meteorological scenario developed by PREP. The output of the PREP program is a sequential hourly listing of the meteorological conditions and plume dispersion category for each hour of meteorological data processed. The output from the MULT program is a listing of the plume dispersion and fogging impact for each meteorological scenario (category) simulated.

The TABLES program combines the output of the PREP and MULT programs and produces a set of tabular frequency of occurrence listings of the various environmental effects produced by the cooling tower plume. The environmental effects computed by the TABLES program are the average of the individual impacts of each scenario model weighted by the number occurrences of that scenario in the input PREP data file.

The post-processing program PAGE produces computer page plots of the output from the TABLES program. Only the first three programs were needed for this analysis. Graphical post-processing was performed using a separate graphics package, rather than the PAGE program. In this analysis, the contour figures were developed using the Golden Software, Inc, Surfer^{tm} graphics processor.

The SACTI-PREP model generates five scenarios that are assumed to produce cooling tower plume icing and fogging, and five additional scenarios that produce cooling tower plume fogging only. Because plume fogging and icing occur during plume downwash conditions, and downwash is assumed to be different for circular and linear cooling towers of the same size, the icing and fogging scenarios for these two tower types are different. These ten scenarios are independent of individual tower or plume geometry characteristics, except that plumes from natural draft cooling towers are assumed not to produce ground-level fogging and icing.

An additional number of scenarios are also developed that are functions of the meteorological conditions occurring in the input meteorological data. These scenarios depend upon observed wind speed, dry bulb and dew point temperatures, atmospheric stability, and other meteorological factors, in addition to specific cooling tower parameters. These scenarios can vary with the specific cooling tower modeled and are used to estimate the potential for icing and fogging impacts.

3.2 Model Input Parameters

Hourly meteorological data for the years 1985 and 1986 from the Bowline Point Station and from 1995 through 1998 from the Indian Point Nuclear Generating Station was used in the modeling of the Unit 3 cooling tower. These data are considered to be and have been demonstrated by Southern Energy to be the most representative meteorological data to assess the potential cooling tower impacts.

The PREP and MULT program were executed for each case described above. In addition, three tower orientations were considered. Table 1 lists the specific cooling tower dimensional parameters input into MULT.

Table 1
Bowline Unit 3 Cooling Tower Operating Parameters

Tower Type:	Linear Mechanical Draft
Number of Cells:	10 (1x10)
Tower Height (meters):	11.6 (38 ft)
Tower Length (meters):	164.6 (540 ft)
Tower Width (meters):	16.8 (55 ft)
Cell Diameter (meters):	9.1 (30 ft)
Tower Eff. Diameter (meters):	33.8 (111 ft)
Tower Heat Duty (MW):	475
Tower Air Flow (ACFM):	1,390,000*
Circulating Water (gpm)	180,000
Cycles of concentration:	4
Drift (@0.0005%) (gpm)	0.9*
Makeup salinity - % (as NaCl)	10000 ppm
Circulating water salinity - % (as $CaCO_3$)	40000 ppm
Site Latitude(degrees):	41.2 N
Site Longitude (degrees):	74.0 W
* Values are approximate depending on actual operating conditions.	

3.3 Modeling Methodology

The SACTI model computed the expected frequency of occurrence of ground-level plume fogging, icing, shadowing, and salt deposition. In the case of plume fogging, icing and shadowing, the SACTI model provides results tabulated as total hours for the five-year block of data. These values are divided by the number of years in the meteorological data set (in this case, five) to determine the annual average. However, in the case of salt deposition, the values provided are maximum deposition rates (i.e. mass/area/time). The units provided by SACTI for deposition are kilograms/square kilometer/month.

3.4 Methodology for Estimating Ground-Level Impacts

The MULT model assumes that fogging and icing potentially occurs during ten pre-defined meteorological scenarios. Fogging is computed to occur for a given scenario when the plume is modeled to be in physical contact with the ground. The area covered by the plume is then taken to be the area of fogging. Likewise, ground-level icing is computed by assuming icing occurs during the five plume fogging scenarios for which the air temperature is less than freezing.

Salt deposition is computed in MULT using the assumption that all drift droplets falling from the plume strike the ground, thereby depositing all dissolved salt within the droplets. Plume shadowing is computed directly in MULT from the modeled plume dimensions and the projections of these plumes on the ground. Plume shadowing events are only counted during the daylight hours, with changes in sunrise and sunset times adjusted for time of year.

4.0 Summary of Modeling Results

This section summarizes the results and provides contour plots of the various cases assessed. Detailed output tables from the SACTI model are included in the CD-ROM provided to support the Article X Application for Bowline Unit 3. The impact types examined were:

- Icing from water droplets in the plume;
- Plume fogging;
- Salt deposition and
- Plume shadowing.

Table 2 presents the maximum annual values found for each impact type, along with the location of that value, and the tower orientation. Contour plots described in this section are included to show the modeled cooling tower impacts qualitatively. The contours represent an interpolated average of the computed impact values. These plots are intended to display the area extent of any impacts, rather than the actual peak impact value.

4.1 Ground Fogging

The maximum potential fogging impact of approximately five hours per year was calculated to occur on or near the Bowline Property line at 200 meters southwest of the cooling tower. Figure 1 presents the worst-case plume fogging impact for the tower. However, fogging is not calculated to have a significant impact on 9W or at the nearest residential area located approximately 1,000 meters southwest of the proposed cooling tower. Significantly less than one hour of fog is calculated to occur at either of these locations, as demonstrated by the contour plots.

4.2 Ground-Level Rime Icing

The maximum hours for rime ice formation are presented in Figure 2 for the proposed and combined tower impacts. This figure shows that less than one hour of rime ice is calculated to occur per year from the cooling tower. The maximum rime ice location is to the southwest of the cooling tower, and on the opposite side of the Bowline Unit1 and Unit 2 boiler and turbine buildings. As such, it is unlikely for any rime ice formation off of the Bowline Property. As with fogging, ground-level icing is demonstrated to not have a significant impact on Interstate 9W or the nearest residential area.

4.3 Salt Deposition

Salt deposition is typically only a consideration when agricultural land is adjacent to the cooling tower. This is not the case for the Unit 3 cooling tower, since most of the adjoining property is industrial or residential. Figure 3 presents the salt deposition contours for the proposed new tower. The maximum deposition rate of about 633 kg/kilometer^2/month occurs to the northeast of the plant, and within a distance of about 200 meters, and on Bowline Property. An appreciable fraction of the projected salt deposition occurs east of the cooling tower, over the Hudson River. Impacts at both locations are considered trivial and insignificant.

4.4 Plume Shadowing and Visibility

Plume shadowing was found to have a fairly steep gradient near the tower, which fell off rapidly away from the tower. The maximum potential impact of plume shadowing occurred 200 meters east of the cooling tower, over the Hudson River. The nearest residence (1,000 meters southwest) would experience less than 50 hours of plume shadowing per year from the proposed new cooling tower. These conditions are likely to occur during periods of cloudiness and/or inclement weather, therefore there will be no significant plume shadowing at the nearest residence. Figure 4 illustrates the level of plume shadowing resulting from the proposed tower.

Table 2
Summary of Proposed Cooling Tower Impacts

Description (units based on 5-years of hourly meteorology)	**Wet Evaporative Tower Average Day/Night Hours**			**Wet Evaporative Tower Average Day Only Hours**		
	Maximum Value	Direction of Plume	Distance from Tower (meters)	Maximum Value	Direction of Plume	Distance from Tower (meters)
Hours of Plume Fogging (hrs/yr)	5	SSW	200	3	SSW	200
Hours of Icing (hrs/yr)	1	SSW	200	1	SSW	200
Plume Shadowing (hrs/yr)	233	E	200	237	E	200
Plume Salt Deposition	633	E	200	604	E	200

Source: TRC Environmental, 2000

4.5 Plume Height and Length

The primary goal of the visual assessment of the cooling tower plume is to define the frequency of occurrence of maximum and average height and length of plumes. The SACTI model uses a meteorological preprocessor to examine the tower conditions and identify plume categories that will result in both possible ground fog events and elevated plumes. The plume categories identified by the model are tabulated by their frequency of occurrence in the meteorological database. The SACTI met processor calculates plume heights and lengths for each category, and for each representative tower equivalent approach angle. The maximum plume height and length for each equivalent angle were identified, and were sorted by increasing length and height. Table 3 presents a summary of the average number of hours per year the proposed cooling tower will have a specific plume length, and height. As shown in this table, approximately 50% of the time the cooling tower plume will be less than 85 meters in length, and less than 65 meters in height.

Table 3
5 Year Meteorology - Day and Night Conditions - Full Wet Tower

Category	Hours Cum Freq	Length (m)		Category	Hours Cum Freq	Height (m)
15	0%	10		14	0%	0
11	22%	33		15	0%	2
18	25%	55		11	22%	35
13	34%	58		12	26%	49
23	36%	60		13	34%	58
12	40%	61		18	37%	62
27	42%	63		23	40%	64
14	42%	64		31	43%	65
31	45%	73		34	46%	65
30	49%	83		42	49%	65
34	52%	85		33	52%	65
33	55%	85		36	54%	65
35	58%	96		38	57%	66
38	60%	96		35	60%	66
36	63%	97		40	63%	67
16	66%	110		27	65%	68
40	69%	119		30	68%	68
21	71%	119		17	70%	94
17	72%	125		22	71%	95
25	74%	136		16	74%	98
22	75%	137		21	76%	103
42	78%	142		25	78%	115
29	80%	151		26	79%	118
32	82%	155		32	81%	121
26	84%	169		29	84%	127
39	86%	237		37	87%	135
37	89%	251		41	90%	150
41	92%	355		39	92%	160
43	95%	584		44	95%	177
44	98%	620		43	98%	205
45	100%	4869		45	100%	666

Source: TRC Environmental, 2000

Similarly, the SACTI model was run using only the daylight hours, which have been defined as one hour before sunrise until one hour after sunset. Table 4 presents a summary of the average number of daylight hours of occurrence of plume height and width. As shown, approximately 50% of the hours the cooling tower will result in a visible plume 71 meters long and and 63 meters in height. These plumes represent those that would be considered visible to the general public. The cooling tower plume photosimulation was based on the 50 percentile plume using the daytime meteorological conditions from the SACTI model.

Table 4
5 Year Meteorology - Day Only Full Wet Tower

Category	Hours Cum Freq	Length (m)		Category	Hours Cum Freq	Height (m)
11	1%	10		24	3%	-3
12	35%	33		20	3%	-3
13	37%	39		19	4%	-3
14	42%	56		14	9%	0
15	43%	59		15	10%	2
16	44%	61		11	11%	35
17	46%	61		12	45%	36
18	46%	64		13	47%	54
19	47%	65		18	47%	63
20	47%	71		23	48%	63
21	52%	111		27	50%	65
22	56%	119		30	51%	66
23	56%	127		33	51%	67
24	59%	129		22	55%	84
25	59%	132		17	56%	91
26	63%	136		16	57%	98
27	65%	139		29	60%	101
28	65%	156		21	64%	103
29	68%	159		28	65%	106
30	69%	163		26	68%	109
33	69%	174		25	69%	115
34	72%	175		35	71%	116
35	75%	180		36	72%	138
36	75%	185		38	75%	140
37	78%	186		34	78%	145
38	81%	203		37	81%	146
39	85%	221		39	85%	149
40	87%	246		40	87%	166
41	90%	293		42	90%	174
42	92%	312		41	92%	185
43	95%	363		43	95%	205
44	98%	521		44	98%	236
45	100%	2177		45	100%	724

Source: TRC Environmental, 2000

Bowline Unit 3 Article X Application
Section 10.0 – Visual Resources - Errata Sheet
Appendix 10B: Cooling Tower Plume Analysis

Appendix 10B	Items Within Existing Appendix Requiring Revision/Deletion	Project Change/Application Revision
1.0 Introduction	Page 1, Paragraph 1, first sentence, which reads, "Bowline Unit 3 will employ a mechanical draft, evaporative cooling tower to remove waste heat from the condenser circulating cooling water."	Delete sentence.
3.2 Model Input Parameters	Page 7, Table 1, Bowline Unit 3 Cooling Tower Operating Parameters	Delete "Bowline Unit 3" and Insert "Mechanical Draft"
4.4 Plume Shadowing and Visibility	Page 9, Paragraph 3, 3rd sentence, starting: "The nearest residence ..."	Revise sentence to read, "The nearest residence (1,000 meters southwest) would experience less than 50 hours of plume shadowing per year from a mechanical draft cooling tower."
4.4 Plume Shadowing and Visibility	Page 9, Paragraph 3, last sentence, starting: "Figure 4 ..."	Revise sentence to read: "Figure 4 illustrates the level of plume shadowing resulting from a mechanical draft cooling tower."
4.5 Plume Height and Length	Page 10, Paragraph 1, 6th sentence, starting: "Table 3 ..."	Revise sentence to read: "Table 3 presents a summary of the average number of hours per year a mechanical draft cooling tower would have a specific plume length and height."
Table 2: Summary of Proposed Cooling Tower Impacts	Page 10, Table 2 Summary of Proposed Cooling Tower Impacts	Revise table title to read, "Summary of Mechanical Draft Cooling Tower Impacts"

Appendix 10C

BOWLINE UNIT 3
STACK PLUME VISIBILITY ANALYSIS

1.0 Introduction

A major exhaust byproduct of the combined cycle turbines proposed for Bowline Unit 3 will be water vapor. With each pound of natural gas fired, over two pounds of water vapor are formed and emitted from the plant stack. The exhaust gas during oil firing will contain a somewhat higher percentage of water vapor due to the steam injected into the combustion for nitrogen oxide control. Since the exhaust gas contains appreciably more water vapor than the ambient air an analysis was performed to determine if the exhaust plume could condense and become visible under normal atmospheric conditions. A visible plume formed under such conditions is called a mixed vapor plume. When hot humid exhaust gas is vented to a cooler humid atmosphere, the plume may be cooled to the temperature at which the vapor will condense and a visible plume forms. This is similar to seeing one's breath on a cold morning.

Visible plumes resulting from condensed water vapor in the combustion exhaust rarely, if ever, cause a significant environmental or safety concern because the plumes are typically elevated well above ground level. As such, a condensed vapor plume may have a potential adverse effect only if it is visible. A plume is considered visible only if it occurs during conditions that would allow it to be viewed by the general public. This excludes plumes being formed at night, and during periods of bad weather (rain, snow, or fog) that obscure visibility. In order to assess the combustion plume visibility for the proposed project, a detailed visible plume analysis was performed with the Visplume plume visibility model developed by TRC.

2.0 Modeling Inputs and Assumptions

The visual assessment for the water vapor emissions resulting from the combustion gas turbines was prepared using the TRC plume visibility model. This model is a post processor used with output results from the widely recognized USEPA ISCST3 atmospheric dispersion model. The basic assumption of the model is that water vapor is a non-reactive gas that when emitted at a temperature well above its dew point will disperse as a gas, the downwind dispersion characteristics of which are simulated using ISCST3. The ISCST3 model was run using five years of actual hourly meteorological data representative of site conditions. The data set included one year of on-site meteorological data recorded at the Bowline Point Power Station in 1985-1986, and four additional years of data recorded at the Indian Point Nuclear Generating Station, for the years 1995-1998. The additional years of Indian Point data were used in order to increase the number of potential plume hours so as to provide a larger database for statistical analysis. This data set is considered representative of the meteorological conditions that will be experienced at the Bowline Property.

Since the object of this study was to determine the potential total number of hours of visible plumes, the analysis was simplified by assuming the same wind direction for each hour. The mixing heights were set to 10km (to avoid plume reflection conditions). The transitional plume rise option was used. Additionally, all calms were set to 1 m/s second and evaluated by the model. This is counter to regulatory modeling performed to ascertain air quality impacts. In such cases calms are ignored. However, in a plume visibility analysis the calms are very important since the vertical plume which occurs under light wind conditions is likely to be visible.

Visible plume formation was determined by comparing the hourly water vapor concentrations calculated at all receptors to actual meteorological observations and the calculated saturation deficit. The saturation deficit is a measure of the amount of additional water vapor that must be added to a volume of air to bring it to saturation (i.e. 100% humidity.) This analysis presents the results of the visual plume assessment for all plumes formed regardless of time of day and weather.

However, the Indian Point data also included a precipitation amount. Using this value as an indicator of weather, the visual plume analysis also identified a rain (i.e. inclement weather) event along with time of day (day or night). A visible plume was assumed to occur if the water vapor concentration exceeded the saturation deficit for each specific location and hour modeled. Under these conditions, TRC's model assumes the vapor plume will condense to form a visible cloud. However, the condensed vapor plume was considered visible only if it formed during the day and there were no recorded observations of inclement weather (or natural fog). Note that daylight periods included the hour before sunrise and the hour after sunset.

Since visible plume formation from combustion sources is primarily a cool temperature phenomenon, the modeling analysis examined the vapor emissions during two primary operating conditions using the worst case (i.e. cold weather) emission conditions:

1) Natural gas firing in three turbines, 100% load with duct firing;

2) Natural gas firing in one turbine and 100% load, Oil firing in 2 turbines at 50% load each (with steam injection for NOx suppression).

1.03 Modeling Results

The analysis examined 43,824 total hourly observations of meteorological conditions which includes a total of 27,499 daylight hours, approximately 63% of the total period. Note that this is greater than the total number of daylight hours that would be expected assuming an even distribution of day and night hours. This is because the analysis also considered the hour before sunrise and the hour after sunset as being within the visible period. Excluding 2,622 hours of rain events (which were assumed to obscure the visibility of any plume, if one should form) resulted in a total of 25,888 possible visible hours within the meteorological record.

The plume visibility analysis concluded that of the total 43,824 hours, only 3,914 hours of plumes (9%) would occur while firing natural gas in 3 turbines at 100% load. Of the total daylight hours (27,499), and discounting rain events, a total of 1,656 hours were indicated to have visible plume formation (6% of the visible hours). Similarly, for two turbines operating on distillate oil at 50% load and one turbine on gas at 100% load, a total of 724 hours of plumes were calculated (2%), and only 278 hours of the possible visible hours (1%). These results may be normalized to average hours per year by dividing the total counts by 5. In this case, we may expect an average of 780 hours of combustion plume formation during a typical year, of which, a plume may be seen by the general public during only 330 hours.

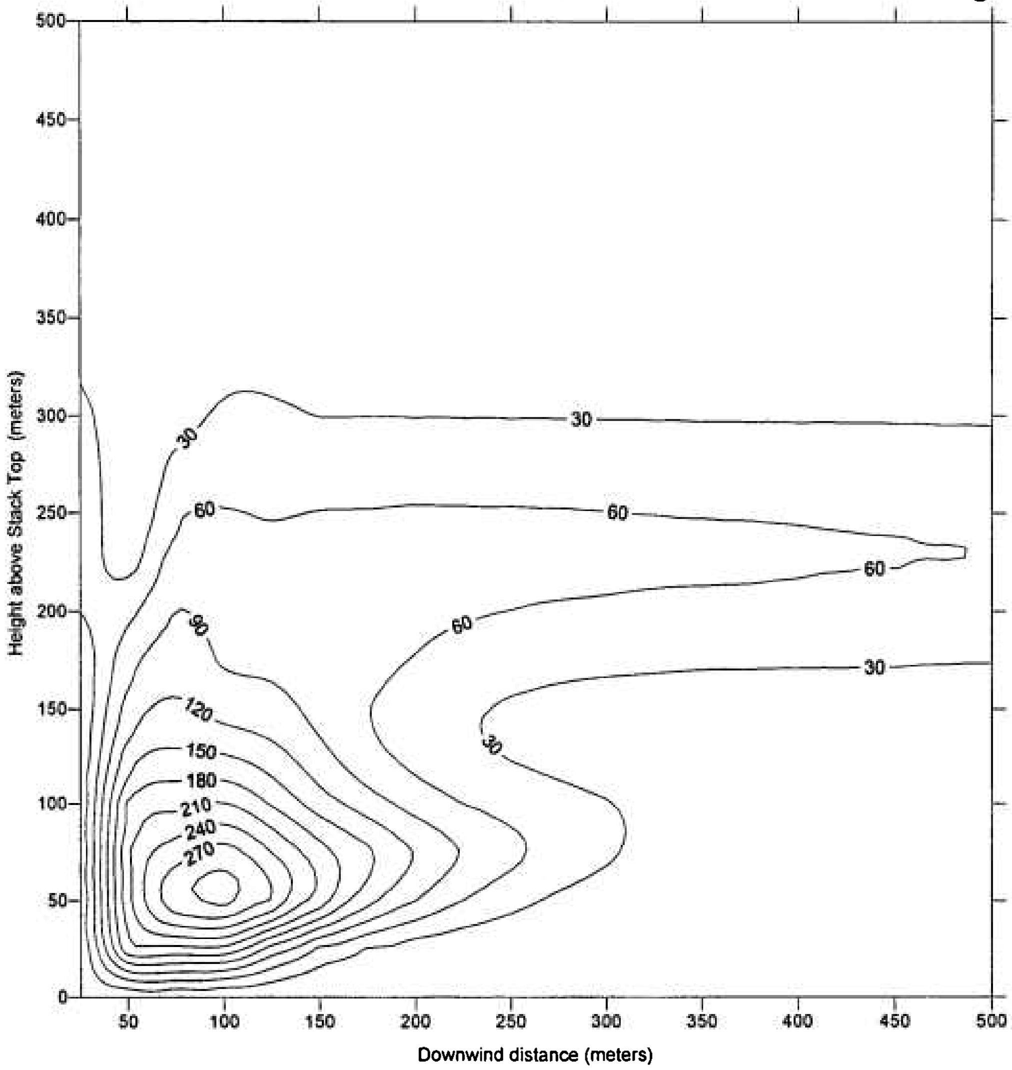
In order to fully visualize the possible formation of a condensed plume resulting from the turbine stacks, contour plots relating the hours of plume formation are included with this analysis. These figures illustrate the average annual hours of all condensed plumes and those plumes that would form under conditions that the general public would readily observe. Note that the plots are direction *independent,* which is to say that the plots represent the average number of plumes that occur regardless of the direction of view. Naturally, certain directions will have a greater likelihood of occurrence due to the prevailing weather conditions; however, the figures should be viewed as presenting a conservative worst case.

The characteristics of the condensed plumes will depend upon the amount of water vapor present and the current atmospheric conditions (i.e. dry bulb and dew point temperatures, stability and wind speed). Under most conditions when a condensed plume forms, it will appear wispy and translucent. The color (seen during the day) will likely be a dull white to light gray. Such plumes are typically not the bright white, billowing plumes seen from boilers that use wet scrubber technology, or from wet evaporative cooling towers. Such plumes are saturated when emitted. This is not the case for a combustion turbine vapor plumes, which are decidedly unsaturated at emission.

3.1 Plume Formation with Natural Gas Firing

Figure 1 presents the average annual hours of possible combustion plume formation assuming Bowline Unit 3 will operate all three turbines on natural gas, at 100% load. This also assumes the worst-case cold temperature emission parameters will occur during all seasons, which is a conservative assumption. All hours for which a condensed plume would occur are shown on Figure 1.

Figure 1: Average Annual Hours for All Combustion Plumes with 100% Natural Gas firing



Note that the greatest frequency of visible plumes is above and downwind of the stack. This is a typical phenomena observed with combustion plumes, which usually do not form until several tens of meters above the stack outlet. The atmospheric thermodynamics resulting in a combustion plume were briefly discussed at the beginning of this report.

Figure 2: Average Annual Visible Hours
Combustion Plumes with 100% Natural Gas firing

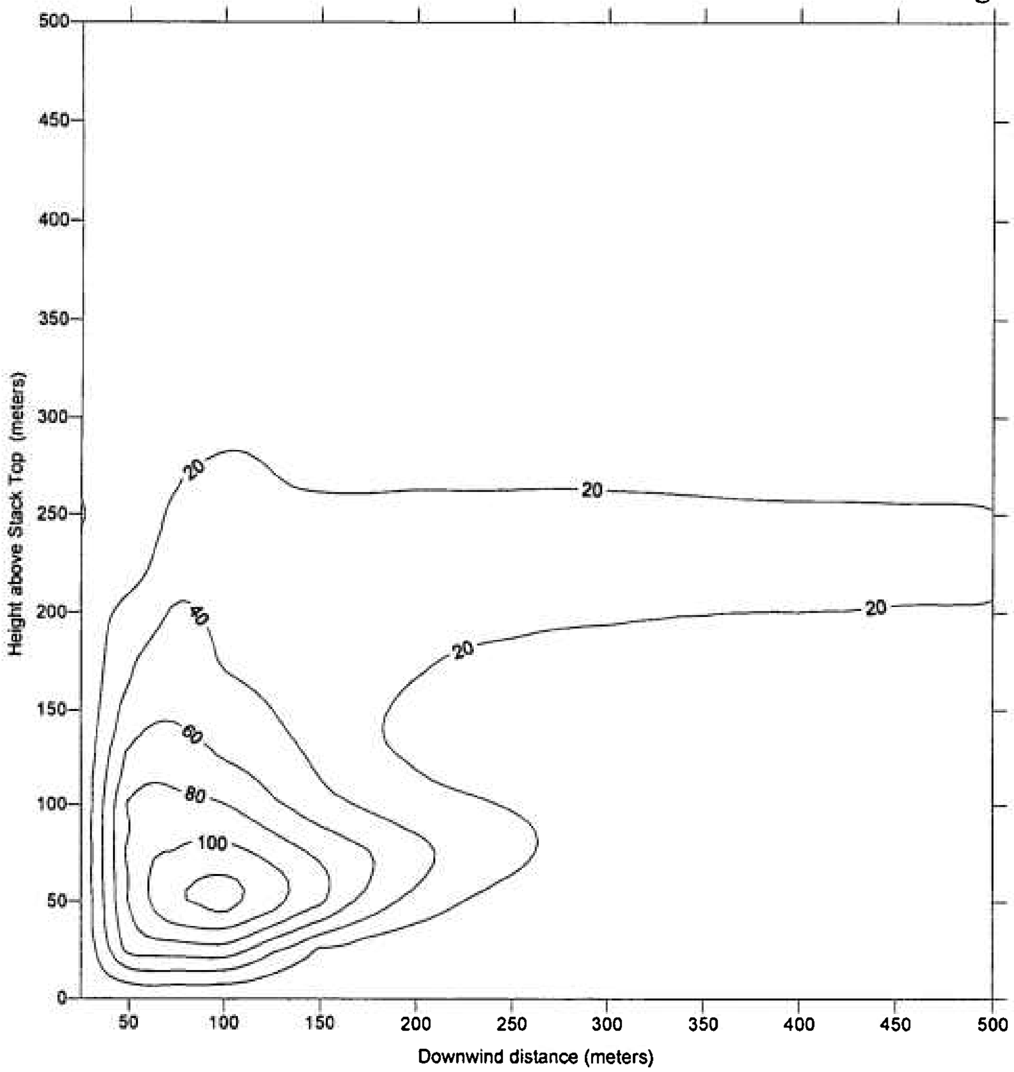


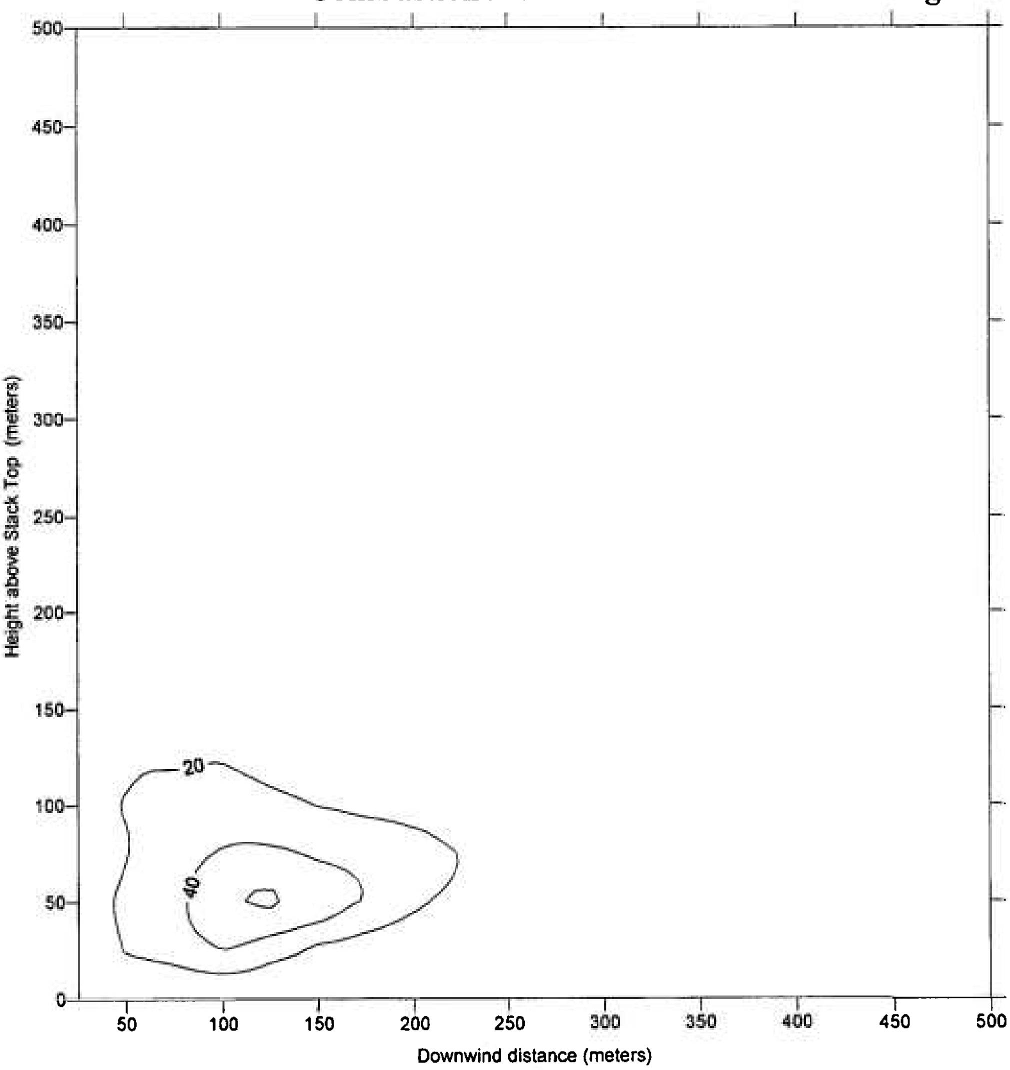
Figure 2 presents the average number of hours per year when the public may actually observe the condensed vapor plumes.

This figure only presents those hours during the day and during fair weather. As can be seen by comparing Figure 2 with Figure 1, two thirds of the condensed plumes occur during the night or with inclement weather. Under normal viewing conditions, the general public may expect to see a visible plume about 330 hours per year with the majority of the plumes to a height of 50-100 m above the stack and 100 m or less downwind of the stack. These hours will typically occur during the early morning.

3.2 Plume Formation with Natural Gas and Oil Firing

Figure 3 presents the condensed combustion plumes assuming Unit 3 will operate two turbines on fuel oil at 50% load with a third turbine at 100% load on natural gas.

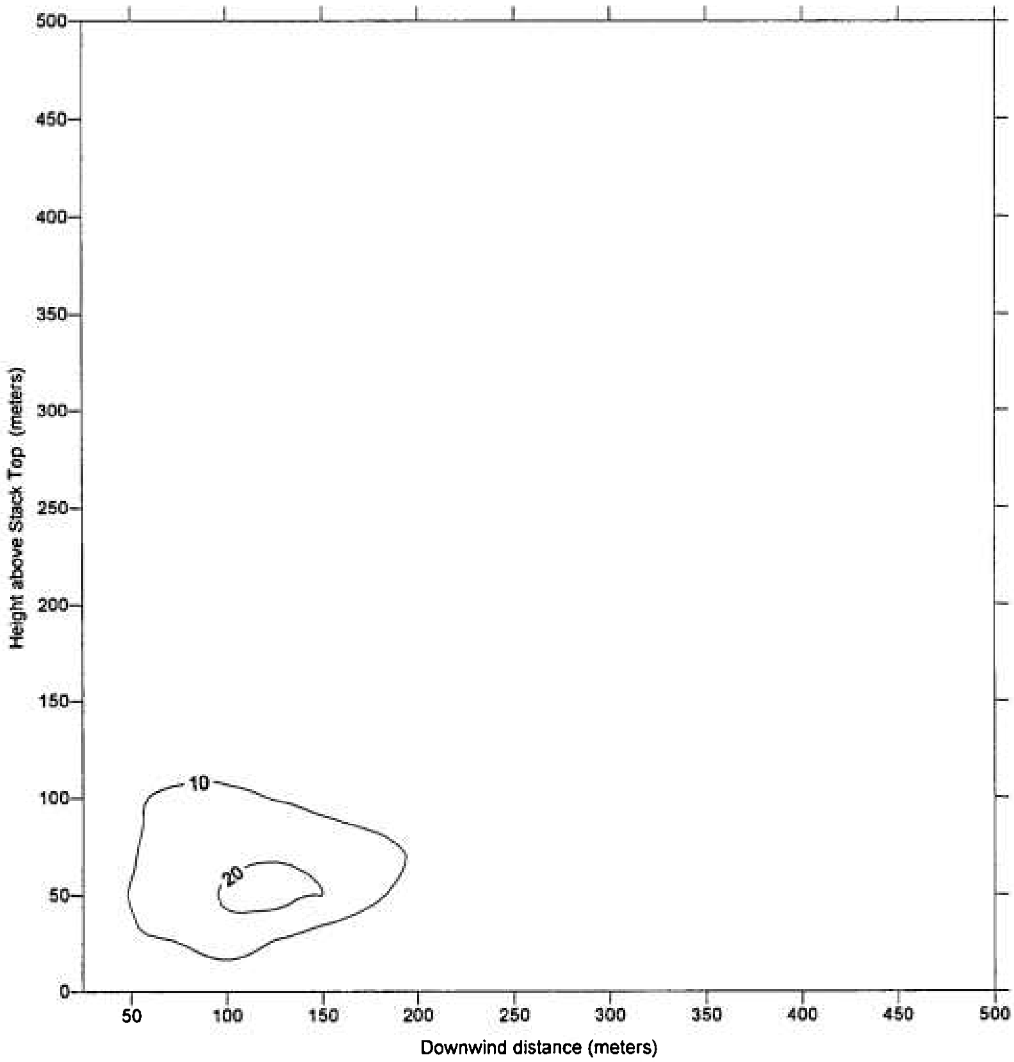
Figure 3: Average Annual Hours for All Combustion Plumes with Oil and Gas Firing



This case is very conservative since it assumes an operating condition that will likely only occur for a limited amount of time during any given year (a total of not more than 1,080 hours). This case also includes a higher percentage of water in the combustion exhaust, which is due to steam injection for NO_x suppression under oil firing. However, the exhaust temperature for oil firing is approximately 50° F higher than that for gas firing. This results in plume with a higher dew point depression, which decreases the likelihood for visible plume formation. As shown by comparing Figure 3 with Figure 1, there are only approximately 56 hours per year of average visible plume formation during oil firing, as compared to nearly 330 hours during natural gas firing.

Similar to Figure 2, Figure 4 presents only the possible visible hours of combustion plume formation during oil firing. As shown in Figure 4, only about 20 hours are projected to be readily seen by the general public. These plumes will be typically very wispy, and will evaporate soon after formation.

Figure 4 Average Annual Visible Hours Combustion Plumes with Oil and Gas firing



3.3 Distribution of Visible Plumes By Month

Table 1 was prepared to present the distribution of possible visible plume formation by month, during the average year. As shown in this table, combustion plume formation is only a cool weather phenomenon, and does not occur during the warmer months.

Table 1
ANNUAL AVERAGE HOURS OF VISIBLE PLUME FORMATION BY MONTH

Month	3 Gas @ 100% load Number of Hours	1 Gas, 2 Oil Number of Hours
January	108	22
February	103	23
March	35	4
April	4	0
May	1	0
June	0	0
July	0	0
August	0	0
September	0	0
October	1	0
November	20	0
December	59	7
Total	**330**	**56**

3.4 Conclusion

Bowline Unit 3 was conservatively assessed to determine the possibility for a visual plume from the operation of the combustion gas turbines. The analysis determined that a visual plume would occur approximately 4% of the time when a plume could be observed during normal operation while firing natural gas. The visible plumes typically will be transient in occurrence and will likely not cause any additional visual intrusion. This is especially true considering that the conditions which result in a plume from Unit 3 will most assuredly result in visible plumes from Units 1 and 2. In conclusion, the exhaust from the combustion turbines may result in a visible plume, but only during the colder months.

J:\DATA\CLIENT\08027\Article X\stackplume.wpd

Appendix 11A

TRC

PHASE IA CULTURAL RESOURCES SURVEY OF THE BOWLINE UNIT 3, HAVERSTRAW, ROCKLAND COUNTY, NEW YORK

TRC

PHASE IA CULTURAL RESOURCES SURVEY OF THE BOWLINE UNIT 3, HAVERSTRAW, ROCKLAND COUNTY, NEW YORK

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Presented by

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OPRHP Project Review Number 99PR2752

Project 25749

December 1999

Summary

TRC Environmental Corporation (TRC) conducted a Phase IA cultural resources survey for Bowline Unit 3 to be developed in the Town of Haverstraw, Rockland County, New York. This work was done at the request of Southern Energy Bowline, L.L.C. (Southern). The Area of Development is approximately 25 acres (10 ha) out of a parcel of 257 acres (104 ha) comprising the existing Bowline Generating Station Property which is owned by Southern. Site files indicate that several brickyards were located on the Bowline Generating Station Property from the mid-nineteenth century to the 1930s.

For this survey, the Area of Development was divided into a western portion (located west of Minisceongo Creek) and an eastern portion (east of the creek). The western portion of the Area of Development has been impacted by mining clay for brick making, use as a dump and automobile junkyard, subsequent filling, and the construction of the existing generating facilities. A geotechnical study determined that the entire western portion was within the former landfill area. No areas with the potential for containing undisturbed subsurface deposits were observed during field visits.

The eastern portion of the Area of Development includes municipal trash deposits indicated by test borings. Much of this portion has been graded and landscaped, and recent alluvial deposits have been reported. Undisturbed ground containing prehistoric, historic agricultural, or early industrial remains is unlikely.

Parts of the Bowline Generating Station Property south and north of the Area of Development also were examined by TRC. Evidence of previous development, including the existing plant facilities, is in the southern part of this property. It is unlikely that intact subsurface cultural deposits are present.

In the northern part of the Bowline Generating Station Property in which no development is planned there is a four-sided brick chimney. Bricks in the chimney were made in the Garner brickyard, which formerly occupied this site. The chimney bricks are, according to a local informant, approximately 100 years old. No evidence of agricultural facilities was seen in this part of the property.

Bowline Unit 3 will not impact any cultural resources. No properties listed in the State or National Registers of Historic Places will be impacted directly by this Project. TRC recommends that no further work be required at the Area of Development.

Acknowledgments

TRC wishes to thank the personnel of Southern's Bowline Units 1 and 2 for providing information and access. Frances Yonke of the Historical Society of Rockland County, Jack Berrian, and Thomas Sullivan were helpful in discussing the history of the region and brick making in particular. Mr. Douglas Mackey and the staff of the New York State Office of Parks, Recreation and Historic Preservation at Peebles Island were cooperative and gave us all requested assistance.

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1.0 Introduction

TRC Environmental Corporation (TRC) of Lyndhurst, New Jersey, conducted a Phase IA cultural resources survey of the location of Bowline Unit 3 in the Town of Haverstraw, Rockland County, New York. Work was done at the request of Southern Energy Bowline, L.L.C. (Southern) in support of an application submitted under Article X of the Public Service Law of New York State. The present report documents the results of the Phase IA survey, performed after receiving comments from the New York State Office of Parks, Recreation and Historic Preservation (OPRHP), which assigned Review Number 99PR2572 to this Project. Background research and fieldwork were conducted in November and December 1999. The results of existing studies (e.g., Schnabel Engineering 1999) have been incorporated into this report.

1.1 Project and Anticipated Impacts

Bowline Unit 3 is a nominal 750 MW combined cycle gas turbine power plant which will be located on a portion of Southern's Bowline Generating Station Property in the Town of Haverstraw, Rockland County, New York. Bowline Unit 3 will be located north of the existing Bowline Units 1 and 2 in two areas divided by Minisceongo Creek. West of the creek, one steam turbine and three combustion turbine generators and one stack are planned; east of the creek, a 10-cell, mechanical draft cooling tower is planned.

Associated with this project are a new natural gas pipeline and two 345 kV electric transmission lines. The impacts of construction of these lines are discussed in two separate reports. The present report is referenced as Holmes and Reycraft (1999a), the report on the associated 345 kV lines is referenced as Holmes and Reycraft (1999b), and the report on the associated natural gas line is referenced as Holmes and Reycraft (1999c).

1.2 Area of Development and Description

The Area of Development is within Southern's Bowline Generating Station Property in the Town of Haverstraw, Rockland County, New York, approximately 35 miles (56 km) north of New York City (Figure 1.1), and is depicted on the Haverstraw, New York, USGS quadrangle (Figure 1.2). It is bounded on the east by the Hudson River, on the south by low-lying land adjacent to the River, on the west by a municipal park and the Samsondale area, and on the north by more low-lying land. Land within 1.0 mile (1.6 km) of the Bowline Generating Station Property includes residential and commercial properties in the Villages of West Haverstraw and Haverstraw. Minisceongo Creek flows from the southeast to the northwest through the property. Most of the land is level, with elevations of less than 20 ft (6 m) above mean sea level. Approximately 25 acres (10 ha) will be impacted by proposed construction, and they are referred to in this report as the Area of Development. The Bowline Generating Station Property owned by Southern consists of 257 acres (104 ha), but no current plans for further construction are associated with Bowline Unit 3.

The Area of Development is divided by Minisceongo Creek into an eastern portion and a western portion (Figure 1.3). The eastern portion, which is the location of the mechanical draft cooling tower, lies east of an existing helicopter pad. Here the ground has been graded and landscaped. The western portion, where generators and one stack are to be built, is north of the existing power plant structures. A gravel access road and railroad spur run through this portion; there is also a gravel parking area.

Outside the Area of Development, and immediately south of Bowline Unit 3, are Bowline Units 1 and 2. The area is characterized by buildings, paved roads, parking areas, and landscaped ground. To the north of the Area of Development is a heavily wooded area with underbrush. This area contains wetlands and structural remains related to brick making, as discussed below.

1.3 Purpose of a Phase IA Survey

The purpose of Phase I cultural resources survey is "to identify archaeologically sensitive areas, cultural/sacred areas, and standing structures that are at least 50 years old, that may be affected by a proposed project and to locate all prehistoric and historic cultural/archaeological resources that may exist within the proposed project area" (New York Archaeological Council 1994).

A Phase IA reconnaissance is intended to gather information on the environmental setting and the cultural/historical setting to provide a basis for a sensitivity assessment. It also should provide a rationale for developing a research design, a sensitivity assessment, and appropriate Phase IB field methods. A Phase IB site locational survey uses subsurface investigation to find features and artifacts, which indicate the presence of sites. Results of a Phase I survey include recommendations regarding future work in a project area.

1.4 Report Format

This report follows the suggestions in the *Standards for Cultural Resource Investigations* (New York Archaeological Council 1994) and general professional standards for archaeological reports. It includes discussions of:

- Introductory information on the Project (Section 1.0)
- An overview of the environmental and cultural/historical settings (Section 2.0)
- Background research, including previous research and recorded sites, and the methods employed for this study (Section 3.0)
- Results and recommendations (Section 4.0)
- References cited (Section 5.0)

1.5 Principal Personnel

The Principal Investigator (PI) was Richard D. Holmes, Ph.D., of TRC's cultural resource staff. Dr. Holmes visited the Area of Development twice in November 1999 and conducted site files and literature searches. Richard M. Reycraft, Ph.D., of TRC provided background material and it has been incorporated into Section 2.0 of this document. Kim Croshier of Hartgen Archeological Associates, Inc., of Troy, New York performed additional site file research. Emily Herd prepared maps, Gwyneth Duncan reviewed the report, Tracey Suzuki edited it, Toni R. Goar assisted with revisions, and Constance King supervised document production. Kevin Maher and Craig Wolfgang of TRC's Lyndhurst office coordinated work on this project.

1.6 Relevant Laws, Regulations, and Standards

TRC conducts environmental and cultural resource investigations under federal and state legislation, including the National Historic Preservation Act of 1966, as amended; the National Environmental Policy Act of 1969; and the New York State Parks, Recreation and Historic Preservation Law. Standards and guidelines that are followed include 36 CFR 60; *Standards for Cultural Resource Investigations and the Curation of Archaeological Collections in New York State* (New York Archaeological Council 1994); and editorial policies of *American Antiquity*.

2.0 Environmental, Cultural, and Historical Setting

2.1 Environmental Overview

2.1.1 Geology

The Area of Development is in the Triassic Lowlands of the Piedmont Province. Bedrock is Triassic arkose and mudstone of the Brunswick Formation of the Newark Group. These sedimentary rocks overlie Palisades diabase, which is exposed in an escarpment to the south (Bonnell 1990). Late Wisconsin glacial ice scoured the bedrock surface, while glacial till, consisting of gravel, sand, silt, and clay, was deposited beneath, and in front, of the ice face. Meltwater from the glacier deposited stratified beds of sand and gravel in valleys. As the glaciers retreated, glacial lakes formed. In these lakes are thick deposits of silt and clay which became important economic resources in historic times.

2.1.2 Soils

Soil in the Area of Development is categorized as urban land (in which at least 50 percent of the land surface is covered by buildings, parking lots, and other impervious structures) and udorthents, wet substratum (somewhat poorly drained to very poorly drained soils that have been altered mainly by filling) (Bonnell 1990). Further information provided by geotechnical engineering studies is presented in Section 3.5. Prior to historic activities, Ipswich soil probably predominated; this soil is poorly drained and subject to inundation, with a water table close to the surface.

2.1.3 Hydrology

The Bowline Generating Station Property is on the western bank of the Haverstraw Bay section of the Hudson River. Near the Area of Development are marshy lowlands associated with Minisceongo Creek and Cedar Pond Brook. Minisceongo Creek is a low-gradient stream with alluvial terraces between Samsondale Avenue and State Highway 9W; further upstream the creek has steeper embankments that show signs of severe erosion and attempts to control the erosion. The Area of Development is divided into two parts by Minisceongo Creek, which runs southeast to northwest. North of the Area of Development, Minisceongo Creek meanders through low-lying wetlands and empties into Stony Point Bay of the Hudson River.

2.1.4 Historic and Recent Land Use

Land in the Area of Development has been used for brick manufacturing from the mid-nineteenth century through the 1930s (Mr. Jack Berrian, personal communication 1999; Mr. Thomas Sullivan, personal communication 1999). Clay pits became ponds (such as the one in the municipal park adjacent to Southern's property, or the one in the northern part of the property), or were used for trash dumping. Aerial photographs from the 1960s show that the land was used for a trash dump and an automobile junkyard. In the 1970s, the property was filled and the existing Bowline Units 1 and 2 constructed.

2.2 Prehistoric Overview

2.2.1 Paleoindian Period (10,500-8000 B.C.)

The current archaeological consensus is that the area surrounding the Hudson River Valley was first occupied during the Early Paleoindian period (10,500-000 B.C.) (Funk 1978; Ritchie 1980). To date, the earliest accepted items of material culture in the region represent Clovis-like lithic assemblages found in open-air sites located on hills and rises (Funk 1978). These early occupations occurred in a tundra or park-tundra like environment created by the retreating Wisconsin ice sheet. Site distribution data are limited, but suggest the presence of larger multi-seasonal, multi-purpose habitation sites and smaller seasonal special purpose camps, such as Kings Road (Funk 1978; Ritchie 1980). Data from early Paleoindian sites in the region suggest that Clovis peoples were primarily big game hunters who exploited caribou, mastodon, moose, elk, and other large Pleistocene fauna when available, and small game and edible plants when megafauna were not available (Ritchie 1956).

Late Paleoindian-period (9000-8000 B.C.) occupations, defined by Plano-like projectile points, are rare in eastern New York. This may reflect changing climatic conditions as coniferous forests replaced the tundra and tundra-park like environments of the earlier period with low carrying capacities for game species (Ritchie 1980).

2.2.2 Archaic Period (8000-1000 B.C.)

Archaic occupation in the northeastern United States can be divided into the Early (8000-6000 B.C), Middle (6000-4000 B.C.) and Late (4000-1400 B.C.) periods (Fowler 1959). Early and Middle Archaic-period occupations are rare in eastern New York, and penetration of this region by Archaic peoples may have coincided with the northward advancement of deciduous forests during the Hypsithermal climatic interval of 8000-5000 B.C. (Ritchie 1971).

Late Archaic sites are much more common in eastern New York. Deciduous forests would have been present in this region for more than a thousand years, and Late Archaic occupations appear well adapted to this environment. At the Late Archaic-period River and Bent sites, approximately 40 percent of the total artifact assemblages were composed of lithic projectile points and atlatl weights, indicating the continued emphasis of hunting. The presence of burned-rock roasting pits, containing carbonized acorn cotyledons, and notched pebble net sinkers also attests to the significance of wild plant and riverine resources (Ritchie 1980).

Late Archaic occupations continued to be located near large river drainages and lakes. Sites from this period appear as either large multipurpose settlements containing abundant sheet midden, or small, specialized camps that lack such debris. Site structural, floral, faunal, and artifactual data attest to a seasonally contingent resource extraction strategy whereby large riverine central-base settlements were occupied by macro-bands throughout the spring and summer, and small camps were either fall-winter micro-band camps or specialized resource extractive locations.

Ritchie (1980) has defined a so-called Transitional stage up to the use of ceramics for the Middle Atlantic region. In New York, this pre-adaptation, known as the Susquehanna tradition, appears to be confined to river drainages in the central part of the state. This transition is defined by the appearance on several Archaic sites of soapstone bowls and crude ceramics with steatite temper. The Transitional stage appears to reflect a change in technology and cooking practices rather than any dietary or economic shift.

2.2.3 Woodland Period (1000 B.C.-A.D. 1600)

The Early Woodland period (1000-300 B.C.) is defined by the introduction of ceramics on a scale larger than the tentative applications found at the end of the Transitional stage. Early Woodland occupations, such as those of the Meadowood phase, continued to be located on rivers and lakes near propitious fishing grounds. Thick- and coarse-tempered gray to black or bluff colored wares, such as Vinette 1, were employed in place of steatite and/or wooden vessels for cooking. The presence of copper beads and implements and marine shell beads suggests ties to the Great Lakes and Atlantic coastal regions, while numerous stone gorgets and tubular ceramic pipes indicate a heightened emphasis on status and ritual.

Mortuary ceremonialism becomes much more formalized during this period, and human remains were often cremated, placed in pits with a variety of grave offerings, and covered with red ochre.

The Middle Woodland period (300 B.C.-A.D. 1000) is characterized by a continued riverine focus and an increase in trade contacts and ceremonialism as documented by the Adena related materials associated with the Middlesex phase in eastern New York (Ritchie 1980).

During the Late Woodland period (A.D. 1000-1600) the region was occupied by the Delaware people. These Algonkian speakers were not related to the Owasco people of upper New York State, who may be ancestral to the Iroquois. Linguistic differences distinguished the aboriginal inhabitants of the region from New England and Long Island. Subsistence was based on hunting, fishing, and cultivation of maize, beans, and squash.

2.3 Historic Overview

Sustained European-Native American contact in the Hudson River Valley dates to 1609 when Henry Hudson sailed up the Hudson River. The first permanent and lasting European settlement of what became New York State was directed by the Dutch West Indian Company, which was founded in 1621. Military outposts were established at New Amsterdam and Fort Orange in 1624. The Dutch Colonial period lasted from 1624 to 1664 when the English took control of what is now New York.

European settlement of what is now Rockland County began around 1675 in the vicinity of Nyack. Several families moved into the area over the next few years. Orange County, which until 1798 included today's Rockland County, was established in 1683. By 1700 there were only a few hundred European residents of Orange County, mostly in the southeastern corner; they included Dutch, English, and French Huguenots. Forests were cleared as agriculture expanded in the area in the early 1700s.

Transportation focused on the Hudson River. During the American Revolution, battles were fought to control this strategic passage. Sloops carried the products of the region to New York City. Among the commodities that were produced were stone, iron, and bricks.

Bricks were made from clay along the Hudson River. Around 1810, Haverstraw became a major brick-making center with two technological developments. A device to mix clay, sand, and coal dust in constant proportions was invented, and then a brick-making machine was invented in the mid-nineteenth century. Building construction in New York City demanded a large supply of bricks, and there were 42 brickyards in Haverstraw. In 1906, a disastrous landslide of a clay bank destroyed part of the town. Economic downturns and changes in construction materials led to the decline of the brick-making business in the 1930s.

Rockland County has not been dominated by industry in the twentieth century. Open land was available, and it was valued as parkland. The Palisades Interstate Park Commission oversaw the creation of parks such as the one at High Tor. Today, much of Rockland County's land is used as parks.

During the twentieth century, transportation became important in the county with the development of the New York Thruway and the Tappan Zee Bridge. The principal change in the character of Rockland County has been increasing suburbanization.

3.0 Background Research and Methods

3.1 Research Methods and Sources

The PI and other TRC staff members visited the Bowline Generating Station Property with Southern personnel and walked over the Area of Development and adjacent land. Subsequently the PI revisited Bowline Generating Station Property to inspect the northern portion of the property, which will not be affected by proposed construction.

The PI, who consulted with OPRHP staff on the project, inspected site files at the OPRHP's repository. Subsequently, a researcher conducted additional site files searches to locate reported archaeological sites within 1.0 mile (1.6 km) of the Area of Development. Additional information on properties listed or determined eligible for the NRHP was made available to TRC; this includes information collected by the Historical Society of Rockland County.

Other studies were incorporated into this report, including the geotechnical engineering report performed for Southern (Schnabel Engineering 1999). Historic aerial photographs were acquired, as well. Telephone interviews were conducted with Frances Yunke of the Historical Society of Rockland County, Jack Berrian, and Thomas Sullivan.

3.2 Assessing Sensitivity

In general, it is possible to rank areas according to their potential for containing archaeological sites on the basis of known information and environmental factors. Doing so can efficiently direct efforts at locating, identifying, and evaluating archaeological sites.

For prehistoric sites, environmental factors include soil characteristics (such as drainage), slope, aspect, and proximity to water and other resources. What must be kept in mind, however, is that the topography present today may be significantly different than it was hundreds or thousands of years ago. Furthermore, archaeologists, anthropologists, and historians must avoid projecting their own cultural preferences on the decisions made by people in the past.

For historic sites, archival and oral history data can provide a guide to structures and activity areas. Surface remains from the historic periods are more likely to exist than prehistoric features. Maps and pictures sometimes can locate sites precisely. Historic roads, watercourses, and standing structures also can suggest historic archaeological sites.

3.3 Historic Contexts

Before beginning an archaeological survey, a researcher should consider what might be found. Examination of previous research and secondary historical and archaeological literature suggests appropriate historic contexts, research issues, and the types of sites that may be expected in the project area. Historic contexts provide the framework for identifying, interpreting, and evaluating sites. Among the historic contexts relevant to the Area of Development are the following:

- Riverine adaptations by prehistoric inhabitants of the lower Hudson Valley;
- Contact among Native American populations in the lower Hudson Valley;
- Native American-European contact in the Hudson Valley;
- European settlement in the Hudson Valley in the seventeenth century;
- The persistence of Dutch culture and the transition from Dutch to English culture;
- Settlement and farming in northern Rockland County; and
- Development of industry and commerce in northern Rockland County, particularly the brick-making industry.

Site types that may be found include:

- Prehistoric villages and camps;
- Prehistoric resource extraction areas;
- Prehistoric hunting areas near wetlands;
- Historic farmsteads;
- Brick making and other industrial sites;
- Roads, including road traces, plank and corduroy road remains, and former road alignments; and
- River transportation facilities.

3.4 Previous Research and Recorded Sites

A survey of the archaeological site records and historical sources was conducted by Nan Rothschild (Rothschild 1977) and is on file at the OPRHP. It notes that the earliest archaeological work done within the Haverstraw quadrangle was by Beauchamp in 1900. Other early archaeologists recorded sites in Rockland County.

New York State Museum site files record the following near the Area of Development:

- NYSM 7926 – Grassy Point, a camp reported by Max Schrabish in 1936;
- NYSM 6370 and 6371 – south and west of the Area of Development, on High Tor, reported with no other information by George Budke in the 1920s; and
- NYSM 4653 – "traces of occupation" reported by A.C. Parker in 1922 (this may overlap the northern edge of the Bowline Generating Station Property, but not the Area of Development).

Within 1.0 mile (1.6 km) of the Area of Development is a site recorded on a NYSM map as "Site U":

- Cedar Pond Brook site, "a heap of stones" reported by Beauchamp in the 1920s.

In the OPRHP site files, including Rothschild (1977), there are more than 70 sites or localities reported within 1.0 mile (1.6 km) of the Area of Development. Among these are several standing structures that are not visible from the Area of Development. On the Hudson River, within the Bowline Generating Station Property, are the following sites or localities with the numbers assigned by Rothschild. These sites or localities no longer exist.

- 113 – Haverstraw brickyard at the far northern end of the Bowline Generating Station Property;
- 114 – Garner brickyard, which includes the northern part of the Bowline Generating Station Property, where a brick chimney is located; and
- 115 – Allison brickyard, which may be at the River's edge of the eastern portion of the Area of Development.

Further south on Bowline Point itself are:

- 116 – Peck's brickyard;
- 117 – Peck's dock; and
- 118 – an unnamed brickyard.

To the west, on State Highway 9W is:

- A087-44-0005, the Treason House site where British Major John Andre stayed in 1780 while meeting with Benedict Arnold to arrange the surrender of West Point. The building was demolished in 1929.

Portions of the right-of-way owned by Southern were surveyed recently for the proposed Millennium Pipeline (Weed and Walsh 1997). This survey located:

- A08740.000161, ROC 101/500, a location containing fill deposits with potential cultural material; and
- A08744.000012, ROC 007, a railroad bridge (New York, West Shore and Buffalo Railroad) crossing the right-of-way and dating to the 1880s.

The Rockland County Planning Department provided information on properties listed on the National Register of Historic Places (NRHP). The following are NRHP properties within 3.0 miles (5 km) of the Area of Development:

- Stony Point Battlefield, Stony Point;
- Stony Point Lighthouse, Stony Point;
- Marine Vessel Commander, Village of Haverstraw (moored on the Hudson River);
- Fraser-Hoyer House, Village of West Haverstraw;
- Kings Daughter Library, Village of Haverstraw;
- U.S. Post Office, Village of Haverstraw;
- Homestead, Village of Haverstraw; and
- Blauvelt House Museum, New City.

3.5 Geotechnical Engineering Studies

Schnabel Engineering Associates, Inc., of Bethesda, Maryland, conducted a geotechnical engineering study of the Area of Development (Schnabel Engineering 1999). The following strata were identified by test borings:

Table 3.1 Test Boring Results (Adapted from Schnabel Engineering 1999).

Stratum	Depths
Stratum A – Clean fill	From surface to depths of 0.5–12.0 ft (0.2–3.7 m)
Stratum A1 – Landfill material	Below Stratum A, to depths of 4.0–22.0 ft (1.2–6.7 m)
Stratum B – Recent alluvium	Below Stratum A1 to depths of 28.5 ft (8.7 m)
Stratum B1 – Recent alluvium	Below Strata A1 and B to depths of 28.0–81.0 ft (8.5–24.7 m)
Stratum C – Glacial till	Below Stratum B to maximum depth of drilling in some test borings, and to depths of 46.0–93.0 ft in other test borings (14.0–28.3 m)
Stratum D – Brunswick Formation	Below Stratum C to maximum depth of drilling

These results demonstrate that clean fill has been deposited across both the eastern portion and the western portion of the Area of Development. Fill was recorded in two of the four test borings in the eastern portion: Test Boring B-26 contained fill in the upper 6.0 ft (1.8 m), and Test Boring B-27 contained 10 ft (3.0 m) of fill. Material from the former landfill also was found. The geotechnical engineering report states:

> *A portion of the site west of Minisceongo Creek [i.e., the Western Portion] is known to have been a municipal landfill or dump. The extent of the landfill was unknown prior to this investigation, but was believed to be limited to the area west of the proposed turbines.*

However, mixed refuse from the dump was found in all test pits and all borings drilled west of Minisceongo Creek [i.e., the Western Portion]. Therefore the former landfill occupies the entire area of planned construction for the turbine generators and stacks. As part of this investigation, Schnabel obtained large-scale photo graphs of the site flown in 1953, 1965, and 1968. These photographs... [Submitted with Schnabel Engineering 1999]... show the development of the landfill prior to the construction of the exiting facility...In general, the landfill material consists of gray and black sandy silt with municipal solid waste and construction debris including wallboard, metal, glass, paper, burlap, and miscellaneous trash (Schnabel Engineering 1999).

4.0 Results and Recommendations

The following results of the cultural resource survey, assessments of archaeological potential, and recommendations are presented. They are made on the basis of two site visits by the PI, background research, site files and literature searches, interviews with knowledgeable informants, and a geotechnical engineering study.

4.1 Results and Assessments

The western portion of the Area of Development has been impacted by mining clay for brick making, use as a dump and automobile junkyard, and subsequent filling and the construction of the existing Bowline Units 1 and 2 (e.g., the railroad spur and gravel-covered areas). The geotechnical study (Schnabel Engineering 1999) concludes that the entire western portion was within the former landfill area. No areas with the potential for containing undisturbed subsurface deposits were observed during site visits.

The eastern portion of the Area of Development includes places where test borings found municipal trash (Schnabel Engineering 1999). Much of this has been graded and landscaped, and recent alluvial deposits also have been reported in this portion. There is not likely to be undisturbed ground containing prehistoric, agricultural, or early industrial remains. The Allison brickyard, reported by Rothschild (1977) as historic locality 115, was in the eastern portion of the Area of Development, but no evidence of remains was seen in the field.

Previous development, including the existing plant facilities, is evident in the southern part of the Bowline Generating Station Property. It is unlikely that intact subsurface cultural deposits will be encountered there.

In the northern part of the Bowline Generation Station Property, which is outside of the Area of Development, is a four-sided brick chimney approximately 50 ft (15 m) tall. The bricks are manufactured with evidence of a maker's mark on a loose fragment observed in the field. Apparently, they were made in the Garner brickyard, which occupied this site. This location corresponds to historic locality 114 reported by Rothschild (1977). Two openings, one circular and one rectangular, are on the face of the chimney and are probably openings for conduits that were connected to an engine house (Mr. Thomas Sullivan, personal communication 1999). Steam power generated in engine houses, such as the one that was attached to this chimney, turned the machinery for mixing clay and moving it into molds. According to Mr. Sullivan, this structure is the last of perhaps 20 or more chimneys that once stood in the vicinity, and he suggested that it is about 100 years old. No evidence of agricultural structures was found in this part of the property. Automobile refuse from the time that the Bowline Generating Station Property was used as an automobile junkyard was seen.

4.2 Recommendations

TRC recommends that no further work be required in the western portion and the eastern portion of the Bowline Generating Station Property.

No work is planned near the brick chimney, which represents early brick making at the Garner brickyard, one of many former brick manufactures in northern Rockland County. Unless plans change to include impacts to the chimney and its immediate area, no additional work is necessary.

Appendix 11B

TRC

PHASE IA CULTURAL RESOURCES SURVEY OF THE 345 kV LINES, TOWN OF HAVERSTRAW AND VILLAGE OF WEST HAVERSTRAW, ROCKLAND COUNTY, NEW YORK

TRC

PHASE IA CULTURAL RESOURCES SURVEY OF THE 345 kV LINES, TOWN OF HAVERSTRAW AND, VILLAGE OF WEST HAVERSTRAW ROCKLAND COUNTY, NEW YORK

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Principal Investigator

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OPRHP Project Review Number 99PR2572

Project 27194

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Summary

TRC Environmental Corporation (TRC) conducted a Phase IA archaeological survey of the route of two 345 kV transmission lines in Rockland County, New York. Southern Energy Bowline, L.L.C. requested this work in connection with its Bowline Unit 3 project. Information on the Bowline Unit 3 project is presented in a separate report prepared by TRC (Holmes and Reycraft 1999a); the natural gas line project is presented in a separate report and referenced as Holmes and Reycraft 1999c. The present report is referenced as Holmes and Reycraft 1999b.

The 345 kV transmission lines Interconnection will be located in a right-of-way up to 300 ft (91 m) wide, extending approximately 1.0 mile (1.6 km) from Southern's Bowline Generating Station Property in the Town of Haverstraw to the West Haverstraw Substation in the Village of West Haverstraw. This includes approximately 4,450 ft of continuing property from Samsondale Avenue to approximately 450 ft east of Bridge Street that is owned in fee by Southern Energy. There are existing natural gas, 345 kV electric, and other utility lines in the right-of-way. Minisceongo Creek runs through the property from Samsondale Avenue to approximately 200 ft east of the western edge of the fee property (between Route 9W and Bridge Street). West of State Highway 9W, the right-of-way crosses Minisceongo Creek in a steep ravine that has eroded banks. It crosses more developed areas in the Garnerville area of the Village of West Haverstraw.

The results and recommendations are summarized as follows:

State and National Registers of Historic Places: No property listed in the State and National Registers of Historic Places will be adversely impacted by the 345 kV transmission lines Interconnection.

Bowline Generating Station Property to Samsondale Avenue: Previous researchers reported buried fill deposits (ROC 101/500, A08740.000161). The right-of-way includes old brickyards and landfill. Intact deposits are unlikely.

Samsondale Avenue to railroad bridge over Minisceongo Creek: Alluvial terraces have been disturbed by vehicles, stream cutting/deposition, and recent tree removal. The Principal Investigator examined roots from felled trees, but no artifacts were seen. It is unlikely that cultural material has withstood flooding or disturbance. The bridge (ROC 007, A08744.000012, ca. 1880) has been evaluated as not eligible for the National Register of Historic Places.

Railroad bridge to State Highway 9W: Although this area is less disturbed than land downstream, it has been inundated recently. There is a steep slope near the highway. Disturbance by tree removal and excavation for utility lines impacted archaeological potential, which is moderate to low.

West of State Highway 9W to West Haverstraw Substation: The right-of-way passes through a paved parking area and park. Banks of the creek are steep where crossed by the right-of-way; erosion is evident. The right-of-way traverses relatively level land on entering the Garnerville area. Previous work reported structures (ROC-008, Rockland Print Works houses; ROC-002, A08744.000011, ca. 1860 house on Bridge Street; ROC-300, A08744.000009, foundation; and ROC-102, A08744.000010, well/cistern). No structures will be impacted. Most of the right-of-way is paved or graded and has low archaeological potential. No documentation of Garnerville is recommended for this project. Construction of utility towers and buried lines has broken the ground, but surfaces do not appear disturbed. Given the northern aspect, the location at the bottom of a slope, and poorly drained soil, there is low archaeological potential in this area.

Acknowledgments

TRC wishes to thank the personnel of Southern's Bowline Generating Station Property for providing information and access. Frances Yonke of the Historical Society of Rockland County, Jack Berrian, and Thomas Sullivan were helpful in discussing the history of the region. Mr. Douglas Mackey and the staff of the New York State Office of Parks, Recreation and Historic Preservation at Peebles Island were cooperative and gave us all requested assistance.

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1.0 Introduction

TRC Environmental Corporation (TRC) of Lyndhurst, New Jersey, conducted a Phase IA survey of the location of the 345 kV transmission lines between Bowline Generating Station property in the Town of Haverstraw and the West Haverstraw Substation in the Village of West Haverstraw, Rockland County, New York. Work was done at the request of Southern Energy Bowline L.L.C. (Southern) in support of an application submitted under Article VII of the Public Service Law of New York State. The New York State Office of Parks, Recreation and Historic Preservation (OPRHP) Review Number for this Project is 99PR2572. Background research and fieldwork were conducted in November and December 1999. The results of existing studies (e.g., Holmes and Reycraft 1999a, 1999c; Schnabel Engineering 1999; Weed and Walsh 1997) and consultations with the OPRHP have been incorporated into this report.

1.1 Project and Anticipated Impacts

The project consists of two new 345 kV transmission lines. The preferred alignment for this Interconnection is an existing right-of-way. In the existing right-of-way are various electric and natural gas lines, including an underground 345 kV electric line and a 16-inch natural gas pipeline.

1.2 Interconnection Location and Description

The Interconnection will be located in the existing right-of-way in Rockland County, New York (Figure 1.1). It is depicted on the Haverstraw, New York, and Thiells, New York USGS quadrangles (Figure 1.2). The total length of the Interconnection is approximately 1.0 mile (1.6 km) and is from Bowline Generating Station Property to the West Haverstraw Substation.

Near the Bowline Generating Station Property, the Interconnection is level and graded. Crossing Samsondale Avenue, the right-of-way is on alluvial terraces next to Minisceongo Creek. This area is wooded, although recent storm damage has felled many trees that maintenance crews have been removing with heavy equipment. A railroad bridge (ca. 1880) crosses the creek in this area. Upstream from the bridge, the land shows less disturbance from traffic or stream cutting/deposition, although floods have damaged a concrete culvert near State Highway 9W. Residential property borders the Interconnection right-of-way. West of State Highway 9W is the paved parking lot of an office building that houses the local Department of Motor Vehicle office and several private offices. The right-of-way crosses the Minisceongo Creek in an area with steep banks. After crossing the creek and ascending the southern bank, the Interconnection is on relatively level ground as it enters Garnerville. This nineteenth-century neighborhood contains structures with varying degrees of architectural modification. Most of the route of the right-of-way is beneath paved or graded land in the Garnerville area. Near the West Haverstraw Substation are overhead utility lines supported by towers. West of the intersection of Bridge and Hunt streets in the Village of West Haverstraw, the Interconnection enters West Haverstraw Substation.

1.3 Purpose of a Phase IA Survey

The purpose of a Phase I cultural resources survey is "to identify archaeologically sensitive areas, cultural/sacred areas, and standing structures that are at least 50 years old, that may be affected by a proposed project and to locate all prehistoric and historic cultural/archaeological resources that may exist within the proposed project area" (New York Archaeological Council 1994).

A Phase IA reconnaissance is intended to gather information on the environmental setting and the cultural/historical setting to provide a basis for a sensitivity assessment. It also should provide a rationale for developing a research design, a sensitivity assessment, and appropriate Phase IB field methods. A Phase IB site locational survey uses subsurface investigation to find features and artifacts, which indicate the presence of sites. Results of a Phase I survey include recommendations regarding future work in a project area.

1.4 Report Format

This report follows the suggestions in the *Standards for Cultural Resource Investigations* (New York Archaeological Council 1994) and general professional standards for archaeological reports. It includes discussions of:

- Introductory information on the 345 kV transmission lines Interconnection (Section 1.0);
- An overview of the environmental and cultural/historical settings (Section 2.0);
- Background research, including previous research and recorded sites, and the methods employed for this study (Section 3.0);
- Results and recommendations (Section 4.0); and
- References cited (Section 5.0).

1.5 Principal Personnel

The Principal Investigator (PI) was Richard D. Holmes, Ph.D., of TRC's cultural resource staff. Dr. Holmes visited the right-of-way twice in November 1999 and conducted site files and literature searches. Richard M. Reycraft, Ph.D., of TRC provided background material and it has been incorporated into Section 2.0 of this document. Kim Croshier of Hartgen Archeological Associates, Inc., of Troy, New York performed additional site file research. Emily Herd prepared maps, Gwyneth Duncan and reviewed the report, Tracey Suzuki edited it, Toni R. Goar assisted with revisions, and Constance King supervised document production. Craig Wolfgang and Kevin Maher of TRC's Lyndhurst office coordinated work on this project.

1.6 Relevant Laws, Regulations, and Standards

TRC conducts environmental and cultural resource investigations under federal and state legislation, including the National Historic Preservation Act of 1966, as amended; the National Environmental Policy Act of 1969; and the New York State Parks, Recreation and Historic Preservation Law. Standards and guidelines that are followed include 36 CFR 60; *Standards for Cultural Resource Investigations and the Curation of Archaeological Collections in New York State* (New York Archaeological Council 1994); and editorial policies of *American Antiquity*.

2.0 Environmental, Cultural, and Historical Setting

2.1 Environmental Overview

2.1.1 Geology

The 345 kV transmission lines Interconnection is in the Triassic Lowlands of the Piedmont Province. Bedrock is Triassic arkose and mudstone of the Brunswick Formation of the Newark Group and also Palisades diabase, which is exposed along the Palisades and on South Mountain (Bonnell 1990). Further west are the Ramapo Mountains. Late Wisconsin glacial ice scoured the bedrock surface, while glacial till, consisting of gravel, sand, silt, and clay, was deposited beneath and in front of the ice face. Meltwater from the glacier deposited stratified beds of sand and gravel in valleys.

2.1.2 Soils

Soil along Minisceongo Creek is predominantly Hinckley gravelly loamy sand. This excessively drained soil is found on stream terraces. In the Garnerville area and on the northern slope of South Mountain, the soil includes Wethersfield gravelly silt loam, which is well drained and found on, or at the foot of ridges; erosion is a problem with this soil type. Also present is Wallington silt loam, which is somewhat poorly drained. Wethersfield gravelly silt loam and Holyoke-Rock complex are on the southern slope of South Mountain and along the right-of-way extending to the southeast. Holyoke-Rock complex is shallow with bedrock outcrops and ledge rock (Bonnell1990).

2.1.3 Hydrology

Minisceongo Creek flows into the Hudson River. The creek is a low-gradient stream with alluvial terraces between Samsondale Avenue and State Highway 9W; further upstream the creek has steeper embankments that show signs of severe erosion and attempts to control it.

2.1.4 Historic and Recent Land Use

Land has been used for agricultural purposes in historic times. Between Samsondale Avenue and State Highway 9W, the right-of-way borders residential areas. A single-track railroad from the 1880s crosses overhead in this part of the right-of-way. Part of the right-of-way passes through communities, such as Garnerville, which developed in the nineteenth century.

2.2 Prehistoric Overview

2.2.1 Paleoindian Period (10,500-8000 B.C.)

The current archaeological consensus is that the area surrounding the Hudson River Valley was first occupied during the Early Paleoindian period (10,500-9000 B.C.) (Funk 1978; Ritchie 1980). To date, the earliest accepted items of material culture in the region are represented by Clovis-like lithic assemblages found in open-air sites located on hills and rises (Funk 1978). These early occupations occurred in a tundra- or park-tundra-like environment created by the retreating Wisconsin ice sheet. Site distribution data are limited, but suggest the presence of larger, multi-seasonal, multi-purpose habitation sites and smaller, seasonal, special purpose camps, such as Kings Road (Funk 1978; Ritchie 1980). Data from early Paleoindian sites in the region suggest that Clovis peoples were primarily big game hunters who exploited caribou, mastodon, moose, elk, and other large Pleistocene fauna when available, and small game and edible plants when megafauna were not available (Ritchie 1956).

Late Paleoindian-period (9000-8000 B.C.) occupations, defined by Plano-like projectile points, are rare in eastern New York. This may reflect changing climatic conditions as coniferous forests replaced the tundra- and tundra-park-like environments of the earlier period with low carrying capacities for game species (Ritchie 1980).

2.2.2 Archaic Period (8000-1000 B.C.)

Archaic occupation in the northeastern United States can be divided into the Early (8000-6000 B.C), Middle (6000-4000 B.C.) and Late (4000-1400 B.C.) period. Early and Middle Archaic-period occupations are rare in eastern New York, and penetration of this region by Archaic peoples may have coincided with the northward advancement of deciduous forests during the Hypsithermal climatic interval of 8000-5000 B.C.

Late Archaic sites are much more common in eastern New York. Deciduous forests would have been present in this region for more than a thousand years and Late Archaic occupations appear well adapted to this environment. At the Late Archaic-period River and Bent sites, approximately 40 percent of the total artifact assemblages were composed of lithic projectile points and atlatl weights, indicating the continued emphasis of hunting. The presence of burned-rock roasting pits, containing carbonized acorn cotyledons, and notched pebble net sinkers also attests to the significance of wild plant and riverine resources (Ritchie 1980).

Late Archaic occupations continued to be located near large river drainages and lakes. Sites from this period appear as either large multipurpose settlements containing abundant sheet midden or small, specialized camps that lack such debris. Structural, floral, faunal, and artifactual data from such sites attest to a seasonally contingent resource extraction strategy whereby large riverine central-base settlements were occupied by macro-bands throughout the spring and summer, and small camps were either fall-winter micro-band camps or specialized resource extractive locations.

Ritchie (1980) has defined a so-called Transitional stage up to the use of ceramics for the Middle Atlantic region. In New York, this pre-adaptation, known as the Susquehanna tradition, appears to be confined to river drainages in the central part of the state. This transition is defined by the appearance on several Archaic sites of soapstone bowls and crude ceramics with steatite temper. The Transitional stage appears to reflect a change in technology and cooking practices rather than any dietary or economic shift.

2.2.3 Woodland Period (1000 B.C.-A.D. 1600)

The Early Woodland period (1000 B.C-300 B.C.) is defined by the introduction of ceramics on a scale larger than the tentative applications found at the end of the Transitional stage. Early Woodland occupations, such as those of the Meadowood phase, continued to be located on rivers and lakes near propitious fishing grounds. Thick- and coarse-tempered gray to black or bluff colored wares, such as Vinette 1, were employed in place of steatite and/or wooden vessels for cooking. The presence of copper beads and implements and marine shell beads suggests ties to the Great Lakes and Atlantic coastal regions, while numerous stone gorgets and tubular ceramic pipes indicate a heightened emphasis on status and ritual. Mortuary ceremonialism becomes much more formalized during this period, and human remains were often cremated, placed in pits with a variety of grave offerings, and covered with red ochre.

The Middle Woodland period (300 B.C.-A.D. 1000) is characterized by a continued riverine focus and an increase in trade contacts and ceremonialism as documented by the Adena related materials associated with the Middlesex phase in eastern New York (Ritchie 1980).

During the Late Woodland period (A.D. 1000-1600) the region was occupied by the Delaware people. These Algonkian speakers were not related to the Owasco people of upper New York State, who may be ancestral to the Iroquois. Linguistic differences distinguished the aboriginal inhabitants of the region from New England and Long Island. Subsistence was based on hunting, fishing, and cultivation of maize, beans, and squash.

2.3 Historic Overview

Sustained European-Native American contact in the Hudson River Valley dates to 1609 when Henry Hudson sailed up the Hudson River. The first permanent and lasting European settlement of what became New York State was directed by the Dutch West Indian Company, which was founded in 1621. Military outposts were established at New Amsterdam and Fort Orange in 1624.

Dutch settlement of what is now Rockland County began around 1675 in the vicinity of Nyack. Several families moved into the area over the next few years. Orange County, which until 1798 included today's Rockland County, was established in 1683. By 1700 there were only a few hundred European residents of Orange County, mostly in the southeastern corner; they included Dutch, English, and French Huguenots. Forests were cleared as agriculture expanded in the area, in the early 1700s.

Although agriculture continued, industry and commerce expanded in the 1800s. Stone was quarried, clay was mined and made into bricks, and iron ore was extracted. The Hudson River provided the main transportation for these products. With the discovery of other sources of iron in other states, the iron industry declined. Brick-making lasted until the 1930s, when the Great Depression and increased use of other building materials lowered the demand for bricks.

Transportation focused on the Hudson River. During the American Revolution, battles were fought to control this strategic passage. Sloops carried the products of the region to New York City. Among the commodities that were produced were stone, iron, and bricks.

Bricks were made from clay along the Hudson River. Around 1810, the Town of Haverstraw became a major brick-making center with two technological developments. A device to mix clay, sand, and coal dust in constant proportions was invented, and then a brick-making machine was invented in the mid-nineteenth century. Building construction in New York City demanded a large supply of bricks, and there were 42 brickyards in the Town of Haverstraw. In 1906, a disastrous landslide of a clay bank destroyed part of the town. Economic downturns and changes in construction materials led to the decline of the brick-making business in the 1930s.

Rockland County has not been dominated by industry in the twentieth century. The Palisades Interstate Park Commission oversaw the creation of parks such as the one at High Tor. Today, much of Rockland County's land is used as parks.

During the twentieth century, transportation became important in the county with the development of the New York Thruway and the Tappan Zee Bridge. The principal change in the character of Rockland County has been increasing suburbanization.

3.0 Background Research and Methods

3.1 Research Methods and Sources

The PI and other TRC staff members visited the 345 kV transmission lines Interconnection with Southern personnel and walked the eastern third of the right-of-way. Subsequently the PI revisited the Interconnection to inspect the western and southern portions of the right-of-way.

The PI, who consulted with OPRHP staff on the project, inspected site files at the OPRHP's repository. Subsequently, a research conducted additional site files searches to locate reported archaeological sites within 1.0 mile (1.6 km) of the 345 kV transmission lines Interconnection. Additional information on properties listed or determined eligible for the NRHP was made available to TRC; this includes information collected by the Historical Society of Rockland County.

3.2 Assessing Sensitivity

In general, it is possible to rank areas according to their potential for containing archaeological sites on the basis of known information and environmental factors. Doing so can efficiently direct efforts at locating, identifying, and evaluating archaeological sites.

For prehistoric sites, environmental factors include soil characteristics (such as drainage), slope, aspect, and proximity to water and other resources. What must be kept in mind, however, is that the topography present today may be significantly different than it was hundreds or thousands of years ago. Furthermore, archaeologists, anthropologists, and historians must avoid projecting their own cultural preferences on the decisions made by people in the past.

For historic sites, archival and oral history data can provide a guide to structures and activity areas. Surface remains from the historic periods are more likely to exist than prehistoric features. Maps and pictures sometimes can locate sites precisely. .Historic roads, watercourses, and standing structures also can suggest historic archaeological sites.

3.3 Historic Contexts

Before beginning an archaeological survey, a researcher should consider what might be found. Examination of previous research and secondary historical and archaeological literature suggests appropriate historic contexts, research issues, and the types of sites that may be expected in the project area. Historic contexts provide the framework for identifying, interpreting, and evaluating sites. Among the historic contexts relevant to the 345 kV transmission lines Interconnection are the following:

- Upland adaptations by prehistoric inhabitants of the lower Hudson Valley;
- Contact among Native American populations in the lower Hudson Valley;
- Native American-European contact in the Hudson Valley;
- European settlement in the Hudson Valley in the seventeenth century;
- The persistence of Dutch culture and the transition from Dutch to English culture; and
- Settlement and farming in northern Rockland County.

Site types that may be found include:

- Prehistoric villages and camps;
- Prehistoric resource extraction areas;
- Prehistoric hunting areas near wetlands;
- Historic farmsteads;
- Mills and other industrial sites; and
- Roads, including road traces, plank and corduroy road remains, and former road alignments.

3.4 Previous Research and Recorded Sites

Buried fill deposits (ROC 101/500, A08740.000161) are reported (Weed and Walsh 1997) east of Samsondale Avenue, near the Bowline Generating Station Property.

A survey of archaeological and historical sites and localities on the Haverstraw quadrangle (Rothschild 1977) is on file at the OPRHP. Rothschild incorporated the architectural inventory of the Historical Society of Rockland County. Her work indicates that several structures are within 1.0 mile (1.6 km) of the 345 kV transmission lines Interconnection, but none will be impacted by the proposed construction. Among the sites and localities (from east to west) are:

- 122 Presbyterian church (no longer standing);
- 126 Paper mill (no longer standing);
- 123 Superintendent's house (1887);
- 125 Peck rolling mill (1830) (no longer standing);
- 124 Peck house ("Samsondale" 1885) (no longer standing);
- 127 Maqueston house;
- 130 Allison house;
- 134 Gurnee house; and
- 136 MacDonald house.

A railroad bridge (ROC 007, A08744.000012) that was built for the New York, West Shore and Buffalo Railroad in the 1880s crosses the right-of-way. This bridge has been evaluated as not eligible to the NRHP.

The following structures and sites are in the Garnerville area near the 345 kV transmission lines Interconnection:

- ROC-008, Rockland Print Works houses;
- ROC-002, A08744.000011, ca. 1860 house at 48-50 Bridge Street;
- ROC-300, A08744.000009, foundation; and
- ROC-102, A08744.000010, well/cistern.

4.0 Results and Recommendations

The following are results of the cultural resource survey, assessments of archaeological potential, and recommendations. They are made on the basis of two site visits by the PI, background research, site files and literature searches, interviews with knowledgeable informants, and previous reports on file at the OPRHP.

4.1 Results and Assessments

At the eastern end is Southern's property containing the Bowline Generating Station. Minisceongo Creek is next to the right-of-way at the entrance to the Bowline Generating Station Property. As noted in the Bowline Unit 3 report (Holmes and Reycraft 1999a), this area was once the location of brickyards. The pond to the north of the right-of-way and west of the Bowline Generating Station Property was once a clay pit. It is apparent that the ground surface, including the banks of the creek, has been graded and landscaped, making it unlikely that undisturbed subsurface deposits exist. Previous researchers noted historic fill deposits (ROC 101/500, A08740.000161) (Weed and Walsh 1997). It is likely that these fill deposits are associated with the landfill that operated in the 1970s and are documented in the vicinity by informant reports, aerial photographs, and a geotechnical engineering report (Schnabel Engineering 1999).

The right-of-way crosses Samsondale Avenue and is generally parallel to Minisceongo Creek; the terrain consists of alluvial terraces, and adjacent properties have been developed for housing. Between Samsondale Avenue and a railroad bridge that crosses the creek, the ground surface has been disturbed by vehicular traffic, stream bank cutting and deposition, and tree removal. During fieldwork, maintenance crews were removing fallen trees that had been uprooted by Hurricane Floyd; this work included the use of heavy machinery. The PI examined the root masses of fallen trees for evidence of prehistoric artifacts, but none were seen. Although the terraces appear to be good places for prehistoric horticulture, there is little likelihood that cultural material could withstand the flooding that takes place here.

The railroad bridge has been reported as ROC 007 and A08744.000012. This railroad was built in the 1880s for the New York, West Shore and Buffalo Railroad. Site records at the OPRHP indicate that this bridge is not eligible to the NRHP.

Upstream, west of the railroad bridge, the ground surface shows less disturbance than does the area downstream of the bridge. High water during the recent storm had inundated the area, and damage to a culvert at State Highway 9W is evident. There is a steep slope from the creek terrace to the highway. Archaeologically, there is moderate potential for subsurface deposits. Mechanical disturbance by tree removal and excavation for previous utility lines, however, has impacted archaeological potential. No subsurface investigation is recommended.

West of State Highway 9W, the right-of-way passes through a paved parking lot for an office building. Here, the right-of-way crosses Minisceongo Creek. The stream crossing is in an area with steep embankments. On the southern side of the creek the land has slumped, creating a sheer cliff. Attempts to control erosion on the stream bank are evident in the gabions deposited on the banks and the rip-rap in the stream bed. Considering the steep slope, it is unlikely that this area was used for habitations prehistorically. Any remains related to historic use of the stream have probably been eliminated by erosion. After the right-of-way crosses the creek, it ascends the southern bank and reaches a more level, wooded area; this area is adjacent to houses and has recent trash on the surface. There is a moderate potential for subsurface remains in the level area away from the creek, although area is limited in extent.

The 345 kV transmission lines Interconnection enters the Garnerville area. Previous surveys reported several standing structures and architectural remains (ROC-008, Rockland Print Works houses; ROC-002, A08744.000011, a ca. 1860 house at 48-50 Bridge Street; ROC-300, A08744.000009, a foundation that was not evaluated; and ROC-102, A08744.000010, a potential well/cistern, not evaluated). The project does not impact the integrity of any structure, and most of the right-of-way runs through paved or graded land; there is a low potential for intact subsurface deposits.

North of U.S. Highway 202, construction of utility towers and buried lines have broken the ground, but surfaces do not appear disturbed. Given the northern aspect, the location at the bottom of a slope, and poorly drained soil, there is low archaeological potential in this area.

No NRHP or State registered properties will be adversely impacted by the project.

4.2 Recommendations

Historic fill deposits east of Samsondale Avenue (ROC 101/500, A08740.000161) were previously reported. It is not likely that these deposits will provide information on residential or industrial use of the right-of-way. No further consideration of the fill deposits is recommended.

The right-of-way between Samsondale Avenue and State Highway 9W has been altered by previous underground utility construction, traffic, stream cutting/deposition, and the removal of felled trees. No subsurface investigations are recommended.

There is low archaeological potential where the right-of-way crosses Minisceongo Creek. No subsurface investigations are required there.

As there will be no direct impact on the standing structures in Garnerville, TRC concludes that the project does not necessitate an architectural survey to document the community or determine boundaries for an historic district. Two features (a foundation, ROC-300, A08744.000009; and the well/cistern, ROC-102, A08744.000010) can be avoided by proposed construction. Unless future project plans directly impact these features, no additional consideration is recommended.

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Appendix 11C

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PHASE IA CULTURAL RESOURCES SURVEY OF THE NATURAL GAS PIPELINE, TOWNS OF HAVERSTRAW AND CLARKSTOWN, VILLAGE OF WEST HAVERSTRAW, ROCKLAND COUNTY, NEW YORK

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PHASE IA CULTURAL RESOURCES SURVEY OF THE NATURAL GAS PIPELINE, TOWNS OF HAVERSTRAW AND CLARKSTOWN, VILLAGE OF WEST HAVERSTRAW, ROCKLAND COUNTY, NEW YORK

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Summary

TRC Environmental Corporation (TRC) conducted a Phase IA archaeological survey of the route of a natural gas pipeline in Rockland County, New York. Southern Energy Bowline, L.L.C. requested this work in connection with its Bowline Unit 3 project. Information on the Bowline Unit 3 project is presented in a separate report prepared by TRC (Holmes and Reycraft 1999a); the 345 kV line project is presented in a separate report and referenced as Holmes and Reycraft 1999b. The present report is referenced as Holmes and Reycraft 1999c.

The natural gas Interconnection will be located in a right-of-way up to 300 ft (91 m) wide, extending approximately 4.2 miles (6.8 km) from Southern's Bowline Generating Station Property in the Town of Haverstraw to the Buena Vista Measuring Station in the Town of Clarkstown. There are existing natural gas, 345 kV electric, and other utility lines in the right-of-way. Minisceongo Creek is next to the right-of-way at the eastern end of the right-of-way. West of State Highway 9W, the right-of-way crosses Minisceongo Creek in a steep ravine that has eroded banks. It crosses more developed areas in the Garnerville area. The right-of-way continues through and beyond High Tor State Park. The distance from the Bowline Generating Station Property to the West Haverstraw Substation is approximately 1.0 mile (1.6 km) and approximately 3.2 miles (5.1 km) from that substation to the Buena Vista Measuring Station. This right-of-way includes part of the alignment of the proposed Millennium Pipeline (Weed and Walsh 1997). The Principal Investigator walked over the eastern portion of the project area and parts of the western portion; since the western portion was previously surveyed, the results of that survey and the determinations of the New York Office of Parks, Recreation and Historic Preservation have been included in this report.

The results and recommendations are summarized as follows:

State and National Registers of Historic Places: No property listed in the State and National Registers of Historic Places will be adversely impacted by the natural gas Interconnection.

Bowline Generating Station Property to Samsondale Avenue: Previous researchers reported buried fill deposits (ROC 101/500, A08740.000161). The right-of-way includes old brickyards and landfill. Intact deposits are unlikely.

Samsondale Avenue to railroad bridge over Minisceongo Creek: Alluvial terraces have been disturbed by vehicles, stream cutting/deposition, and recent tree removal. The Principal Investigator examined roots from felled trees, but no artifacts were seen. It is unlikely that cultural material has withstood flooding or disturbance. The bridge (ROC 007, A08744.000012, ca. 1880) has been evaluated as not eligible for the National Register of Historic Places.

Railroad bridge to State Highway 9W: Although this area is less disturbed than land downstream, it has been inundated recently. There is a steep slope near the highway. Disturbance by tree removal and excavation for utility lines impacted archaeological potential, which is moderate to low.

West of State Highway 9W to West Haverstraw Substation: The right-of-way passes through a paved parking area and park. Banks of the creek are steep where crossed by the right-of-way; erosion is evident. The right-of-way traverses relatively level land on entering the Garnerville area. Previous work reported structures (ROC-008, Rockland Print Works houses; ROC-002, A08744.000011, ca. 1860 house on Bridge Street; ROC-300, A08744.000009, foundation; and ROC-102, A08744.000010, well/cistern). No structures will be impacted. Most of the right-of-way is paved or graded and has low archaeological potential. No documentation of Garnerville is recommended for this project. Construction of utility towers

and buried lines has broken the ground, but surfaces do not appear disturbed. Given the northern aspect, the location at the bottom of a slope, and poorly drained soil, there is low archaeological potential in this area.

Northern slope of mountains: With a slope of 15–25 percent, there is a low potential for sites.

South of mountains, to Buena Vista Measuring Station: This was the portion visited in part by the Principal Investigator, but it was not walked over in its entirety. Millennium Pipeline's consultants recommended approximately 5,100 ft (1,554 m) of the right-of-way for subsurface testing, with some additional areas requiring a lower level of effort; the New York Office of Parks, Recreation and Historic Preservation has concurred with this recommendation.

The scope of further work will be determined in consultation with the New York Office of Parks, Recreation and Historic Preservation.

Acknowledgments

TRC wishes to thank the personnel of Southern's Bowline Generating Station Property for providing information and access. Frances Yonke of the Historical Society of Rockland County, Jack Berrian, and Thomas Sullivan were helpful in discussing the history of the region. Mr. Douglas Mackey and the staff of the New York State Office of Parks, Recreation and Historic Preservation at Peebles Island were cooperative and gave us all requested assistance.

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1.0 Introduction

TRC Environmental Corporation (TRC) of Lyndhurst, New Jersey, conducted a Phase IA survey of the location of the natural gas pipeline between the Towns of Haverstraw and Clarkstown, Rockland County, New York. Work was done at the request of Southern Energy Bowline L.L.C. (Southern) in support of an application submitted under Article VII of the Public Service Law of New York State. The New York State Office of Parks, Recreation and Historic Preservation (OPRHP) Review Number for this Project is 99PR2572. Background research and fieldwork were conducted in November and December 1999. The results of existing studies (e.g., Holmes and Reycraft 1999a, 1999b; Schnabel Engineering 1999; Weed and Walsh 1997) and consultations with the OPRHP have been incorporated into this report.

1.1 Project and Anticipated Impacts

The Project is a new natural gas pipeline. The preferred alignment for this line is an existing right-of-way. In the existing right-of-way are various electric and natural gas lines, including an underground 345 kV electric line and a 16-inch natural gas pipeline.

1.2 Interconnection Location and Description

The Interconnection is the existing right-of-way in Rockland County, New York (Figure 1.1). It is depicted on the Haverstraw, New York, and Thiells, New York USGS quadrangles (Figure 1.2). The total length of the Interconnection is approximately 4.2 miles (6.8 km); this includes about 1.0 mile (1.6 km) from Bowline Generating Station Property to the West Haverstraw Substation, and approximately 3.2 miles (5.1 km) from that substation to the Buena Vista Measuring Station. The right-of-way is the alignment of the proposed Millennium Pipeline (Weed and Walsh 1997).

Near the Bowline Generating Station Property, the Interconnection is level and graded. Crossing Samsondale Avenue, the right-of-way is on alluvial terraces next to Minisceongo Creek. This area is wooded, although recent storm damage has felled many trees that maintenance crews have been removing with heavy equipment. A railroad bridge (ca. 1880) crosses the creek in this area. Upstream from the bridge, the land shows less disturbance from traffic or stream cutting/deposition, although floods have damaged a concrete culvert near State Highway 9W. Residential property borders the Interconnection right-of-way. West of State Highway 9W is the paved parking lot of an office building. The right-of-way enters a park next to the banks of Minisceongo Creek in an area with steep banks. After crossing the creek and ascending the southern bank, the Interconnection is on relatively level ground as it enters Garnerville. This nineteenth-century neighborhood contains structures with varying degrees of architectural modification. Most of the route of the right-of-way is beneath paved or graded land in the Garnerville area. Near the West Haverstraw Substation are overhead utility lines supported by towers. West of the intersection of Bridge and Hunt streets in the Village of West Haverstraw, the Interconnection enters West Haverstraw Substation. Then, the right-of-way ascends a steep slope on the northern face of South Mountain, crosses High Tor State Park and descends into private land that is wooded, with sub-rural housing. The Buena Vista Measuring Station is the western end of the Interconnection.

1.3 Purpose of a Phase IA Survey

The purpose of a Phase I cultural resources survey is "to identify archaeologically sensitive areas, cultural/sacred areas, and standing structures that are at least 50 years old, that may be affected by a proposed project and to locate all prehistoric and historic cultural/archaeological resources that may exist within the proposed project area" (New York Archaeological Council 1994).

A Phase IA reconnaissance is intended to gather information on the environmental setting and the cultural/historical setting to provide a basis for a sensitivity assessment. It also should provide a rationale for developing a research design, a sensitivity assessment, and appropriate Phase IB field methods. A Phase IB site locational survey uses subsurface investigation to find features and artifacts, which indicate the presence of sites. Results of a Phase I survey include recommendations regarding future work in a project area.

1.4 Report Format

This report follows the suggestions in the *Standards for Cultural Resource Investigations* (New York Archaeological Council 1994) and general professional standards for archaeological reports. It includes discussions of:

- Introductory information on the Natural Gas Interconnection (Section 1.0);
- An overview of the environmental and cultural/historical settings (Section 2.0);
- Background research, including previous research and recorded sites, and the methods employed for this study (Section 3.0);
- Results and recommendations (Section 4.0); and
- References cited (Section 5.0).

1.5 Principal Personnel

The Principal Investigator (PI) was Richard D. Holmes, Ph.D., of TRC's cultural resource staff. Dr. Holmes visited the right-of-way twice in November 1999 and conducted site files and literature searches. Richard M. Reycraft, Ph.D., of TRC provided background material and it has been incorporated into Section 2.0 of this document. Kim Croshier of Hartgen Archeological Associates, Inc., of Troy, New York performed additional site file research. Emily Herd prepared maps, Gwyneth Duncan reviewed the report, Tracey Suzuki edited it, Toni R. Goar assisted with revisions, and Constance King supervised document production. Craig Wolfgang and Kevin Maher of TRC's Lyndhurst office coordinated work on this project.

1.6 Relevant Laws, Regulations, and Standards

TRC conducts environmental and cultural resource investigations under federal and state legislation, including the National Historic Preservation Act of 1966, as amended; the National Environmental Policy Act of 1969; and the New York State Parks, Recreation and Historic Preservation Law. Standards and guidelines that are followed include 36 CFR 60; *Standards for Cultural Resource Investigations and the Curation of Archaeological Collections in New York State* (New York Archaeological Council 1994); and editorial policies of *American Antiquity*.

2.0 Environmental, Cultural, and Historical Setting

2.1 Environmental Overview

2.1.1 Geology

The natural gas Interconnection is in the Triassic Lowlands of the Piedmont Province. Bedrock is Triassic arkose and mudstone of the Brunswick Formation of the Newark Group and also Palisades diabase, which is exposed along the Palisades and on South Mountain (Bonnell 1990). Further west are the Ramapo Mountains. Late Wisconsin glacial ice scoured the bedrock surface, while glacial till, consisting of gravel, sand, silt, and clay, was deposited beneath and in front of the ice face. Meltwater from the glacier deposited stratified beds of sand and gravel in valleys.

2.1.2 Soils

Soil along Minisceongo Creek is predominantly Hinckley gravelly loamy sand. This excessively drained soil is found on stream terraces. In the Garnerville area and on the northern slope of South Mountain, the soil includes Wethersfield gravelly silt loam, which is well drained and found on, or at the foot of ridges; erosion is a problem with this soil type. Also present is Wallington silt loam, which is somewhat poorly drained. Wethersfield gravelly silt loam and Holyoke-Rock complex are on the southern slope of South Mountain and along the right-of-way extending to the southeast. Holyoke-Rock complex is shallow with bedrock outcrops and ledge rock (Bonnell1990).

2.1.3 Hydrology

Minisceongo Creek flows into the Hudson River. The creek is a low-gradient stream with alluvial terraces between Samsondale Avenue and State Highway 9W; further upstream the creek has steeper embankments that show signs of severe erosion and attempts to control it. In High Tor State Park and on the south side of South Mountain, there are small drainages that feed ponds and, further east there are swamps.

2.1.4 Historic and Recent Land Use

Land has been used for agricultural purposes in historic times. Between Samsondale Avenue and State Highway 9W, the right-of-way borders residential areas. A single-track railroad from the 1880s crosses overhead in this part of the right-of-way. Part of the right-of-way passes through communities, such as Garnerville, which developed in the nineteenth century. A long section is in High Tor State Park, which is open and recreational space set aside as part of the Palisades Interstate Park System. Recent sub-rural housing has been constructed near or adjacent to the right-of-way.

2.2 Prehistoric Overview

2.2.1 Paleoindian Period (10,500-8000 B.C.)

The current archaeological consensus is that the area surrounding the Hudson River Valley was first occupied during the Early Paleoindian period (10,500-9000 B.C.) (Funk 1978; Ritchie 1980). To date, the earliest accepted items of material culture in the region are represented by Clovis-like lithic assemblages found in open-air sites located on hills and rises (Funk 1978). These early occupations occurred in a tundra- or park-tundra-like environment created by the retreating Wisconsin ice sheet. Site distribution data are limited, but suggest the presence of larger, multi-seasonal, multi-purpose habitation sites and smaller, seasonal, special purpose camps, such as Kings Road (Funk 1978; Ritchie 1980). Data from early Paleoindian sites in the region suggest that Clovis peoples were primarily big game hunters who exploited caribou, mastodon, moose, elk, and other large Pleistocene fauna when available, and small game and edible plants when megafauna were not available (Ritchie 1956).

Late Paleoindian-period (9000-8000 B.C.) occupations, defined by Plano-like projectile points, are rare in eastern New York. This may reflect changing climatic conditions as coniferous forests replaced the tundra- and tundra-park-like environments of the earlier period with low carrying capacities for game species (Ritchie 1980).

2.2.2 Archaic Period (8000-1000 B.C.)

Archaic occupation in the northeastern United States can be divided into the Early (8000-6000 B.C), Middle (6000-4000 B.C.) and Late (4000-1400 B.C.) period. Early and Middle Archaic-period occupations are rare in eastern New York, and penetration of this region by Archaic peoples may have coincided with the northward advancement of deciduous forests during the Hypsithermal climatic interval of 8000-5000 B.C.

Late Archaic sites are much more common in eastern New York. Deciduous forests would have been present in this region for more than a thousand years and Late Archaic occupations appear well adapted to this environment. At the Late Archaic-period River and Bent sites, approximately 40 percent of the total artifact assemblages were composed of lithic projectile points and atlatl weights, indicating the continued emphasis of hunting. The presence of burned-rock roasting pits, containing carbonized acorn cotyledons, and notched pebble net sinkers also attests to the significance of wild plant and riverine resources (Ritchie 1980).

Late Archaic occupations continued to be located near large river drainages and lakes. Sites from this period appear as either large multipurpose settlements containing abundant sheet midden or small, specialized camps that lack such debris. Structural, floral, faunal, and artifactual data from such sites attest to a seasonally contingent resource extraction strategy whereby large riverine central-base settlements were occupied by macro-bands throughout the spring and summer, and small camps were either fall-winter micro-band camps or specialized resource extractive locations.

Ritchie (1980) has defined a so-called Transitional stage up to the use of ceramics for the Middle Atlantic region. In New York, this pre-adaptation, known as the Susquehanna tradition, appears to be confined to river drainages in the central part of the state. This transition is defined by the appearance on several Archaic sites of soapstone bowls and crude ceramics with steatite temper. The Transitional stage appears to reflect a change in technology and cooking practices rather than any dietary or economic shift.

2.2.3 Woodland Period (1000 B.C.-A.D. 1600)

The Early Woodland period (1000-300 B.C.) is defined by the introduction of ceramics on a scale larger than the tentative applications found at the end of the Transitional stage. Early Woodland occupations, such as those of the Meadowood phase, continued to be located on rivers and lakes near propitious fishing grounds. Thick- and coarse-tempered gray to black or bluff colored wares, such as Vinette 1, were employed in place of steatite and/or wooden vessels for cooking. The presence of copper beads and implements and marine shell beads suggests ties to the Great Lakes and Atlantic coastal regions, while numerous stone gorgets and tubular ceramic pipes indicate a heightened emphasis on status and ritual. Mortuary ceremonialism becomes much more formalized during this period, and human remains were often cremated, placed in pits with a variety of grave offerings, and covered with red ochre.

The Middle Woodland period (300 B.C.-A.D. 1000) is characterized by a continued riverine focus and an increase in trade contacts and ceremonialism as documented by the Adena related materials associated with the Middlesex phase in eastern New York (Ritchie 1980).

During the Late Woodland period (A.D. 1000-A.D.1600) the region was occupied by the Delaware people. These Algonkian speakers were not related to the Owasco people of upper New York State, who may be ancestral to the Iroquois. Linguistic differences distinguished the aboriginal inhabitants of the region from New England and Long Island. Subsistence was based on hunting, fishing, and cultivation of maize, beans, and squash.

2.3 Historic Overview

Sustained European-Native American contact in the Hudson River Valley dates to 1609 when Henry Hudson sailed up the Hudson River. The first permanent and lasting European settlement of what became New York State was directed by the Dutch West Indian Company, which was founded in 1621. Military outposts were established at New Amsterdam and Fort Orange in 1624.

Dutch settlement of what is now Rockland County began around 1675 in the vicinity of Nyack. Several families moved into the area over the next few years. Orange County, which until 1798 included today's Rockland County, was established in 1683. By 1700 there were only a few hundred European residents of Orange County, mostly in the southeastern corner; they included Dutch, English, and French Huguenots. Forests were cleared as agriculture expanded in the area, in the early 1700s.

Although agriculture continued, industry and commerce expanded in the 1800s. Stone was quarried, clay was mined and made into bricks, and iron ore was extracted. The Hudson River provided the main transportation for these products. With the discovery of other sources of iron in other states, the iron industry declined. Brick-making lasted until the 1930s, when the Great Depression and increased use of other building materials lowered the demand for bricks.

Transportation focused on the Hudson River. During the American Revolution, battles were fought to control this strategic passage. Sloops carried the products of the region to New York City. Among the commodities that were produced were stone, iron, and bricks.

Bricks were made from clay along the Hudson River. Around 1810, the Town of Haverstraw became a major brick-making center with two technological developments. A device to mix clay, sand, and coal dust in constant proportions was invented, and then a brick-making machine was invented in the mid-nineteenth century. Building construction in New York City demanded a large supply of bricks, and there were 42 brickyards in the Town of Haverstraw. In 1906, a disastrous landslide of a clay bank destroyed part of the town. Economic downturns and changes in construction materials led to the decline of the brick-making business in the 1930s.

Rockland County has not been dominated by industry in the twentieth century. The Palisades Interstate Park Commission oversaw the creation of parks such as the one at High Tor. Today, much of Rockland County's land is used as parks.

During the twentieth century, transportation became important in the county with the development of the New York Thruway and the Tappan Zee Bridge. The principal change in the character of Rockland County has been increasing suburbanization.

3.0 Background Research and Methods

3.1 Research Methods and Sources

The PI and other TRC staff members visited the natural gas Interconnection with Southern personnel and walked the eastern third of the right-of-way. Subsequently the PI revisited the Interconnection to inspect the western and southern portions of the right-of-way. Not all of the right-of-way was walked over by the PI since it had been investigated previously; information on this part of the right-of-way is included in a report submitted to the OPRHP (Weed and Walsh 1997).

The PI, who consulted with OPRHP staff on the project, inspected site files at the OPRHP's repository. Subsequently, a research conducted additional site files searches to locate reported archaeological sites within 1.0 mile (1.6 km) of the natural gas Interconnection. Additional information on properties listed or determined eligible for the NRHP was made available to TRC; this includes information collected by the Historical Society of Rockland County.

3.2 Assessing Sensitivity

In general, it is possible to rank areas according to their potential for containing archaeological sites on the basis of known information and environmental factors. Doing so can efficiently direct efforts at locating, identifying, and evaluating archaeological sites.

For prehistoric sites, environmental factors include soil characteristics (such as drainage), slope, aspect, and proximity to water and other resources. What must be kept in mind, however, is that the topography present today may be significantly different than it was hundreds or thousands of years ago. Furthermore, archaeologists, anthropologists, and historians must avoid projecting their own cultural preferences on the decisions made by people in the past.

For historic sites, archival and oral history data can provide a guide to structures and activity areas. Surface remains from the historic periods are more likely to exist than prehistoric features. Maps and pictures sometimes can locate sites precisely. Historic roads, watercourses, and standing structures also can suggest historic archaeological sites.

3.3 Historic Contexts

Before beginning an archaeological survey, a researcher should consider what might be found. Examination of previous research and secondary historical and archaeological literature suggests appropriate historic contexts, research issues, and the types of sites that may be expected in the project area. Historic contexts provide the framework for identifying, interpreting, and evaluating sites. Among the historic contexts relevant to the natural gas Interconnection are the following:

- Upland adaptations by prehistoric inhabitants of the lower Hudson Valley;
- Contact among Native American populations in the lower Hudson Valley;
- Native American-European contact in the Hudson Valley;
- European settlement in the Hudson Valley in the seventeenth century;
- The persistence of Dutch culture and the transition from Dutch to English culture; and
- Settlement and farming in northern Rockland County.

Site types that may be found include:

- Prehistoric villages and camps;
- Prehistoric resource extraction areas;
- Prehistoric hunting areas near wetlands;
- Historic farmsteads;
- Mills and other industrial sites; and
- Roads, including road traces, plank and corduroy road remains, and former road alignments.

3.4 Previous Research and Recorded Sites

Buried fill deposits (ROC 101/500, A08740.000161) are reported (Weed and Walsh 1997) east of Samsondale Avenue, near the Bowline Generating Station Property.

A survey of archaeological and historical sites and localities on the Haverstraw quadrangle (Rothschild 1977) is on file at the OPRHP. Rothschild incorporated the architectural inventory of the Historical Society of Rockland County. Her work indicates that several structures are within 1.0 mile (1.6 km) of the natural gas Interconnection, but none will be impacted by the proposed construction. Among the sites and localities (from east to west) are:

- 122 Presbyterian church (no longer standing);
- 126 Paper mill (no longer standing);
- 123 Superintendent's house (1887);
- 125 Peck rolling mill (1830) (no longer standing);
- 124 Peck house ("Samsondale" 1885) (no longer standing);
- 127 Maqueston house;
- 130 Allison house;
- 134 Gurnee house; and
- 136 MacDonald house.

A railroad bridge (ROC 007, A08744.000012) that was built for the New York, West Shore and Buffalo Railroad in the 1880s crosses the right-of-way. This bridge has been evaluated as not eligible to the NRHP.

The following structures and sites are in Garnerville near the natural gas Interconnection:

- ROC-008, Rockland Print Works houses;
- ROC-002, A08744.000011, ca. 1860 house at 48-50 Bridge Street;
- ROC-300, A08744.000009, foundation; and
- ROC-102, A08744.000010, well/cistern.

New York State Museum site files record site 6370 on the southern side of South Mountain, east of the natural gas Interconnection. This site, for which there is no additional information, was located by George Budke in the 1920s.

Other sites south of South Mountain and east of the natural gas Interconnection within 1.0 mile (1.6 km) include:

- A087-01-0023, a prehistoric site (Klein 1978);
- A087-01-0013, a prehistoric midden, possibly Late Archaic;
- A087-01-0014, an historic dump;
- A087-01-0015, the Biegel site, possibly Late Archaic;
- A087-01-0016, an historic dump; and
- A087-01-0017, possibly the Onderdonk Mill site, ca.1778.

To the west of the natural gas Interconnection, but within 1.0 mile (1.6 km) of it are:

- A08704.000206 (ROC-9845), a collapsed structure;
- A08704.000055, a Middle and Late Archaic camp (Collamer and Associates 1991; Hartgen Archeological Associates 1992); and
- A087-04-0017, a mill race from the nineteenth century.

Also in the vicinity are NYSM sites 6420 and 6422, reported in the 1920s with no additional information.

4.0 Results and Recommendations

The following are results of the cultural resource survey, assessments of archaeological potential, and recommendations. They are made on the basis of two site visits by the PI, background research, site files and literature searches, interviews with knowledgeable informants, and previous reports on file at the OPRHP.

4.1 Results and Assessments

At the eastern end is Southern's property containing the Bowline Generating Station. Minisceongo Creek is next to the right-of-way at the entrance to the Bowline Generating Station Property. As noted in the Bowline Unit 3 report (Holmes and Reycraft 1999a), this area was once the location of brickyards. The pond to the north of the right-of-way and west of the Bowline Generating Station Property was once a clay pit. It is apparent that the ground surface, including the banks of the creek, has been graded and landscaped, making it unlikely that undisturbed subsurface deposits exist. Previous researchers noted historic fill deposits (ROC 101/500, A08740.000161) (Weed and Walsh 1997). It is likely that these fill deposits are associated with the landfill that operated in the 1970s and are documented in the vicinity by informant reports, aerial photographs, and a geotechnical engineering report (Schnabel Engineering 1999).

The right-of-way crosses Samsondale Avenue and is generally parallel to Minisceongo Creek; the terrain consists of alluvial terraces, and adjacent properties have been developed for housing. Between Samsondale Avenue and a railroad bridge that crosses the creek, the ground surface has been disturbed by vehicular traffic, stream bank cutting and deposition, and tree removal. During fieldwork, maintenance crews were removing fallen trees that had been uprooted by Hurricane Floyd; this work included the use of heavy machinery. The PI examined the root masses of fallen trees for evidence of prehistoric artifacts, but none were seen. Although the terraces appear to be good places for prehistoric horticulture, there is little likelihood that cultural material could withstand the flooding that takes place here.

The railroad bridge has been reported as ROC 007 and A08744.000012. This railroad was built in the 1880s for the New York, West Shore and Buffalo Railroad. Site records at the OPRHP indicate that this bridge is not eligible to the NRHP.

Upstream, west of the railroad bridge, the ground surface shows less disturbance than does the area downstream of the bridge. High water during the recent storm had inundated the area, and damage to a culvert at State Highway 9W is evident. There is a steep slope from the creek terrace to the highway. Archaeologically, there is moderate potential for subsurface deposits. Mechanical disturbance by tree removal and excavation for previous utility lines, however, has impacted archaeological potential. No subsurface investigation is recommended.

West of State Highway 9W, the right-of-way passes through a paved parking lot for an office building. To the west, the right-of-way crosses Minisceongo Creek. The stream crossing is in an area with steep embankments. On the southern side of the creek the land has slumped, creating a sheer cliff. Attempts to control erosion on the stream bank are evident in the gabions deposited on the banks and the rip-rap in the stream bed. Considering the steep slope, it is unlikely that this area was used for habitations prehistorically. Any remains related to historic use of the stream have probably been eliminated by erosion. After the right-of-way crosses the creek, it ascends the southern bank and reaches a more level, wooded area; this area is adjacent to houses and has recent trash on the surface. There is a moderate potential for subsurface remains in the level area away from the creek, although area is limited in extent.

The natural gas Interconnection enters the Town of Garnerville. Previous surveys reported several standing structures and architectural remains (ROC-008, Rockland Print Works houses; ROC-002, A08744.000011, a ca. 1860 house at 48-50 Bridge Street; ROC-300, A08744.000009, a foundation that was not evaluated; and ROC-102, A08744.000010, a potential well/cistern, not evaluated). The project does not impact the integrity of any structure, and most of the right-of-way runs through paved or graded land; there is a low potential for intact subsurface deposits.

North of U.S. Highway 202, construction of utility towers and buried lines have broken the ground, but surfaces do not appear disturbed. Given the northern aspect, the location at the bottom of a slope, and poorly drained soil, there is low archaeological potential in this area. On the northern face of South Mountain there is a slope of 15–25 percent; consequently, there is a low potential for sites, particularly habitation sites.

The right-of-way enters High Tor State Park, which includes rock outcrops. The area south of the mountains in the park was visited in part by the PI, but it was not walked over in its entirety. Millennium Pipeline's consultants recommended approximately 5,100 ft (1,554 m) of the right-of-way for subsurface testing, with some additional areas requiring a lower level of effort; the OPRHP has concurred with this recommendation.

No NRHP or State registered properties will be adversely impacted by the project.

4.2 Recommendations

Historic fill deposits east of Samsondale Avenue (ROC 101/500, A08740.000161) were previously reported. It is not likely that these deposits will provide information on residential or industrial use of the right-of-way. No further consideration of the fill deposits is recommended.

The right-of-way between Samsondale Avenue and State Highway 9W has been altered by previous underground utility construction, traffic, stream cutting/deposition, and the removal of felled trees. No subsurface investigations are recommended.

There is low archaeological potential where the right-of-way crosses Minisceongo Creek. No subsurface investigations are required there.

As there will be no direct impact on the standing structures in Garnerville, TRC concludes that the project does not necessitate an architectural survey to document the community or determine boundaries for an historic district. Two features (a foundation, ROC-300, A08744.000009; and the well/cistern, ROC-102, A08744.000010) can be avoided by proposed construction. Unless future project plans directly impact these features, no additional consideration is recommended.

Subsurface survey (i.e., Phase IB) will be required for part of the western portion of the right-of-way between High Tor State Park and Buena Vista Measuring Station. Areas other than the 5,100 ft (1,554 m) determined by the OPRHP as having a high potential for containing archaeological sites may require a lower level of effort. Consultation with the OPRHP should be undertaken before beginning a program of subsurface investigations as part of a Phase IB survey.

Appendix 11D

Selection of Relevant Portions of

Standards for Cultural Resource Investigations and the Curation of Archaeological Collections in New York State

Sections included are relevant to Article X application appendices on cultural resources (Holmes and Reycraft 1999a, 1999b, 1999c):

Title, Table of Contents, pp. 1-4, 9-12, and 16-19.

Standards for Cultural Resource Investigations and the Curation of Archaeological Collections in New York State

by

The New York Archaeological Council

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1.0 INTRODUCTION

Standards for Phase IA, IB, II, and III Cultural Resource Investigations; the Production of Cultural Resource Management Reports; and the Curation of Archaeological Collections, have been developed in order to ensure a degree of uniformity in the approach taken by NYAC archaeologists. It is hoped that other archaeologists, private developers, local, state, and federal agencies will make use of these standards towards the fulfillment of their preservation obligations under a variety of federal, state, and local laws and preservation ordinances.

The purpose of these guidelines is to ensure that archaeological work of the highest caliber is carried out in New York. These guidelines will help to clarify NYAC's expectations for the often diverse approaches to cultural resource investigations utilized by the increasing numbers of individuals and corporate groups that are becoming involved in cultural resource compliance reviews. All professional/supervisory level personnel must meet the qualifications set forth in 36 CFR 61. Their aim is to promote consistent, high-quality performance, and documentation. Although detailed in some cases, these guidelines are not intended to be all-encompassing nor to address all possible situations.

It is likewise expected that published guidelines will result in more acceptable, efficient, and cost-effective research on New York archaeological sites. Innovation beyond the scope of these recommended procedures prepared by the NYAC Standards Committee is expected and encouraged.

Good judgement and common sense must prevail. These guidelines will be subject to periodic revision and refinement.

2.0 PHASE I CULTURAL RESOURCE INVESTIGATIONS: RECONNAISSANCE

2.1 Goals of Phase I Investigations

The primary goals of Phase I Cultural Resource Investigations are to identify archaeologically sensitive areas, cultural/sacred areas, and standing structures that are at least 50 years old, that may be affected by a proposed project and to locate all prehistoric and historic cultural/archaeological resources that may exist within the proposed project area. The goals of Phase I work need to be flexible to reflect the size of the project and stage of project planning, and can be undertaken in subphases (Phase IA and IB), if appropriate.

When a review process determines that a project will not affect any known or recorded site(s) but is located in an area where insufficient previous survey has been conducted, and where there is a moderate or high probability that previously unrecorded sites may occur, Phase I cultural resource investigations should be conducted. The purpose of these investigations is to locate *all* surface and/or subsurface sites that occur within the project area. Site locations are frequently discovered as a result of documentary research, informant interviews, land-surface inspection, and subsurface testing.

Due to the complexities often characterizing projects and sites located in urban settings, these guidelines apply primarily to projects situated in non-urban environments. At some point in the near future, guidelines will be established for Phase I work in urban environments (cf. Pennsylvania guidelines) as well as underwater contexts.

2.2 Phase IA: Literature Search and Sensitivity Assessment

Phase IA investigations are intended to gather information concerning the environmental/physical setting of a specific project area as well as its cultural setting. It is the interrelationship of the physical environment and the cultural/historical setting that provides the basis for the sensitivity assessment. This research should include a consideration of relevant geomorphology and soils information, culture history, and previous archaeological research to provide for the development of explicit expectations or predictions regarding the nature and locations of sites. Regardless of the project size, archaeologists should consider all relevant data in developing these expectations. The specific sources from which background information should be drawn will vary according to project size and the availability of comparative data. The information presented and analyses performed should assist reviewers in understanding and evaluating the importance of environmental and cultural/historical resources within and surrounding the project area. Finally, it should also provide the rationale for developing the research design, the sensitivity assessment, and for selecting appropriate Phase IB field methodology as well as for evaluating project impacts.

2.2.1. Environmental/Physical Setting

A summary of relevant information, with accompanying maps (where appropriate), concerning the environmental/physical setting should address the following: geology, soils, hydrology, physiography/geomorphology, climate, flora, fauna, and recent human/natural disturbances.

2.2.2. Background Research

Background research should include a preliminary review of manuscripts, maps, atlases, historical documents, unpublished notes, previous surveys, state and local site inventories, and published material relevant to the project area to locate possible sites and provide the basis for documenting the cultural setting for the project area. The specific sources from which background information should be drawn will vary according to project size and the availability of comparative data. Where information pertaining to the specific project area or environs is not available expectations should be developed from regional or state plans for the conservation of archaeological resources, investigations of similar environments outside the local area, or other environmental data. The results of this background research should be included in the report as documentation and justification for the sensitivity assessment and site location predictions.

The following list of topics may be useful in considerations of cultural setting. A comprehensive treatment of the cultural setting of a project area will most likely only involve some subset of this list. These have been adapted from a list of historic contexts developed by the New York State Historic Preservation Office (NYS SHPO).

- Transportation
- Economy
  - Industry
  - Agriculture
- Social Organization
  - Government
  - Education
- Social Change
  - Contact and Settlement Post-Revolutionary
  - War Expansion
  - Social and Political Movements
- Religion
- Communication
- Recreation
  - Entertainment
  - Tourism
- Demography
  - Immigration
  - Emigration
- Community Planning and Development
- Engineering
- Architecture
- Science
- Art and Literature
- Ethnicity

It is recognized that a variety of individuals, especially those interested in or living near a specific project area, may have important information not available from any other source. Such information can enhance the data gathered from the written record alone. Informant interviews with persons (e.g. avocational archaeologists, landowners, state or local government agency staff) who may be familiar with the project area and possible archaeological sites can make a valuable contribution to these investigations.

A field visit to the project area should be undertaken to determine the possibility of prior disturbance/destruction and the physiographic evidence for potential sites. Where conditions at the time of the field visit differ from those portrayed on map resources, the current conditions should be described and the map resources amended accordingly. If the initial field check shows that any sites have been previously destroyed, or that for other obvious reasons no sites exist there, the appropriate review agency should be consulted. It may be determined that no further Phase I survey is required. The basis for such conclusions must be submitted in writing with supporting documentation (e.g. building/grading plans, photographs).

2.2.3 Sensitivity Assessment

An estimate of the archaeological sensitivity of a given area provides the archaeologist with a tool with which to design appropriate field procedures for the investigation of that area. These sensitivity projections are generally based upon the following factors: statements of locational preferences or tendencies for particular settlement systems, characteristics of the local environment which provide essential or desirable resources (e.g. proximity to perennial water sources, well-drained soils, floral and faunal resources, raw materials, and/or trade and transportation routes), the density of known archaeological and historical resources within the general area, and the extent of known disturbances which can potentially affect the integrity of sites and the recovery of material from them.

The analysis of data gathered for the environmental/physical setting and the cultural setting must address the following questions: Given the data gathered for the environmental/physical setting and the cultural setting of the project area what is the likelihood of finding prehistoric or historic cultural/archaeological resources? What types of sites are likely to be found? What is the likely condition of sites that might be found?

2.3 Phase IB: Field Investigation Guidelines

Appropriate field investigations comprise a systematic, on-site field inspection designed to assess archaeologically sensitive areas and environmental characteristics relevant to site locations and formation processes. Such investigations include, but are not limited to systematic surface survey, subsurface shovel-testing, and remote sensing studies.

Subsurface testing is often the major component of this level of investigation and is required except in those cases in which the presence or absence of resources can be determined by direct observation (e.g. surface survey), by the examination of specific documented references, or by the detailed documentation of prior disturbance of such a degree that all traces of intact cultural resources have been erased.

Field-testing procedures for Phase IB Field Investigations should verify site locations provided by informants, confirm site locations suggested by the literature search, and discover previously unknown sites. The areas to be subjected to a field survey are selected on the basis of the data gathered during the Phase IA evaluation and all probable locations of project construction, staging areas, or any other areas of potential impact. Detailed evaluation of specific resources is not carried out at this level; however, it is necessary to record and describe sites as fully as possible to aid in the formulation of recommendations for avoidance if site boundaries are adequately defined or further evaluation. The precise locations of identified resources with respect to areas of impact of the proposed project must be clearly established.

Because portions of project areas often differ in the likelihood of containing sites, contracted archaeologists encountering or anticipating considerable diversity in site densities within the project area should devise survey strategies in consultation with the appropriate review agency. In cases where sampling specific portions (or strata) of a project area is planned, sampling designs that ensure equal probability of identifying sites in all surveyed locales must be devised. Some areas may, however, be eliminated from survey due to the lesser probability that sites would occur. Areas characterized by more than 12-15 per cent slope may fall into this category; obvious exceptions to elimination of such areas of slope would include terraces and possible rockshelter sites. Where the field testing or literature search reveals areas of disturbance in which no sites could remain intact, documentation of this disturbance via photographs, construction plans, stratigraphic profiles, soil borings, etc. must be included in the report. Areas of standing water may also be excluded from testing, if appropriate and if reasonable explanations for avoiding such areas are presented. Areas not subjected to intensive archaeological investigations should be documented photographically in the archaeological report and on project area maps.

2.3.1 Systematic Surface Survey
Areas that have not been plowed and disked in the past should not be plowed or disked to facilitate a systematic surface survey. If previous plowing cannot be documented, a limited shovel-testing program to document the presence of a plowzone should be undertaken. Each systematic surface survey should be performed according to the following standards, unless alternative methods have been developed in consultation with the appropriate review agency. A limited subsurface shovel-testing program should also be conducted in conjunction with (and prior to) all surface surveys in order to assess plowzone depths and characteristics of underlying soils.

If all non-wooded, previously cultivated portions of the project area can be plowed and disked, a systematic surface investigation can be undertaken once the area has been prepared and subjected to a steady rainfall. Systematic controlled surface surveys may only be performed if adequate surface visibility (i.e. 70% or better) exists. Plowing and disking in strips with intervening areas of unplowed ground no wider than 15 meters may be an acceptable means of field preparation if and only if shovel tests are excavated at 15-meter intervals throughout the unplowed areas.

Archaeological field crews should align themselves at 3-meter to 5-meter intervals in a straight line and pass across the prepared areas searching the surface for artifacts. Each artifact find spot or artifact concentration should be clearly marked and assigned a unique field number. After the artifacts have been flagged, a surface map identifying artifact locations and/or concentrations, depending upon the specific situation and number of artifacts, should be prepared.

2.3.2 Subsurface Shovel-Testing
Subsurface shovel-testing programs should be performed according to the following standards, unless alternative methods have been developed in consultation with the appropriate review agency. Where surface visibility is impaired (e.g. grass lawns, wooded areas), the field survey consists of the excavation of 30- to 50-centimeter minimum diameter test units to undisturbed or non-artifact bearing subsoil at a maximum of 15-meter intervals (or 2 per 460 square meters of surface area = 16 tests per acre = 44 tests per hectare). All excavated soils should be screened through 1/4-inch hardware cloth.

Transects should be established with a compass and taped and/or paced measurements depending upon local conditions. Transects and shovel tests should be numbered in a systematic fashion. Soils excavated from shovel tests should be carefully screened as noted above in order to recover cultural material. All stratigraphic profiles should be described in field notebooks or on appropriate field forms. Information recorded in notebooks should include, but not be confined to, descriptions of soil type, texture, color, condition, and the presence or absence of cultural materials or cultural features.

Documentation of field work activities should include the recording of field observations in notebooks and on appropriate forms. Photography should be employed to document field conditions, observations, and field techniques.

When cultural materials are discovered in isolated shovel-test units, a minimum of four additional units should be dug in the vicinity or the initial test units should be expanded to insure against mistaking evidence of actual sites for "stray finds."

If no cultural resources identified through the Phase IA and/or Phase IB surveys will be impacted by the proposed project, then the survey process is complete. If cultural resources identified by these studies are within the proposed impact area, further evaluation may be required to determine the potential eligibility of the resource(s) for inclusion in the State or National Registers of Historic Places (NRHP). The extent of additional cultural resource study may be reduced by project modifications (e.g. realignment, relocations) that avoid or minimize potential impacts, only if sufficient testing to define valid site boundaries or buffer zones has been completed.

2.4 Phase IB Report
The final Phase IB report should present the results of the field investigations, including a description of the survey design and methodology; complete records of soil stratigraphy; and an artifact catalog including identification, estimated date range, and quantity or weight, as appropriate. The locations of all test units must be accurately plotted on a project area map, with locations of identified resources clearly defined. Photographs that illustrate salient points of the survey are an important component of the final report. Detailed recommendations and supporting rationale for additional investigation must be incorporated into the conclusions of the Phase IB study. For a detailed summary of the requirements for Phase I Reports refer to the NYAC Standards for the Production of CRM Reports (Section 6).

2.5 Disposition of Collections
Provision for the responsible curation of the archaeological collection (material remains and associated records) generated as a result of Phase I investigations, is an integral part of any reconnaissance-level survey. Collections made during Phase I field investigations are often the only collections made from a site, especially if mitigation measures include site avoidance. These collections may represent the remains of resources eligible for listing on the State and/or National Register. However, since the

sites will be avoided, no Phase II investigations are conducted and evaluation of the site cannot be completed based solely upon the results of Phase I work. Arrangements must be made in advance of any field work for the proper processing, documentation, and curation of collections as outlined in Standards for the Curation of Archaeological Collections (Section 7).

3.0 PHASE II CULTURAL RESOURCE INVESTIGATIONS: SITE EVALUATION

3.1 Goals of Phase II Investigations

The primary goals of Phase II Cultural Resource Investigations are to obtain detailed information on the integrity, limits, structure, function, and cultural/historical context of an archaeological site sufficient to evaluate its potential National Register eligibility. These objectives necessitate the recovery and analysis of artifacts, their context and distribution, and any other pertinent data necessary for an adequate evaluation. Based on this information, each site can be assessed to determine its eligibility for the State or National Registers of Historic Places. A site's significance and eligibility are directly related to data collected during a Phase II investigation, the site's integrity, research questions that may be answered at the site, and the site's importance in relation to the known archaeological resource base.

A site is eligible for the National Register if it meets one or more of the following criteria (as set forth in 9 NYCRR 427 and 428 or 36 CFR 800):

A. Associated with events that have made a significant contribution to the broad patterns of our history;
B. Associated with the lives of persons significant in our past;
C. Embodies the distinctive characteristics of a type, period or method of construction; or represents a significant and distinguishable entity whose components may lack individual distinction; or,
D. Has yielded, or may be likely to yield, information important in prehistory or history.

Specific data are needed to adequately address these criteria and to prepare a proper site significance evaluation. These include, but may not be limited to, site boundaries and an estimate of site size; temporal and/or cultural affiliation; intra-site artifact/feature patterning; site function; and placement within geographic and interpretive contexts. Additional important factors include the potential that the data present on the site have for yielding additional important information and both the physical and temporal integrity of the site. This multivariate evaluation of site significance will also provide the initial framework on which to base a subsequent data recovery program if one is required as part of the data recovery plan for the site.

3.1.1. Site Boundaries/Site Size

An estimate of the extent of the site is one dimension of variability important in interpreting site significance. Establishing site boundaries is also essential in determining how much of an impact a proposed project will have on a potentially eligible site. Since project limits are arbitrarily defined in geographic space, it may be necessary to estimate the likelihood that the site extends outside the project boundaries. National Register Bulletin Number 12 outlines various ways of estimating site boundaries. Site size is also an important factor in placing the occupation within regional and cultural settlement systems.

3.1.2 Temporal and/or Cultural Affiliation

Assigning a site to a general time period or specific cultural phase or tradition is an integral aspect of significance. This information helps place the site within an initial context for interpretation and may interface with divisions of interest in the State Plan. Temporal/cultural divisions may vary horizontally across the site or vertically within the natural stratigraphy of the soils.

3.1.3 Intra-Site Artifact/Feature Patterning

Artifacts may be distributed across a site area in a uniform, random, or clustered fashion. Identifying the characteristics of the horizontal and vertical distribution pattern provides the initial structure for interpreting the site. The presence of features (e.g. hearths, pits, cistern, privy, well, postmolds) adds an additional component to the structure of the occupation as well as providing an information-rich element for analyzing the site's placement within the temporal/cultural and subsistence/settlement systems. Power-assisted stripping should not be undertaken as part of site evaluation unless accompanied by intensive recovery and analysis of plowzone data. As a rule, power machinery use should be restricted to data recovery (Phase III) and the removal of sterile overburden.

3.1.4. Site Function and Context

Using the existing information on intra-site clustering, artifact type distributions, and feature presence, a preliminary assessment of site function allows tentative placement of the site within the known temporal, regional, and developmental context of the area. This classification and placement may also relate to study units defined as important in the State Plan.

3.1.5. Data Potential and Site Integrity

The criteria for eligibility to the State and National Registers specifically requires the archaeologist to assess whether the data present on the site have the potential to yield information important to understanding the area's history and prehistory. Part of this assessment necessitates an evaluation of whether the site has suffered physical impacts that have destroyed its research potential. Likewise, archaeologists must determine if temporal components exist in unmixed contexts, whether they be horizontal or vertical, and evaluate to what extent mixing has affected the research potential of the site.

Certain methods have a proven record of efficiently obtaining information relevant to the State or National Register criteria from archaeological sites. These procedures are outlined below.

3.2 Phase II Documentary Research

For both prehistoric and historic sites, Phase II documentary research provides two types of information: (1) information on the types of data expected from the site as derived from previous work on the site and/or on known sites in the locale and region; and (2) local, regional, and national contexts within which to evaluate the importance of the site and to identify research questions that can be addressed. Research efforts should include more intensive interviews with local informants as well as regional and state experts; specific research of published and unpublished site reports from the region to determine how the site may fit within local and regional chronologies, subsistence/settlement systems, and established theoretical contexts; construction of expectations concerning the types of data that may be present and the types of field strategies appropriate for obtaining these data; and review of research issues and theoretical contexts within the disciplines of anthropology, archaeology, and history to which the data on the site might be relevant, Research questions for historic sites should focus on issues that cannot be addressed solely through written records. The results of this review should form the basis for any future data recovery plans.

3.3 Phase II Field Work/Excavation Guidelines

Phase II field work is not limited to the documentation of the presence/absence of artifacts as in the Phase IB investigations, nor to a specific impact zone as in a Phase III data recovery program. The Phase II investigation is often the last time a site will be examined and the last opportunity for an archaeologist to collect information from the entire site area. It is essential that basic or "base-line" information be collected at the Phase II level of investigation for future reference and research.

3.3.1. Surface Investigation Guidelines

Systematic controlled surface surveys may only be performed if adequate surface visibility (i.e. 70% or better) exists. A systematic surface survey of the project/site area may help provide a tentative estimate of a site's horizontal boundaries and the presence/absence of artifact concentrations. With landowner permission, it may be possible to quickly check outside the project limits to determine if the site extends beyond these arbitrary boundaries. No area should be plowed that has not been previously plowed. Depth of plowing should not exceed the depth of the existing plowzone. This depth can be determined from the Phase IB shovel-testing program.

A systematic surface survey will provide information only on those sites present in the plow zone. If the Phase IB investigations showed that sub-plowzone components are present, then additional subsurface excavations will be necessary to estimate site boundaries. In either case, subsurface testing is warranted to maximize the recovery of information from the plowzone, sub-plowzone, and to appropriately address the criteria for eligibility.

Systematic surface survey includes, but is not limited to, walking close-interval transects (5-meter intervals or less) and marking each artifact location for point provenience mapping or collecting within standard units or cells established at a systematic interval across the project/site area. All artifact locations identified during a systematic surface survey must be documented either through piece plotting or by surface collection cell.

If artifacts are collected by surface cells, both the size and spacing of the units should be determined on the basis of the results of the Phase IB survey and any other appropriate considerations. If a site appears to have low artifact density (e.g. less than 5 artifacts per collection cell), then a larger collection cell may be justified. Collection cell size should not exceed 5 meter x 5 meter since it is unlikely that the plowing process moved artifacts more than this. In general, the size and spacing of the cells should be less than that used in the Phase IB investigations. If the artifacts appear to be evenly distributed across the project area, then an interval as large as 10 meters could be justified. If the artifacts appear to be tightly clustered, then intervals of 5 meters or less may be warranted.

In the case of historic sites, where evidence of a foundation was found during the Phase IB investigation, a more clustered or radial pattern of collection could occur using the foundation walls or an historic feature as a focal point.

3.3.2 Subsurface Testing/Excavation Guidelines

Subsurface testing is an essential component of a site evaluation. Methods include, but are not limited to, a systematic shovel-test program, test-unit excavations, and remote sensing. In most cases, the majority of the information used in evaluating a site's significance and eligibility for inclusion on the State or National Registers derives from this testing. As with surface inspection, subsurface investigations should be designed to gather sufficient data to provide an accurate estimate of site boundaries, both for plowzone and sub-plowzone components. In addition, information on the presence and degree of artifact clustering is derived from this method. Artifacts analyzed by cluster contribute to interpretations of site function as does evidence of features collected during testing. Subsurface methods increase the volume of soil examined, thereby increasing the chances of recovering diagnostic cultural material and radiocarbon samples that will help identify the temporal components present. Recovery of tools assists in identifying intra-site structure and contributes to the overall interpretation of site types. Subsurface testing is a major means of assessing the physical and cultural integrity of a site and provides valuable information on the data potential present.

Shovel Tests: The excavation of shovel-test units (round or square no larger than 0.25 square meters) within a project/site area is a quick and efficient method of obtaining site-specific information. In order to obtain data on site boundaries and artifact variability both horizontally and vertically on the site, the spacing and depth of units should be carefully selected. As previously discussed under Surface Investigation Guidelines (Section 3.3.1), information from the Phase IB survey should be used to establish these parameters.

For example, if the results of the Phase IB investigations revealed that a large, uniform distribution of artifacts was present, then shovel tests spaced at 10-meter intervals may be justified. However, if discreet artifact clustering is identified, then intervals no greater than 5 meters are warranted. Similarly, if the Phase IB investigations isolated a sub-plowzone component, then depths of all shovel tests should exceed the maximum depth of artifacts previously identified by at least 10 centimeters. On deep, flood-deposited soils, it may be prudent to extend all shovel-tests to a minimum depth of 1.0 meter. If information obtained in the previous Phase I investigations, Phase II excavations, or soil borings indicate that deeply buried stratified cultural deposits may exist in a project area, mechanically excavated trenches may be appropriate to determine the presence/absence of such phenomena.

All excavated soil should be screened through hardware cloth no greater than 1/4 inch in size. If it is expected that large numbers of small artifacts may be present, such as beads and micro-flakes, then a sample of the soil should be passed through 1/8-inch or smaller mesh, as well. Artifacts from the plowzone and different soil levels should be provenienced separately.

The results of the shovel-testing program should be sufficient to provide an accurate estimation of site boundaries, at least within the project limits and to prepare a distribution map identifying the amount, degree, and type of artifact clustering present.

Test-Unit Excavations: Test-unit excavations are larger, more rigorously controlled excavation units than shovel-test units. Common types of test units are squares and trenches. Units usually measure a minimum of 1.00 square meter and rarely exceed 5.00 square meters. This range accommodates 1.00 x 1.00 meter squares as well as 1.00 meter wide x 5.00 meter long trenches. The size, configuration, and depth of excavation units are contingent upon parameters derived from the Phase IB survey as well as the information collected during surface survey and shovel-testing.

Excavation units should be placed in those areas of the site most likely to yield data relevant to adequately address the goals and objectives of the Phase II investigations. Placement of test units should reflect the results of the systematic surface survey and/or shovel-testing program as well as the expectations regarding site type/function. For prehistoric sites, this may mean excavation of test units within clusters of high artifact concentrations; on historic sites, placement of units adjacent to foundation walls or in suspected midden locations may be appropriate.

During the Phase II field work, it is not necessary to aim for excavation of a specific sampling fraction of the entire site area. Rather, it is more important to provide coverage of all the artifact clusters and structural features present since these are the areas likely to yield the most information on the site.

The choice of natural vs. arbitrary excavation levels and level thickness should facilitate the controlled collection of information necessary for evaluating site significance. Units should be excavated by hand using trowels or shovel skimmed; features should always be trowelled. It is common for the plowzone to be removed as one natural layer. However, it is rarely appropriate to remove the subsoil as a layer. Instead the subsoil (and unplowed topsoils) should be excavated in arbitrary levels within natural stratigraphic layers. The thickness of each arbitrary level should never exceed 10 centimeters.

In general, all measurements should be recorded in the metric system with English equivalents reported in parentheses. However, in cases of historic sites, when considered appropriate and approved by the SHPO, measurements may be recorded in feet and inches with metric equivalents reported in parentheses. In urban settings where mechanized equipment is used to remove asphalt and fill, particular care must be taken to maintain vertical and horizontal control via careful measurement in those instances where excavation in predetermined thicknesses is not possible.

All excavation units must have appropriate documentation including profiles of at least one wall, feature plans and profiles, and photographic documentation. All appropriate samples should be collected even when funds are not immediately available for their analysis. For instance, soil samples from features and unit levels and carbon samples should be routinely collected for present or future analysis.

Remote Sensing: Remote sensing covers all techniques that use other than excavation and physical inspection methods to observe and record subsurface phenomena. Frequently, techniques include soil resistivity, proton magnetometer, gradiometer, ground penetrating radar (GPR), and various photographic techniques (aerial, infrared, etc.).

In order for the data collected through the use of remote sensing techniques to be of value in evaluating the nature, extent, and importance of an archaeological resource, caution is necessary in using these techniques and interpreting their results. First, the archaeologist must clearly understand the characteristics of the data recovered and the potential limitations of the technique being utilized. Second, the natural geophysical properties of an area are important and will directly affect the results. Close coordination between the archaeologist and the geophysical specialist are thus necessary to ensure accurate interpretation of the data. Third, the nature and importance of phenomena identified through remote sensing must be evaluated through actual excavation and recording of some, or all of the phenomena unless anomalies will be avoided.

3.4 Phase II Analysis and Report

The archaeologist must provide sufficient information about the site to allow the review agency to make a determination of eligibility to the State or National Register of Historic Places; to assess the expected impacts to the site from the proposed construction; and to offer recommendations to mitigate these adverse impacts either through avoidance, redesign, data recovery, recordation, or a combination of these. The archaeologist should provide an explicit discussion of the site(s) eligibility, or non-eligibility for listing on the State or National Register based on the data collected during the Phase II investigations. The rationale for evaluation of significance should be clearly stated and justified. The report should also include a discussion of the impacts that are likely to occur on the site(s) if the project proceeds as planned and offer appropriate recommendations for resource management or impact mitigation.

If site avoidance is recommended for a cultural resource, the report should include detailed site protection requirements to be implemented before, during, and after construction to ensure that the resource is not accidentally impacted. If Phase III data recovery investigations are recommended for all or part of a site as an appropriate means of mitigation, the archaeologist should provide recommendations that should be used as the basis for developing a data recovery plan (see Section 4.2).

3.5 Urban Contexts
Due to the complex and diverse nature of implementing research methods in urban contexts, Phase II field strategies should be undertaken only after intensive documentary and map research has been completed for the parcel under study. The field strategies selected to obtain sufficient information for addressing the State or National Register criteria should be formulated in consultation with the appropriate reviewing agency.

3.6 Underwater Sites
As with urban contexts, submerged sites constitute a special category of cultural resources. Phase II methods should be designed in cooperation with the reviewing agency in compliance with specific guidelines for the systematic and scientific conduct of these types of investigations.

3.7 Supplemental Phase II Investigations
In specific cases, where a site with unique, historically documented data is excavated, but the Phase II excavations do not recover the physical evidence expected, it may be appropriate for all involved parties to consider additional Phase II investigations, undertaking archaeological monitoring during the initial phases of construction, or site stripping. As an example, if strong documentary evidence exists for the presence of human burials, but none is discovered during the field investigations, it may be appropriate to conduct supplemental monitoring during preliminary site preparation or construction to identify such features if present. Where such monitoring is employed, contingency plans should be made to implement resource evaluation and data recovery and such plans should be accounted for in archaeological and construction schedules. Monitoring is, however, never a substitute for adequate Phase II investigations.

3.8 Disposition of Collections
Provision for the responsible curation of the archaeological collection (material remains and associated records) generated as a result of Phase II investigations at an acceptable repository is an integral part of any site evaluation. Arrangements must be made in advance of any field work for the proper processing, documentation, and curation of collections as outlined in Standards for the Curation of Archaeological Collections (Section 7).

4.0 PHASE III CULTURAL RESOURCE INVESTIGATIONS: DATA RECOVERY

Phase III Cultural Resource Investigations are required if an archaeological/historical resource listed on or eligible for inclusion on the State or National Registers of Historic Places is identified and impacts to this resource by a proposed project are anticipated. When a data recovery plan is developed, it should be based on a balanced combination of resource-preservation, engineering, environmental, and economic concerns. Mitigation may take the form of avoidance through project redesign, reduction of the direct impact on the resource with data recovery on the portion to be destroyed, data recovery prior to construction, recordation of structural remains, and/or a combination of the above.

4.1 Goals of Phase III Data Recovery/Impact Mitigation
While varying quantities and quality of data are collected during Phase I and Phase II cultural resource investigations, Phase III investigations are specifically designed to recover information contained in a significant archaeological site before all or part of it is destroyed. Thus, the goals of Phase III Data Recovery/Impact Mitigation excavations focus on collecting and preserving cultural, environmental, and any other data of value from a site before it is lost. Due to the project-specific nature of this phase, data recovery plans should be developed on a case-by-case basis in consultation with the SHPO, project sponsor, interested parties, and other involved state and federal agencies.

4.2 Phase III Research Design/Data Recovery Plan
A research design is an integral part of any professional archaeological project. In any Phase III investigation, a research design takes the form of a data recovery plan that must be approved by the SHPO and other involved state and federal agencies prior to commencement of work. The data recovery plan shall be consistent with the Secretary of the Interior's Standards and Guidelines for Archaeological Documentation (48 FR 44734-37) and take into account the Council's publication, Treatment of Archaeological Properties (Advisory Council on Historic Preservation, (draft) 1980). The data recovery plan should reflect a knowledge of the existing archaeological/historical database and research questions considered important at the local, regional, and/or national level. The data recovery plan must provide a detailed discussion of the research topics and questions to be addressed; the types of data that must be gathered in order to address these questions; strategies and methodology for recovery of the necessary data; methods of analyses and interpretation; a schedule for completion of the various aspects of the investigations; the names and background of all key project personnel and consultants who will participate in the research; disposition of collections and field records; and any other necessary information deemed appropriate by the SHPO and other involved state and federal agencies or the Advisory Council on Historic Preservation.

4.3 Phase III Field Work/Excavation Guidelines
Data recovery should be as complete as possible. It should be tailored to the research questions established in the data recovery plan, and to whatever degree possible, to future archaeological research. The basic field work and excavation guidelines established for Phase I and Phase II investigations should be followed for any similar work undertaken in this phase. As a general rule, artifactual information should not be sacrificed for feature information and vice versa. Whenever possible, mechanized

stripping should be restricted to that portion of the site expected to be destroyed.

When preparing to undertake field work for a Phase III data recovery program an archaeologist must be prepared to provide the following: an explicit statement of the procedures used to collect the archaeological data; an explanation and justification of the methodology employed in data collection and recording; a discussion of the system for identifying and recording the spatial and contextual provenience of cultural material and other physical data; detailed descriptions of specialized procedures such as flotation, soil chemistry (pH, phosphates, etc.), and collection of radiocarbon samples; and any other relevant information as deemed appropriate by the reviewing agency.

Structural components such as depositional strata and cultural features identified during subsurface testing should be fully and accurately described and documented by acceptable means. Locations of all sampling and testing units should be recorded on project/site maps. Any important contextual relationships and associations between objects, cultural features, and environmental features should be described and explained.

Unless a site is to be completely destroyed, permanent reference points should be established at the site to facilitate relocation of excavation units and features.

4.4 Phase III Analysis and Report

The Phase III report is expected to be special in both content and format. The description, analysis, and interpretation of information collected should consider all forms of data collected. The reader should be given as complete and accurate an understanding of the site, its function, temporal and cultural affiliations, etc. as possible. All types of data analyzed (e.g. faunal, floral, geological or geomorphological, architectural, historical) should be integrated into site interpretation.

Any additions or modifications to the approved data recovery plan should be explained and justified. In addition, decisions made after field work has been completed as to whether or not to analyze all data collected should be addressed.

Excavation units and any other subsurface tests should be described in detail including stratigraphic profiles, soil conditions and characteristics; depths of deposits; and description and justification for excavation techniques. Depending on the nature and complexity of the site, it may be appropriate to discuss individual excavation units separately or to treat common deposits located in more than one unit together.

All laboratory procedures relevant to artifact and special sample processing, differential handling of certain classes of material, artifact identification and cataloging, and storage should be discussed.

Any previous applicable work should be incorporated into the analysis of the site. Examples of such work would include, but not be restricted to local and regional work that is directly related to the site, culture(s), or time period(s) represented; related work in other geographic areas; theoretical or descriptive archaeological work; and any relevant research or information from other disciplines that have direct bearing on the analyses and interpretation of data collected at the site.

The report should include a discussion of contributions and potential contributions the Phase III investigations have made or could make to state, local, or national prehistory or history as appropriate. It may also be possible to discuss the study's contributions to broad anthropological and theoretical issues or to the State Plan if data generated during the investigations are suitable for such purposes.

Finally, the archaeologist should disseminate the information to the archaeological community and the lay public. An integral part of any data recovery should be publications, presentations at meetings and/or community programs, such as slide talks and exhibits.

4.5 Supplemental Phase III Investigations

If an approved Phase III data recovery plan does not result in the recovery of the physical evidence known to exist at a particular site and if the site will be destroyed, then all involved parties should strongly consider undertaking archaeological monitoring during the initial phases of construction or additional Phase III investigations which could possibly include mechanized site stripping. Archaeologically supervised stripping or site destruction under archaeological control can be a very effective means of evaluating the validity of a project field research design, particularly if the data recovery plan employs a sampling regime. It provides an means of assuring that data collected during the implementation of the data recovery plan are representative of the true nature of the archaeological site. Destruction under control may also be applicable to situations where looting of uncollected materials within the project impact zone may occur following the completion of data recovery. As previously noted, Phase III investigations are specifically designed to recover information contained in a significant archaeological site before all or part of it is destroyed. If deemed appropriate, this supplemental work should ensure that the goals of Phase III are satisfied before the site and its associated data are lost. Under no circumstances should such activities be undertaken on sites or portions of sites not subject to imminent destruction. Monitoring is not a substitute for an adequate Phase III investigation.

4.6 Disposition of Collections

Provision for the responsible curation of the archaeological collection (material remains and associated records) generated as a result of Phase III investigations at an acceptable repository is an integral part of any data recovery plan. Arrangements must be made in advance of any field work for the proper processing, documentation, and curation of collections as outlined in Standards for the Curation of Archaeological Collections (Section 7).

5.0 DISCOVERY OF HUMAN REMAINS

The discovery of human remains and items of cultural patrimony as defined by Section 3001 of the Native American Graves Protection and Repatriation Act (NAGPRA) in any phase of cultural resource investigations requires special consideration and care. Any discoveries of human remains on State lands must be reported to the State Museum. At all times human remains must be treated with the utmost dignity and respect. Should human burials be encountered, the location should immediately be secured and protected from damage and disturbance. Unless burial excavation is the purpose of or an explicit component of the approved research design, human remains should be left in-situ until consultation with the project sponsor, the SHPO, federally recognized Native American groups, concerned parties, and involved state and federal agencies has taken place. The excavation, study, and disposition of human remains should take place in accordance with all applicable federal, state, and local laws. The NYAC Policy on Human Remains (dated 1972; Appendix B) and Guidelines for Consideration of Traditional Cultural Values in Historic Preservation Review published by the President's Advisory Council on Historic Preservation can provide helpful guidance on the proper treatment of human remains.

6.0 STANDARDS FOR THE PRODUCTION OF CRM REPORTS

The following report guidelines summarize general content and suggested formats for any CRM report. It is understood that reports written for agencies that have their own specific report requirements should be written accordingly, but these reports should also include the information outlined in these standards. The National Park Service report format is also an appropriate model for reports.

These standards have not been designed to exclude categories of information not listed, nor to offer a rigid format for final reports. It is also important to note that reports are expected to pertain only to the level of research and analysis appropriate to the level of cultural resource investigation undertaken. In addition, these standards have been prepared under the assumption that CRM reports must fulfill the needs of the lead agency involved as well as those of any other reviewer. Finally, any report prepared in accordance with NYAC standards should include completed New York State Prehistoric or Historic Archaeological Site Forms and Building Structure Inventory forms where appropriate.

For the purposes of these guidelines, a "reviewer" is anyone who reads, examines, or studies the report for a lead agency, municipality, citizen group, university, or similar body in order to evaluate the cultural resource investigations completed, the results, and the recommendations.

Given the potential distribution of the CRM report, it is also important to provide information that will allow appropriate reviewers the opportunity to make informed evaluations but at the same time protect the fragile archaeological/historical resource base from potential dangers posed by unscrupulous individuals. As such, some type of non-disclosure statement or method of site location protection within the report will be required.

6.1 Title Page

Each report should contain a title page that provides at least the following: the title of the report, including the level of investigation (e.g. Phase IA, IB, I, II, or III); the name and location of the minor civil subdivision (city/village/town, county, state) of the project; any pertinent project identification number (e.g. Highway PIN, Permit Number); author(s), contributor(s), project director(s), principal investigator(s); date report was prepared; name and address of the project sponsor for whom the report was prepared; and the organizational affiliation with address of the archaeological consultant.

6.2 Table of Contents

The table of contents should be arranged in a logical manner and should constitute a list of primary and secondary internal divisions of the report with their beginning page numbers. Lists of figures, tables, and plates (with page numbers) should immediately follow the list of section headings. They may be listed on separate pages if the lists are lengthy. It may also be appropriate to list authors of sections and subsections in the proper place within the table of contents.

A typical report table of contents may include the following: Management Summary; Introduction; Environmental/Physical Setting; Background Research and Sensitivity Assessment; Research Design; Field Methods and Procedures; Results; Summary, Conclusions; and Recommendations; References Cited; Acknowledgments; Appendixes; List of Figures; List of Tables; and List of Photographs/Plates.

6.3 Management Summary

The management summary, like an abstract, should serve as a brief, clear outline of the proposed project, the investigations, results, and recommendations. It is often used by non-archaeologists and should be written with this category of reader as well as any agency reviewer in mind.

The management summary should include sections outlining the following: project location, project description, project size, regulatory and/or lead agency, landform/environment, work completed, problems encountered, results, and conclusions and recommendations.

6.4 Introduction

The introduction should outline and summarize all pertinent sections of the report and should include at least the following:

(1) The names of the project sponsor and the contact person; the date on which the consultant was contacted to perform the work; the date on which the parties contracted to perform the investigations; contract numbers and permit/project numbers; legislation relevant to the work

(2) A written description of the proposed project including the nature of the construction or land alteration, geographic limits of the project areas, potential impacts, and project alternatives, if any are known

(3) The purpose of the investigations, discussion of the scope of work, and the report format

(4) The composition of the research staff and the dates of investigation

(5) The temporary and permanent repositories of field data, artifacts, and other important project materials

(6) Sufficient maps and illustrations to identify the project location including, but not necessarily restricted to, the location of the project within the state and county, the location of the project area on a named USGS 7.5' topographic map or DOT map, and a project area map

6.5 Environmental/Physical Setting
This section of the report should summarize the environmental factors relating to actual and potential cultural resources, including archaeological sites, landscapes and extant structures, within or adjacent to the project area. This information is necessary for both developing research methods and for evaluating project impact. Minimally, the following should be included, with accompanying maps where appropriate: geology, soils, hydrology, physiography/geomorphology, climate, flora, fauna, and recent human/natural disturbance.

6.6 Background Research and Sensitivity Assessment
The section summarizing the background research and sensitivity assessment should be written in such a manner as to assist reviewers in understanding and evaluating the importance of archaeological resources in the project area as well as the rationale for any further research recommended. The following general guidelines apply for reporting the results of the background literature search and sensitivity assessment: specify the steps taken in obtaining information; cite all sources including oral testimony, and provide full references in the report; explain omissions and lack of cultural activity where pertinent to the conclusions of the sensitivity assessment; provide a summary of the cultural background and environmental attributes and limitations of the area; review information on known archaeological and other cultural resources and previous studies in the area; include information on the foci and extent of previous coverage of the area and the research questions addressed; and specify where all records resulting from the background research will be curated. DO NOT provide specific site locations in reports for public distribution;

6.6.1 Background Research
Summaries of the following should be covered under Background Research: site file searches at the state and local levels; archaeological literature search, including both published and unpublished sources; examination of historic maps and archival information; searches of State and National Register files at SHPO, specifying SRHP/NRHP-listed, SRHP/NRHP-eligible, and SRHP/NRHP-inventoried sites; informant interviews; examination of institutional and private artifact collections; consultation with other professional archaeologists, locally active historians, and municipal authorities; field visit(s); the person(s) involved, the date of the visit, and the observations made.

A table listing the known cultural resources within a one-mile radius of project area should be included in the report with maps (see above *re* reports for public distribution) and photographs where appropriate.

6.6.2 Sensitivity Assessments
Summaries of the following should be covered under Sensitivity Assessment: the sensitivity rating expressed as low, moderate, high, or mixed, that reflects the likelihood that cultural resources are present within the project area; definition of the rating system used and its implications for further research; discussion of the types and conditions of cultural resources likely to be found within the project area; rationale for assigning the sensitivity rating; and relevant environmental and/or historic contexts such as those in SHPO's list developed for state-wide planning (see Section 2.2.2).

6.7 Research Design
The research design should reflect a knowledge of the existing database and research questions considered important at least at the local and regional levels. The degree of complexity or detail should be appropriate to the level of investigations undertaken. This section of the report should include the following: an identification of the theoretical goals as stated in the form of specific hypotheses to be tested or problems to be investigated; the identification of the relevant analytical variables: specification of the data necessary for empirical testing; specification and justification of the methods and techniques for collecting and studying the data; and discussion of possible outcomes of the analyses.

6.8 Field Methods and Procedures
This section of a Phase I report should include discussions of the following: walkover survey strategies designed to determine the presence of visible foundations, artifact scatters, disturbed ground, excessive slope, etc.; the type and size of excavation/collection unit used to locate resources and the reasons for this selection (e.g. shovel-test units for artifact recovery, larger units for surface collections, trenches for identifying buried historic foundations or deeply buried prehistoric sites); testing interval and design (e.g. single transect, regular grid, staggered grid) and rationale for this selection; when plowing and collecting, the length and interval between furrows, whether cultural material was piece-plotted or collected in systematically placed units, type of weather and ground conditions (e.g. cloudy vs. bright sun, dry vs. moist soil, adequacy of potential artifact visibility); excavation and artifact recovery techniques (e.g. shovel vs. machine excavation, natural vs. arbitrary layers/levels, depth to sterile soil, remote sensing methods, soil stripping strategies) and rationale; average depth of test units; typical soil profiles; the size of screen mesh; the adequacy of horizontal and vertical survey coverage; areas not surveyed and

reasons why; and the potential biases in results (if any) from gaps in coverage.

This section of a Phase II report should, in addition, include discussions of the following: the type and size of excavation/collection units used during the site examination; the field sampling strategy and rationale for its selection; the excavation/collection techniques and how these relate to the data expected; and any impediments to the site examination that may have influenced the results.

This section of a Phase III report should, in addition, include discussions of the following: explanation of and justifications for the data recovery field strategy and methods; the treatment and analysis of floral, faunal, or other organic matter recovered; and all laboratory procedures relating to the stabilization, labelling, cataloging, and storage of artifacts and records, including the curation facility.

6.9 Results

The results section of a report should clearly outline in the text and on maps the project boundaries, testing strategies, and cultural resources identified during testing. Depending upon the specific nature of the project and the investigations undertaken, it may be the site(s), standing structures, single test units, or single artifacts recovered from a plowed field that serve as the primary unit of discussion. Descriptions may be organized by starting at one end of a project area and moving to the other or by grouping similar resources together (e.g. all prehistoric resources separate from historic resources and standing structures).

6.9.1 Components of a Phase I Report

Key components of this section of the text for a Phase I report should include the following: project size; the number of and intervals between shovel test units (with the shovel-test unit records included as an appendix); the number of tests actually excavated; the number of units, if any, that produced cultural material; the numbers and types of artifacts recovered and their cultural affiliation, if known (with the artifact list/catalog included as an appendix); the nature of the artifact distribution (e.g. clusters of artifacts, uniform scatter, random distribution, features); physiographic context of the artifacts (e.g. floodplain, terrace, swamp, lake); stratigraphic context of the artifacts (e.g. surface, plowzone, buried); lists of all standing structures that are at least 50 years old as well as structures that are less than 50 years old and are exempt from Office of Parks, Recreation and Historic Preservation (OPRHP) guidelines; site and structure inventory forms for all prehistoric and historic archaeological sites and standing structures that are at least 50 years old; and a master project map that details the testing strategy and results.

6.9.2 Components of a Phase II Report

Key components of this section of the text for a Phase II report should include the following: the number of each type of excavation unit used in the site examination including detailed descriptions of typical and unusual profiles of excavation units; the range of artifact types recovered from testing (with the artifact catalog included as an appendix); the average density of material per unit as well as other summary statistics that help describe the site; the estimated site size and the proportion of the site contained within the project boundaries; the size of the area actually excavated (total sq m); the nature of the vertical stratification of the site (e.g. site contained within the plowzone, sub-plowzone, layered in the sub-plowzone); any internal clustering within the site; the types of features present (with photographs, floor plans, and profiles included as appropriate); temporal associations of the sites based on diagnostic artifacts or radiocarbon dating if available; summaries of floral, faunal, and other specialized analyses; summaries of functional, technological, and stylistic analyses of specific artifact groups; interpretations of site function; interpretations of the place of the site within a larger temporal, regional, or theoretical context; and research potential of the site.

6.9.3 Components of a Phase III Report

Key components of this section of the text for a Phase III report should include the following: complete artifact inventories integrating all phases of investigation; results of artifact analyses; results of all floral, faunal, and radiocarbon analyses; integration and interpretation of the results of all tests and analyses; the application of these integrated results to the research questions and goals of the study as made explicit in the research design; all pertinent plans and sections of excavation units and features encountered; and any biases or extraneous factors that may have affected the outcome of the excavations and analyses. All Phase III report photographs, tables, maps, and other graphics should be of publishable quality and follow National Park Service guidelines.

6.9.4 Project Map Specifications

Project maps should include the following: an outline of the project boundaries in reference to fixed features such as roadways, power lines, rivers, canals, and railroads; the locations of all important features within the project boundaries such as standing structures, ditches, and disturbed areas; the locations of all test units actually excavated or collected differentiated according to those that contained artifacts and those that did not; the locations of all suspected artifact clusters and features such as foundations, wells, and middens; the identifications of all structures that are at least 50 years old or other important standing structures in the project area; numbered photo angles of all photographs included in the text; a title block identifying the project name, location, date of investigation, and contractor performing the survey; key to all symbols used on the map; a bar scale using both English and metric measurements; and a north arrow (specify whether grid, magnetic, or geographic).

Maps accompanying a Phase II report should, in addition to the information listed for project maps, include the following: estimates of site boundaries; detailed maps of all individual site excavations; site locations labelled with site name and number; locations of features and any radiocarbon dated samples. Maps accompanying a Phase III report should also include the locations of all excavation units, backhoe trenches, and areas of machine stripping.

6.10 Summary, Conclusions. and Recommendations

The final section of an archaeological survey report should serve as a stand-alone summary of the activities and findings reported in detail in the body of the report.

6.10.1 Components of a Phase I Report

For a Phase I report, this section should summarize the scope, methodology, areal coverage, and findings of the investigations; identify any areas where archaeological materials were discovered; point out gaps in survey coverage or areas where weather, owner-access refusal, or other conditions prevented or necessitated less than thorough investigations; indicate the institutional repository for artifacts, field notes, and records for the project; evaluate the results of the investigations in terms of the project's theoretical orientation, bias, and assumptions identified in the research design; compare the results of the investigations to those of others conducted in the area; place the study within a regional context in terms of its contribution to regional knowledge and the degree to which its results reflect what is known of the area; assess the project impact; explain the need for and general scope of additional work, if any; make and justify recommendations for project modifications to protect sites if accurate site boundaries can be established; and consider secondary effects of the project as well as the direct impacts (e.g. housing development resulting from road, sewer, or waterline construction or site isolation resulting from gravel mining).

6.10.2 Components of a Phase II Report

For a Phase II report, this section should summarize the arguments regarding the significance or non-significance of the resources investigated; state whether or not sufficient information has been collected to address the criteria for eligibility for listing on the State or National Registers of Historic Places such as information pertinent to the integrity, research potential, and the adequacy of horizontal and vertical boundary information; and present possible options for the treatment of any resources considered significant (e.g. avoidance through redesign, protective conditions, and/or data recovery) along with specific recommendations as to how these might be implemented.

6.10.3 Components of a Phase III Report

For a Phase III report this section should include summaries of the research design and of the recovery, analysis, and interpretation of information collected during the data recovery program; an evaluation of the success of the data recovery plan and any modifications made to it; an interpretation of data recovered from the site(s) and their importance in relation to the relevant historic context(s) established for the region; a discussion of contributions the Phase III investigations have made to the current state of knowledge of prehistory or history and the state plan; recommendations for updating or revising research questions, goals, and preservation priorities in the state historic preservation plan; recommendations for supplemental Phase III investigations, if appropriate (Section 4.5); recommendations for the conservation, short-term, and long-term curation of the collection; and finally, recommendations for dissemination of all appropriate information to the archaeological community and public outreac programs.

6.11 References Cited

Every effort should be made to insure that this part of the report is complete and accurate. We urge the consistent adoption of the American Antiquity format and refer readers to its most recently published style guide.

7.0 STANDARDS FOR THE CURATION OF ARCHAEOLOGICAL COLLECTIONS[1]

7.1. Definitions

For the purposes of these standards, the following definition apply:

7.1.1. Collection means material remains that are excavated o removed during a survey, excavation or other study of a prehistori or historic resource, and associated records that are prepared o assembled in connection with the survey, excavation, or other study.

7.1.2. Material remains means artifacts, objects, specimens anc other physical evidence that are excavated or removed in connection with efforts to locate, evaluate, document, study. preserve or recover a prehistoric or historic resource. Classes o material remains (and illustrative examples) that may be in collection include, but are not limited to:

(A) Components of structures and features (such as houses, mills, piers, fortifications, raceways, earthworks, and mounds);
(B) Intact or fragmentary artifacts of human manufacture (such as tools, weapons, pottery, basketry, and textiles);
(C) Intact or fragmentary natural objects used by humans (such a rock crystals, feathers, and pigments);
(D) By-products, waste products or debris resulting from the manufacture or use of man-made or natural materials (such as slag dumps, cores, and debitage);
(E) Organic material (such as vegetable and animal remains, and coprolites);
(F) Human remains (such as bone, teeth, mummified flesh, burials and cremations);
(G) Components of petroglyphs, pictographs, intaglios or other works of artistic or symbolic representation;
(H) Components of shipwrecks (such as pieces of the ship's hull. rigging, armaments, apparel, tackle, contents, and cargo);
(I) Environmental and chronometric specimens (such as pollen. seeds, wood, shell, bone, charcoal, tree core samples, soil, sedimen cores, obsidian, volcanic ash, and baked clay); and
(J) Paleontological specimens that are found in direct physical relationship with a prehistoric or historic resource.

1 Adapted from Department of the Interior, National Park Service 356 CFR Part 79 and the Standards of Research Performance of the Society of Professional Archaeologists.

7.1.3. Associated records means original records (or copies thereof) that are prepared, assembled and document efforts to locate, evaluate, record, study, preserve, or recover a prehistoric or historic resource. Some records such as field notes, artifact inventories, and oral histories may be originals that are prepared as a result of the field work, analysis, and report preparation. Other records such as deeds, survey plats, historical maps and diaries may be copies of original public or archival documents that are assembled and studied as a result of historical research. Classes of associated records (and illustrative examples) that may be in a collection include, but are not limited to:

(A) Records relating to the identification, evaluation, documentation, study, preservation or recovery of a resource (such as site forms, field notes, drawings, maps, photographs, slides, negatives, films, video and audio cassette tapes, oral histories, artifact inventories, laboratory reports, computer cards and tapes, computer disks and diskettes, printouts of computerized data, manuscripts, reports, and accession, catalog, and inventory records);

(B) Records relating to the identification of a resource using remote sensing methods and equipment (such as satellite and aerial photography and imagery, side scan sonar, magnetometers, subbottom profilers, radar, and fathometers);

(C) Public records essential to understanding the resource (such as deeds, survey plats, military and census records, birth, marriage and death certificates, immigration and naturalization papers, tax forms, and reports);

(D) Archival records essential to understanding the resource (such as historical maps, drawings and photographs, manuscripts, architectural and landscape plans, correspondence, diaries, ledgers, catalogs, and receipts); and

(E) Administrative records relating to the survey excavation or other study of the resource (such as scopes of work, requests for proposals, research proposals, contracts, antiquities permits, reports, documents relating to compliance with Section 106 of the National Historic Preservation Act (16 U.S.C. 470), and National Register of Historic Places nomination and determination of eligibility forms).

7.1.4 Curatorial services means providing curatorial services means managing and preserving a collection according to professional museum and archival practices, including but not limited to:

(A) Inventorying, accessioning, labeling, and cataloging a collection;

(B) Identifying, evaluating, and documenting a collection;

(C) Storing and maintaining a collection using appropriate methods and containers, and under appropriate environmental conditions and physically secure controls;

(D) Periodically inspecting a collection and taking actions as may be necessary to preserve it;

(E) Providing access and facilities to study a collection; and

(F) Handling, cleaning, stabilizing, and conserving a collection in such a manner to preserve it.

7.1.5 Qualified museum professional means a person who possesses training, knowledge, experience, and demonstrable competence in museum methods and techniques appropriate to the nature and content of the collection under the person's management and care, and commensurate with the person's duties and responsibilities. In general, a graduate degree in museum science or subject matter applicable to archaeology, or equivalent training and experience, and three years of professional experience are required for museum positions that demand independent professional responsibility as well as subject specialization (archaeology) and scholarship. Standards that may be used, as appropriate, for classifying positions and for evaluating a person's qualifications include, but are not limited to, the following federal guidelines:

(A) The Office of Personnel Management's "Position Classification Standards for Positions under the General Schedule Classification System" (U.S. Government Printing Office, stock No. 906-028-00000-0, 1981) are used by Federal agencies to determine appropriate occupational series and grade levels for positions in the Federal service. Occupational series most commonly associated with museum work are the museum curator series (GS/GM-1015) and the museum technician and specialist series (GS/GM-1016). Other scientific and professional series that may have collateral museum duties include, but are not limited to, the archivist series (GS/GM-1420), the archeologist series (GS/GM-193), the anthropologist series (GS/GM-190), and the historian series (GS/GM-170). In general, grades GS-9 and below are assistants and trainees while grades GS-11 and above are determined according to the level of independent professional responsibility, degree of specialization and scholarship, and the nature, variety, complexity, type, and scope of the work.

(B) The Office of Personnel Management's "Qualification Standards for Positions under the General Schedule (Handbook X-118)" (U.S. Government Printing Office, stock No. 906-030-00000-4, 1986) establish educational, experience and training requirements for employment with the Federal Government under the various occupational series. A graduate degree in museum science or applicable subject matter, or equivalent training and experience, and three years of professional experience are required for museum positions at grades GS-11 and above.

(C) The "Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation" (48 FR 44716, Sept. 29, 1983) provide technical advice about archeological and historic preservation activities and methods for use by Federal, State and local Governments and others. One section presents qualification standards for a number of historic preservation professions. While no standards are presented for collections managers, museum curators or technicians, standards are presented for other professions (i.e. historians, archeologists, architectural historians, architects, and historic architects) that may have collateral museum duties.

7.2 Responsibilities of the Archaeologist

1. If material remains are collected as a result of a survey, excavation, or other study of a prehistoric or historic resource, a system for identifying and recording their proveniences must be maintained.

2. All associated records from an archaeological project should be intelligible to other archaeologists. If terms lacking commonly held referents are used, they should be clearly defined.
3. During accessioning, analysis, and storage of the material remains and associated records in the laboratory, the archaeologist must take precautions to ensure that correlations between the material remains and the associated records are maintained, so that provenience, contextual relationships, and the like are not confused or obscured.
4. The archaeologist must ensure that a collection resulting from a project will be deposited at a repository that can provide curatorial services, that employs at least one qualified professional with experience in collections management/curation.
5. The initial processing of the material remains (including appropriate cleaning, sorting, labeling, cataloging, stabilizing, and packaging) must be completed, and associated records prepared and organized in accordance with the repository's processing and documentation procedures.
6. A professional archaeologist should refuse to participate in any research which does not comply with the above criteria.

7.3 Guidelines for Selecting a Repository
1. When possible, collections from New York should be deposited in a repository that:
(i) is in the State;
(ii) stores and maintains other collections from the same site or project location; or
(iii) houses collections from a similar geographic region or cultural area.
2. The collection should not be subdivided and stored at more than a single repository unless such subdivision is necessary to meet special storage, conservation, or research needs.
3. Material remains and associated records should be deposited in the same repository to maintain the integrity and research value of the collection.

7.4 Criteria for Institutions Serving as Repositories for Archaeological Collections
1. The institution must be chartered as a museum by the Board of Regents of the State of New York or similar body, or be an institution of higher education recognized by the State of New York.
2. The repository must certify, in writing, that the collection shall be cared for, maintained, and made accessible in accordance with the standards in this part.
3. The repository must be able to provide adequate, long-term curatorial services including:
(A) Accessioning, labelling, cataloging, storing, maintaining, inventorying and conserving the particular collection on a long-term basis using professional museum and archival practices; and
(B) Comply with the following, as appropriate to the nature and content of the collection;
(1) Maintain complete and accurate records of the collection, including:
(a) records on acquisitions;
(b) catalog and artifact inventory lists;
(c) descriptive information, including field notes, site forms, and reports;
(d) photographs, negatives, and slides;
(e) locational information, including maps;
(f) information on the condition of the collection, including any completed conservation treatments;
(g) approved loans and other uses;
(h) inventory and inspection records, including any environmental monitoring records;
(i) records on any deaccessions and subsequent transfers, repatriations, or discards;
(2) Dedicating the requisite facilities, equipment, and space in the physical plant to properly store, study, and conserve the collection. Space used for storage, study, conservation, and, if exhibited, any exhibition must not be used for non-curatorial purposes that would endanger or damage the collection;
(3) Keeping the collection under physically secure conditions with storage, laboratory, study, and any exhibition areas by
(a) having the physical plant meet local electrical, fire, building, health and safety codes;
(b) having an appropriate and operational fire detection and suppression system;
(c) having an appropriate and operational intrusion detection and deterrent system;
(d) having an adequate emergency management plan that establishes procedures for responding to fires, floods, natural disasters, civil unrest, acts of violence, structural failures, and failures of mechanical systems within the physical plant;
(e) providing fragile or valuable items in a collection with additional security such as locking the items in a safe, vault or museum specimen cabinet, as appropriate;
(f) limiting and controlling access to keys, the collection, and the physical plant; and
(g) periodically inspecting the physical plant for possible security weaknesses and environmental control problems, and taking necessary actions to maintain the integrity of the collection;
(4) Requiring staff and any consultants who are responsible for managing and preserving the collection, and for conducting inspections and inventories as described in sections 3.(B)(7) and 3.(B)(8), to be either qualified museum professionals or professional archaeologists guided by a professional museum conservation consultant.
(5) Handling, storing, cleaning, conserving and, if exhibited, exhibiting the collection in a manner that
(a) is appropriate to the nature of the material remains and associated records;
(b) protects them from breakage and possible deterioration from adverse temperature and relative humidity, visible light, ultraviolet radiation, dust, soot, gases, mold, fungus, insects, rodents, and general neglect; and
(c) preserves data that may be studied in future laboratory analyses. when material remains in a collection are to be treated with chemical solutions or preservatives that will permanently alter the

remains, when possible, retain untreated representative samples of each affected artifact type, environmental specimen or other category of material remains to be treated. untreated samples should not be stabilized or conserved beyond dry brushing;

(6) Storing site forms, field notes, artifacts, inventory lists, computer disks and tapes, catalog forms, and a copy of the final report in a manner that will protect them from theft and fire such as

(a) storing the records in an appropriate insulated, fire resistant, locking cabinet, safe, vault or other container, or in a location with a fire suppression system;

(b) storing a duplicate set of records in a separate location; or

(c) ensuring that records are maintained and accessible through another party. For example, copies of final reports and site forms frequently are maintained by the State Historic Preservation Officer, the State Archeologist or the State Museum or university. The Tribal Historic Preservation Officer and Indian tribal museum ordinarily maintain records on collections recovered from sites located on Indian lands. The National Technical Information Service and the Defense Technical Information Service maintain copies of final reports that have been deposited by Federal agencies. The National Archeological Database maintains summary information on archeological reports and projects, including information on the location of those reports.

(7) Periodically inspecting the collection or having a professional conservation assessment done regularly for the collection for the purposes of assessing the condition of the material remains and associated records, and monitoring those remains and records for possible deterioration and damage; and performing only those actions as are absolutely necessary to stabilize the collection and rid it of any agents of deterioration.

(a) Material remains and records of a fragile or perishable nature should be inspected for deterioration and damage on a more frequent basis than lithic or more stable remains or records.

(b) Because frequent handling will accelerate the breakdown of fragile materials, material remains and records should be viewed but handled as little as possible during inspections.

(8) Periodically inventorying the collection by accession, lot, or catalog record for the purpose of verifying the location of the material remains and associated records

(a) Material remains and records of a valuable nature should be inventoried on a more frequent basis than other less valuable remains or records.

(b) Because frequent handling will accelerate the breakdown of fragile materials, material remains and records should be viewed but handled as little as possible during inventories.

(9) Providing access to the collection for scientific, educational, and religious uses, subject to such terms and conditions as are necessary to protect and preserve the condition, research potential, religious or sacred importance, and uniqueness of the collection, such as

(a) Scientific and educational uses. A collection shall be made available to qualified professionals for study, loan and use for such purposes as in-house and traveling exhibits, teaching, public interpretation, scientific analysis, and scholarly research. Qualified professionals would include, but not be limited to, curators, conservators, collection managers, exhibitors, researchers, scholars, archaeological contractors, and educators. Students may use a collection when under the direction of a qualified professional.

(b) Religious uses. Religious remains in a collection shall be made available to persons for use in religious rituals or spiritual activities. Religious remains generally are of interest to medicine men and women, and other religious practitioners and persons from Indian tribes, and other indigenous and immigrant ethnic, social, and religious groups that have aboriginal or historic ties to the lands from which the remains are recovered, and have traditionally used the remains or class of remains in religious rituals or spiritual activities.

(c) The repository shall not allow uses that would alter, damage, or destroy an object in a collection unless the repository determines that such use is necessary for scientific studies or public interpretation, and the potential gain in scientific or interpretive information outweighs the potential loss of the object. When possible, such use should be limited to unprovenienced, non-unique, non-fragile objects, or to a sample of objects drawn from a larger collection of similar objects.

(d) No collection (or part thereof) shall be loaned to any person without a written agreement between the repository and the borrower that specifies the terms and conditions of the loan. At a minimum, a loan agreement shall specify

(1) the collection or object being loaned;

(2) the purpose of the loan;

(3) the length of the loan;

(4) any restrictions on scientific, educational or religious uses, including whether any object may be altered, damaged or destroyed;

(5) except as provided in section 2(9)(c), the stipulation that the borrower shall handle the collection or object being borrowed during the term of the loan so as not to damage or reduce its scientific, educational, religious, or cultural value; and

(6) any requirements for insuring the object

or collection being borrowed for any loss, damage or destruction during transit and while in the borrower's possession.

(e) The repository shall maintain administrative records that document approved scientific, educational, and religious uses of the collection.

Appendix A

FEDERAL LAWS, REGULATIONS AND GUIDELINES

National Historic Preservation Act of 1966, as amended.

- 36 CFR Part 800 Protection of Historic Properties
- 36 CFR Part 60 National Register of Historic Places
- 36 CFR Part 61 Procedures for Approved State and Local Government Historic Preservation Programs
- 36 CFR Part 79 Curation of Federally Owned and Administered Archaeological Collections
- Archaeology and Historic Preservation: Secretary of Interior's Standards and Guidelines

Department of Transportation Act of 1966

National Environmental Policy Act of 1969

Archaeology and Historic Preservation Act of 1974

Archaeological Resource Protection Act of 1979

- 43 CFR Part 7 Protection of Archaeological Resources: Uniform Regulations

Abandoned Shipwreck Act of 1987

- Abandoned Shipwreck Act Guidelines

Native American Grave and Repatriation Act of 1990

NEW YORK STATE LAWS AND REGULATIONS

State Historic Preservation Act - Article 14 of Parks, Recreation and Historic Preservation Law

- 9 NYCRR Part 426 Authority and Purpose
- 9 NYCRR Part 427 State Register of Historic Places
- 9 NYCRR Part 428 State Agency Activities Affecting Historic and Cultural Properties

State Environmental Quality Review Act - Article 8 of Environmental Conservation Law

- 6 NYCRR Part 617 State Environmental Quality Review
- The SEQR Handbook (1992 edition)

PERTINENT GUIDANCE DOCUMENTS AND "HOW TO" MATERIALS

Advisory Council on Historic Preservation

- The Treatment of Archaeological Properties
- Section 106 Step-by-Step

U. S. Department of the Interior

Technical Brief No. 11 Legal Background of Archaeological Resource Protection

National Register Bulletins

- #12 Definition of National Register Boundaries for Archaeological Properties
- #15 How to Apply the National Register Criteria for Evaluation
- #16A How to Complete National Register Registration Forms
- #16B How to Complete National Register Multiple Property Documentation Form
- #29 Guidelines for Restricting Information About Historic and Prehistoric Resources
- #36 Evaluating and Registering Historical Archaeology Sites and Districts
- #38 Guidelines for Evaluating and Documenting Traditional Cultural Properties
- #41 Guidelines for Evaluating and Registering Cemeteries and Burial Places
- #43 Defining Boundaries for National Register Properties

To obtain copies and or updated versions of the above documents, please address your request to the relevant agencies listed below.

Advisory Council On Historic Preservation
1100 Pennsylvania Avenue, NW, Suite 809
Washington, DC 20004

National Register of Historic Places
National Park Service
U.S. Dept. of Interior
P.O. Box 37127
Washington, DC 20013-7127

Archaeological Assistance Division
National Park Service
U.S. Dept. of Interior
P.O. Box 37127
Washington, DC 20013-7127

New York State Office of Parks, Recreation and Historic Preservation
Historic Preservation Field Services Bureau
Peebles Island
P.O. Box 189
Waterford, NY 12188-0189
Phone 518-237-8643

New York State Museum
Anthropological Survey
Cultural Education Center
Empire State Plaza
Albany, NY 12230

New York State Department of Environmental Conservation
50 Wolf Road
Albany NY 12233

Appendix B
NYAC BURIAL RESOLUTION
15 September 1972

Whereas, the Native Americans of New York State regard the disturbance of their burials in the ground as disrespectful to their dead; and

Whereas, the New York Archaeological Council, the representatives of the majority of the professional archaeologists working in New York State recognizes that the same legal and ethical treatment should be accorded all human burials irrespective of racial or ethnic origins; and

Whereas, NYAC recognizes that despite our position the disturbance of burials by others is and will be a reality; therefore,

Resolved,

1) That the New York Archaeological Council urges a moratorium on planned burial excavation of Indian skeletons in New York State until such time as public opinion regards the recovery of skeletal data as a scientific endeavor irrespective of racial or ethnic identity,

2) That we oppose the excavation of burials for teaching purposes as pedagogically unnecessary and scientifically destructive,

3) That we agree in the future to reburial of Indian skeletons in a manner and at a time prescribed by the Native Americans whenever burials are chance encounters during archaeological excavations or other earth moving activities,

4) That we request the opportunity to study these skeletons for their scientific and historic significance before reburial, and

5) That when a burial ground is being disturbed by untrained individuals, a committee of local Native Americans and archaeologists should jointly plan the salvage of information and the preservation of remains.

Appendix C
NYAC CODE OF ETHICS AND PRACTICE
Archaeology is a profession, and the privilege of professional practice requires professional morality and professional responsibility, as well as professional competence, on the part of each practitioner.

A. The Archaeologist's Responsibility to the Public:
(1) An archaeologist shall:

a. recognize a commitment to present archaeology and its research results to the public in a responsible manner;

b. actively support conservation of the archaeological resource base;

c. be sensitive to, and respect the legitimate concerns of, groups whose culture histories are the subjects of archaeological investigations;

d. avoid and discourage exaggerated, misleading, or unwarranted statements about archaeological matters that might induce others to engage in unethical or illegal activity;

e. support and comply with the terms of the UNESCO Convention on the means of prohibiting and preventing the illicit import, export, and transfer of ownership of cultural property.

(2) An archaeologist shall not:

a. engage in any illegal or unethical conduct involving archaeological matters or knowingly permit the use of her/his name in support of any illegal or unethical activity involving archaeological matters;

b. give a professional opinion, make a public report, or give legal testimony involving archaeological matters without being as thoroughly informed as might reasonably be expected;

c. engage in conduct involving dishonesty, fraud, deceit, or misrepresentation about archaeological matters;

d. undertake any research that affects the archaeological resource base for which she/he is not qualified.

B. The Archaeologist's Responsibility to Her/His Colleagues:
(1) An archaeologist shall:

a. give appropriate credit for work done by others;

b. keep informed and knowledgeable about developments in her/his field or fields of specialization;

c. accurately, and without undue delay, prepare and properly disseminate a description of research done and its results;

d. communicate and cooperate with colleagues having common professional interests;

e. give due respect to colleagues' interest in, and right to, inform about, sites, areas, collections, or data where there is a mutual active or potentially active research concern;

f. know and comply with all laws applicable to her/his archaeological research, as well as with any relevant procedures promulgated by duly constituted professional organizations;

g. report knowledge of violations of this Code to proper authorities.

(2) An archaeologist shall not:

a. falsely or maliciously attempt to injure the reputation of another archaeologist;

b. commit plagiarism in oral or written communication;

c. undertake research that affects the archaeological resource base unless reasonably prompt, appropriate analysis and reporting can be expected;

d. refuse a reasonable request from a qualified colleague for research data.

C. The Archaeologist's Responsibility to Employers and Clients:
(1) An archaeologist shall:

a. respect the interests of her/his employer or client, so far as is consistent with the public welfare and this Code of Standards;
b. refuse to comply with any request or demand of an employer or client which conflicts with the Code or Standards;
c. recommend to employers or clients the employment of other archaeological or other expert consultants upon encountered archaeological problems beyond her/his competence;
d. exercise reasonable care to prevent her/his employees, colleagues, associates and others whose services are utilized by her/him from revealing or using confidential information. Confidential information means information of a non-archaeological nature gained in the course of employment which the employer or client has requested be held inviolate, or the disclosure of which would be embarrassing or would be likely to be detrimental to the employer or client. Information ceases to be confidential when the employer or client so indicates or when such information becomes publicly known.

(2) An archaeologist shall not:
a. reveal confidential information, unless required by law;
b. use confidential information to the disadvantage of the client or employer; or
c. use confidential information for the advantage of herself/himself or a third person, unless the client consents after full disclosure;
d. accept compensation or anything of value for recommending the employment of another archaeologist or other person, unless such compensation or thing of value is fully disclosed to the potential employer or client;
e. recommend or participate in any research which does not comply with the requirements of the SOPA Standards of Research Performance

Appendix D
GLOSSARY

Adverse impact: A damaging change to the quality of the cultural resource's significant characteristics. An adverse impact will result in the loss of important information.

Archaeological resources: The subsurface remains of buildings, fireplaces, storage pits, habitation areas, and other features of past human activity. Investigating archaeological resources requires the use of a specialized set of techniques and methods for extracting the maximum information from the ground. Archaeological resources can be either prehistoric or historic in origin.

Archaeological sites: One type of cultural resource, unique in that they are the only way to learn about people who kept no written records. They also can be used to confirm, correct, and expand upon the written records left by our ancestors.

Archaeology: A set of methods and techniques designed to recover important information about the life-ways of past peoples and cultures from the remains they left in the ground.

Artifact: See Material remains.

Collection: Any material remains that are excavated or removed during a survey, excavation or other study of a prehistoric or historic resource, and associated records that are prepared or assembled in connection with the survey, excavation, or other study.

Cultural resources: The collective evidence of the past activities and accomplishments of people. They include buildings, objects, features, locations, and structures with scientific, historic, and cultural value.

Extant resources: Buildings or structures which are still standing in much the same form as when they were first constructed. Historic houses, bridges, and farmsteads are examples.

Feature: Intact evidence of cultural activity, typically in the form of hearths, pits, cisterns, privies, wells, postmolds, or other intentional, permanent alterations of the ground surface.

Historic property: Any building, structure, object, district, place, site, or area significant in the history, architecture, archaeology, or culture of the State of New York, its communities, or the Nation.

Impact: Any change, whether good or bad, in the quality of a cultural resource's significant historic, architectural, or archaeological characteristics.

Impact mitigation: A course of action which lessens the harm that will be inflicted upon a cultural resource. It may include work restrictions, repair, restoration, documentation, the installation of a protective covering, or the planned removal of a resource. In the case of archaeological sites, the latter typically involves full-scale excavations.

Material remains: Objects, specimens and other physical evidence that are excavated or removed in connection with efforts to locate, evaluate, document, study, preserve or recover a prehistoric or historic resource.

National Register of Historic Places: The nation's official list of historic, architectural, archaeological, and cultural resources worthy of preservation. The Register contains individual sites and historic districts of national, state, or local significance. The Register is maintained by the United States Department of the Interior.

NYAC: New York Archaeological Council, a not-for-profit association of professional archaeologists with an interest in New York State archaeology.

Prehistoric/historic resources: Prehistoric resources date to the time before written records for a specific area, while historic resources are those dating to the time of written records. In North America, the time of written records began about A.D. 1500 with the arrival of European explorers. However, some parts of the country were not visited by outsiders until much later.

Reviewer: Anyone who reads, examines, or studies the report for a lead agency, municipality, citizen group, university, or similar body in order to evaluate the cultural resource investigations completed, the results, and the recommendations.

SHPO: State Historic Preservation Officer, who is an appointed official responsible for administering the National Historic Preservation Act (NHPA) within a state government or jurisdiction.

Significant property: A cultural resource that meets the criteria of the State or National Register of Historic Places.

Appendix 11E

UNANTICIPATED DISCOVERY PLAN

FOR CULTURAL RESOURCES AND HUMAN BURIALS

1.0 Introduction

In accordance with Stipulation No. 3, Cultural Resources, Clause 4, Southern Energy (Southern) is presenting the following Unanticipated Discovery Plan for Cultural Resources and Human Burials (Plan) that may be found during construction of Bowline Unit 3, Rockland County, New York. This Plan describes procedures to ensure that any potentially significant archaeological resources discovered during construction, including human remains, are dealt with in full compliance with applicable regulations. More specifically, this Plan describes procedures to:

- Ensure that personnel working on this project are trained in basic archaeological site awareness, identification and related procedures

- Ensure that any potentially significant archaeological resources discovered during construction, including human remains, are dealt with in full compliance with applicable regulations. The Plan is intended to be consistent with federal regulations at 36 CFR 800.11, Protection of Historic and Cultural Properties. There are no specific State of New York regulations or procedures applicable to this Plan. In New York State, accepted practice involves immediate notification of appropriate officials, and development of discovery-specific procedures in consultation with the New York State Office of Parks, Recreation and Historic Preservation (OPRHP), State and local police, and medical officials.

- Ensure that procedures and lines of communication with the appropriate government officials are clearly established prior to the start of construction. In this manner, any discoveries can be addressed in a timely manner with minimal impact to construction schedules as well as cultural resources.

2.0 Training

Basic training is required for field inspectors and construction contractors to recognize potential discoveries of historic properties or human remains. Field inspectors and construction contractors must have a basic understanding of, and sensitivity to, the possibility of discovering cultural and historic resources and human remains. Specialists or archaeologists will be called upon when required following any unanticipated discoveries during construction, as described in this Plan.

The purpose of the basic training is to provide the basis for cultural resource compliance and to provide an overview of the general cultural history of the region. Basic training emphasizes the procedures to be followed, as outlined in this Plan, regarding the actions to be taken, and notifications, required, in the event of a significant unanticipated discovery of an historic property or human remains. Following training, both field inspectors and construction contractors are expected to be aware of the kinds of archaeological resources that may be encountered during construction.

Basic cultural resources training will be part of the overall environmental briefing that will be presented to field inspectors and construction contractors prior to the start of construction. Basic cultural resources training is designed to ensure that field inspectors and construction contractors understand the extent of the archaeological survey and field investigations that have been performed for this project. Training will present the distinction between previously identified discoveries and what would constitute an unanticipated discovery.

Trainees will be instructed to be conscious of cultural resource indicators during construction, such as recognizable quantities of bone, unusual stone or ash deposits, evidence of spoil piles, or trench or foundation walls. The inspectors and construction contractors will be instructed to follow the specific procedures outlined in this Plan, in the event that potentially significant cultural resources or human remains are discovered during construction.

3.0 Procedures for Unanticipated Discoveries

All construction personnel working at Bowline Unit 3 and associated Interconnections will be instructed to initial the following procedures in the event that unanticipated historic properties or human remains are encountered during construction.

Unanticipated discoveries that trigger initiation of the following procedures include:

- Any recognizable potentially significant concentrations of artifacts or evidence of human occupation; and
- Any evidence of human remains.

Part of the construction personnel's routine duties will involve examination of trenches, building excavations and/or spoil piles for evidence of artifacts or human remains. The following procedures will be initiated in the event of discovering unanticipated historical properties or human remains.

3.1 Unanticipated Cultural Resources

Construction contractor personnel involved in unanticipated discoveries of historic properties immediately must suspend activities that could affect the integrity of the discovery and must notify the Construction Manager. The Construction Manager, in turn, must notify Southern personnel. Notification includes information about the specific location of the construction area and the nature of the discovery.

Southern personnel involved in unanticipated discoveries of historic properties immediately must direct construction contractors to suspend activities that could affect the integrity of the discovery and must notify the Construction Manager. Notification includes information about the specific location and construction area, and the nature of the discovery.

If any artifacts or historic property remains are discovered in an area that was not previously cleared for construction during pre-construction Phase 1 investigations, then the Environmental Inspector will inform the construction contractor's Construction Manager and Manager of Environmental Resources. A certified archaeologist will be called to review the discovery. Any personnel with information on the discovery will discuss the location and nature of the discovery with the archaeologist. Visual barriers will be installed around the discovery area to protect if from disturbance until a decision is made.

If an archaeologist is not immediately available, and further work in the discovery is not imminent, then photographs or drawings of the discovery may be mailed, delivered or transmitted by facsimile to the archaeologist for review. Based on the information provided, the archaeologist will determine if a visit to the area is required. If a visit is required, the archaeologist will be expected to be there within 24 hours after notification.

If on-site archaeological investigations are required, Southern's Environmental Inspector will notify the construction contractor's Construction Manager. No work that could affect the discovery will be performed until the archaeologist reviews the discovery.

The archaeologist will determine, based on the artifacts or historic property remains discovered, and based on the cultural sensitivity of the area in general, whether the discovery is potentially significant, and whether it requires immediate notification to the OPRHP, and other agencies or parties by telephone. If immediate notification is not required, or if other written information is required, data regarding the discovery will be transmitted by facsimile or sent by express mail, or similar expedited delivery, to these parties.

The archaeologist will consult and coordinate with the OPRHP, and other parties to propose procedures for treating and handling the discovery, and to clear the discovery area while minimizing impacts to the construction schedule, to the extent possible.

Suspended construction activities in the discovery area may not proceed until approval has been obtained from the OPRHP, and other involved agencies and parties as appropriate, following completion of the agreed discovery-specific procedures. The concurrence of Southern's Manager of Environmental Resources and his notification of the construction contractor's Construction Manager, in writing, is required to re-start suspended construction activities.

3.2 Human Remains

If any historic or prehistoric human remains are discovered, they will probably be discovered in excavations, below areas reached by any pre-construction archaeological investigations.

3.2.1 Guidance and Consultations

Treatment of historic or prehistoric human remains encountered during construction will be guided by:

- The policy statement adopted by the Advisory Council on Historic Preservation (Advisory Council),
- The Native American Graves Protection and Repatriation Act (NAGPRA), and
- Appendix B (1972 New York Archaeological Council Burial Resolution) of the *Standard for the Cultural Resource Investigations and the Curation of Archaeological Collections in New York State.*

Consultations should be undertaken with:

- The OPRHP,
- The New York State Police
- Local police and officials, and
- Interested parties, including Native American groups identified by the OPRHP.

The Advisory Council policy recommends that, to the extent allowed, by law, treatment of human remains should adhere to the following principles:

- Human remains and grave goods (i.e., material intentionally interred with a human burial) should not be disinterred unless required in advance of some kind of disturbance, such as construction;
- Disinterment, when necessary, should be done carefully, respectfully, completely, by archaeologists, in accordance with proper archaeological methods;
- In general, human remains and grave goods should be reburied in consultation with the descendants of the dead;

- Prior to reburial, minimal, non-destructive studies of the human remains and grave goods should be performed, and pre-approved by the descendents; and

- Studies and reburial should occur according to a definite, agreed-upon schedule.

3.2.2 Discovery, Suspension of Work, Notifications, and Procedures

If human remains are discovered by any personnel on the construction site, all construction work in the immediate vicinity that could affect the integrity of the discovery will be suspended. Southern's Environmental Inspector and the construction contractor's Construction Manager will be informed immediately, and notified of the exact location of the remains, as well as the time of discovery.

Southern's Environmental Inspector will be responsible for informing Southern's Manager of Environmental Resources, who will be responsible for retaining the services of a qualified and certified archaeologist. Southern's Manager of Environmental Resources will be responsible for notifying the appropriate government agency officials and other parties listed in this Plan, within 24 hours of the discovery.

Human remains may be excavated, if approved, in consultation with the OPRHP, the New York State Police, local police, Native Americans and other involved agencies and parties as appropriate. Excavation of the human remains will be pursuant to any agreement between Southern and the involved parties that specifies the excavation methods to be used and the data to be recovered.

Any discoveries made on weekends will be protected until all of the appropriate parties have been contacted.

Prior to construction, Southern will make an effort to identify all affiliated Native American tribes with the assistance of qualified archaeologists and anthropologists. This will involve literature searches and consultation with the OPRHP.

As directed by the New York State Police, Southern will have the primary responsibility for contacting the appropriate medical officials and next-of-kin for recent human remain discoveries.

Care will be exercised to excavate, transport, and store any human remains in a manner that respects and protects the sacred significance of the remains.

Suspended construction activities in the discovery area may not proceed until approval has been obtained from the OPRHP and other involved agencies and parties as appropriate, following completion of the agreed discovery-specific procedures. The concurrence of Southern's Manager of Environmental Resources and his notification of the construction contractor's Construction Manager, in writing, is required to re-start suspended construction activities.

3.2.3 Agency Notification Telephone Numbers and Addresses

If human remains are discovered, the OPRHP and the New York State Police will be notified within 24 hours. These agencies will be notified at the telephone numbers listed below. If notifications are made during weekends, or at other times when telephones may not be monitored, information will be transmitted via facsimile, if available, to the listed numbers. Other written information may be sent to the listed addresses by express mail or a similar method of expedited delivery.

New York State Historic Preservation Office
Peebles Island
P.O. Box 189
Waterford, NY 121188
(518) 237-8643

New York State Police
Troop F Headquarters
Crystal Run Road
Middletown, NY 10940-9755
(914) 344-5300

Appendix 12A

TRC

BOWLINE UNIT 3
NOISE STUDY
TECHNICAL REPORT

Prepared by:

TRC Environmental Corporation
Lyndhurst, NJ

FEBRUARY, 2000

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APPENDICES

1.0 INTRODUCTION

TRC Environmental (TRC) performed a noise assessment of the proposed Bowline Unit 3 power plant (Project). The assessment consisted of two parts; an ambient noise monitoring program in the vicinity of the Project Site in order to characterize the existing noise environment; and a noise impact evaluation of the Project. The background ambient noise monitoring programs were conducted during the summer (June 1999) and winter (November 1999) periods. The noise impact evaluation consisted of performing computer noise modeling of the major noise producing equipment and performing an impact assessment using the modified Composite Noise Rating (CNR) Method as required by the NYSDPS.

2.0 GENERAL INFORMATION ON NOISE

Noise is defined as unwanted sound resulting from vibrations in the air. Excessive noise can cause annoyance and adverse health effects. Annoyance can include sleep disturbance and speech interference. It can also distract attention and make activities more difficult to perform (EPA, 1978).

The range of pressures that cause the vibrations that create noise is large. Noise is therefore measured on a logarithmic scale, expressed in decibels (dB). Noise is typically measured on the A-weighted scale (dBA). The A-weighting scale was developed and has been shown to provide a good correlation with the human response to sound and is the most widely used descriptor for community noise assessments. (Harris, 1991).

Common descriptors of noise include the L_{eq}, L_{90} and L_{10}. These descriptors are defined below.

L_{eq}	The equivalent noise level over a specified period of time (i.e. 1-hour). It is a single value of sound which includes all of the varying sound energy in a given duration.
Statistical Sound Levels	The A-weighted L_{90} and L_{10} sound level exceeded a certain percentage of the time. The L_{90} is the sound level exceeded 90 percent of the time and is often considered the background or residual noise level. The L_{10} is the sound level exceeded 10 percent of the

time and is a measurement of intrusive sounds, such as aircraft overflight.

2.1 Applicable Standards/Criteria

Noise Standards

The Rockland County Department of Health has a noise standard (Article IX) which is, in accordance with Chapter 167-13 of the Haverstraw Zoning code, applicable to the proposed project. The standard limits continuous noise produced by a source to no greater than 65 dBA during the day (7 am to 10 pm) and 55 dBA at night (10 pm to 7 am) as measured at the point that the sound enters Class A Land (which includes residential uses). Article IX expressly exempts noise produced on construction sites between the hours of 6:00 a.m. and 10:00 p.m. from these noise restrictions.

There are no State of Federal noise standards applicable to this project.

NYSDPS Criteria

The NYSDPS utilizes a noise impact assessment method known as the modified CNR method in order to determine the potential for noise impact from a proposed electric generating facility. The modified CNR method is a rating method that is used to predict the response of a community to a noise source. This methodology, which has been used extensively in New York State, takes into account many factors including the expected sound levels from the plant, the character of the expected noise (e.g., tonal, impulsive, intermittent), duration, time of day, time of year, and subjective factors such as community attitude and history of previous exposure. The resulting rating is used to determine the expected community response. The NYSDPS has historically accepted a rating of "D", corresponding to a response of "sporadic complaints", although is currently requesting for new projects that a more stringent rating of "C", corresponding to "no reaction although noise is noticeable" be achieved.

This rating method utilizes the measured residual octave band levels measured during the summer and winter noise monitoring programs. In order to remain conservative in the analysis, the L_{90} octave band levels measured during the late night hours, when ambient noise sources are typically lowest, were used.

3.0 BACKGROUND NOISE MONITORING PROGRAM

The area in the vicinity of the Project consists of residential, recreational, commercial and industrial land uses. The nearest residential areas include Mackey Court to the west and McKenzie Avenue to the south. The Haverstraw Marina is located to the north. The Hudson River borders the site to the east. The nearest church/school was identified as the Saint Peter's School and Church, located southwest of the Project Site. A site area map is presented as Figure 1.

3.1 Methodology

The noise monitoring programs were conducted on June 21-22, 1999 and November 29-30, 1999. Both programs consisted of a continuous and simultaneous 24-hour survey at the nearest three residential monitoring locations and the nearest identified school/church location. Short-term (15-minute) monitoring was also conducted at the Haverstraw Marina for a total of five receptors. Short-term monitoring was also conducted at the four continuous monitoring locations in order to supplement the continuous data and in order to make observations of the local noise sources.

Continuous monitoring was conducted utilizing Bruel & Kjaer 2236 precision integrating sound level meters with integral data loggers. The meters meet ANSI S1.4-1983 requirements for precision Type 1 sound level meters. The meters were calibrated before and after each survey period using a Bruel & Kjaer Model 4231 sound level calibrator. The microphones were fitted with windscreens to reduce wind generated noise and mounted at a height of approximately five feet above the ground.

The continuous instruments were programmed to measure and log the equivalent sound level (L_{eq}), and the statistical sound levels exceeded 10 and 90 percent of the time (L_{10} and L_{90}). These levels were measured and logged every 10 minutes over the duration of the 24 hour daytime and nighttime survey period. At the end of the period, the data were downloaded to computer for storage and analysis. Graphs of the data were produced for presentation.

L_{90} octave band measurements were also performed during the day and late at night in order to determine the tonal characteristics of the residual or background noise levels. These data were obtained with B&K Model 2260 and Rion NA-29E precision integrating sound level meters and octave band analyzers with integral data loggers. These meters also meet ANSI S1.4-1983 requirements for precision Type 1 sound level meters.

In addition to noise level measurements, the contributing noise sources were identified and recorded, along with the prevailing meteorological conditions. Wind speed and direction were obtained via a Dwyer hand held wind meter and a compass and/or determined by examining a topographic map of the area, respectively. Temperature was measured with a thermistor. Sky conditions were observed and recorded at each location.

3.2 Noise Monitoring Locations

The monitoring locations chosen represent the nearest noise sensitive receptors (e.g., residences, schools, churches) to the proposed project in the four compass directions surrounding the proposed project. There are no receptors to the east of the project. Provided below is a list of the monitoring locations.

- Mackey Court
- Nearest Residential South of the Plant
- Jefferson Street
- Saint Peter's School and Church
- Haverstraw Marina

Other schools are located in the area, but the Saint Peter's school was identified as the nearest to the Project.

3.3 Noise Monitoring Results

3.3.1 Continuous Data

Meteorological conditions during the summer monitoring program consisted of clear skies, near calm winds, and temperatures ranging from 55^0 to 80^0 F. During the winter program, skies were clear to partly cloudy with daytime temperatures of 45^0 to 50^0 F and northwest winds of 5 to 10 miles per hour (mph). Nighttime temperatures were approximately 30^0 F with light (less than 5 mph) to near calm winds.

Noise sources during both programs consisted of the existing Bowline plant, natural sounds (birds, rustling leaves, human activity), local traffic and aircraft. A summary of the observed noise sources at each location, in order of significance, is presented in Table 1 below.

TABLE 1
OBSERVED NOISE SOURCES

Location	Observed Noise Sources - June 1999	
	Daytime	Nighttime
1 - Mackey Court	Bowline plant, natural sounds, aircraft, local traffic	Natural sounds, Bowline plant
2 - McKenzie Avenue	Bowline plant, natural sounds, local traffic, train	Stereo in nearby house, Bowline plant
3 - Jefferson Street	Bowline plant, local traffic, aircraft, natural sounds	Bowline, plant natural sounds
4 - St. Peter's Church/School	Natural sounds, local traffic, Bowline plant	Natural sounds, Bowline plant, local traffic
5 - Haverstraw Marina	Natural sounds, aircraft, local traffic	Industrial source north of site

Location	Observed Noise Sources - November 1999	
	Daytime	Nighttime
1 - Mackey Court	Bowline plant, local traffic, aircraft, natural sounds	Bowline plant, train
2 - McKenzie Avenue	Landscaping equipment, Bowline plant, aircraft	Bowline plant
3 - Jefferson Street	Bowline plant, local traffic, natural sounds	Bowline plant, aircraft, natural sounds
4 - St. Peter's Church/School	Natural sounds, Bowline plant, local traffic,	Bowline plant
5 - Haverstraw Marina	River tide, industrial source north of site, natural sounds	Bowline plant

A summary of the continuous L_{90} monitoring data from both programs is presented graphically in Figures 2 through 5. Additional data plots, depicting all the continuous monitoring data for each location and each season are presented in Appendix A as Figures A-1 through A-8. The L_{90} noise level, which is the level exceeded 90 percent of the measurement time, is considered to characterize the residual noise level. The residual noise level is defined to be the sound level that would be present in the absence of intrusive sources, such as barking dogs, intermittent traffic and aircraft overflights. A review of the data in this table reveals that noise levels were slightly lower during the winter, due to less prevalent natural sounds. In general, however, no significant differences were noted between the summer and winter periods. The sharp peak in the winter L_{90} level at McKenzie Avenue is due to landscaping activities.

3.3.2 Short-Term Data

As noted previously, the continuous data collection was supplemented with co-located, short-term (15-minute) measurements. In addition, short-term measurements were also conducted at the Haverstraw Marina. The results of the short-term monitoring for both programs at all locations are presented in Tables 2 and 3 below.

TABLE 2
SHORT-TERM DAYTIME NOISE LEVEL DATA

Location	Daytime (Summer/Winter)			
	Monitoring Period	L_{eq}	L_{90}	L_{10}
1 - Mackey Court	June 21 / 1555-1608	56/52	48/46	56/53
2 - McKenzie Avenue	June 21 / 1640-1655	52/65	50/55	54/69
3 - Jefferson Street	June 22 / 1257-1310	51/58	47/53	55/60
4 - St. Peter's Church/School	June 22 / 1321-1334	46/55	44/49	48/57
5 - Haverstraw Marina	June 21 / 1524-1536	47/51	39/48	49/53

TABLE 3
SHORT-TERM NIGHTTIME NOISE LEVEL DATA

Location	Nighttime (Summer/Winter)			
	Monitoring Period	L_{eq}	L_{90}	L_{10}
1 - Mackey Court	June 22 / 0453-0506	54/48	48/46	57/49
2 - McKenzie Avenue	June 22 / 0350-0403	52/50	51/48	53/51
3 - Jefferson Street	June 22 / 0408-0421	52/52	50/48	52/53
4 - St. Peter's Church/School	June 22 / 0430-0443	49/44	47/41	51/46
5 - Haverstraw Marina	June 22 / 0327-0340	48/44	46/40	50/47

The short term data collected late at night at the continuous locations, which were measured to supplement the 24-hour data, are in good agreement with the graphical data presented in Figures 2 through 5.

The noise monitoring programs were conducted primarily to establish the existing residual (L_{90}) late night noise levels at each location for use in the noise impact assessment. Provided in Table 4 below is a summary of the residual late night noise levels, which were developed based upon both the continuous and short term monitoring data presented.

TABLE 4
RESIDUAL LATE NIGHT NOISE LEVELS (dBA)

Receptor	Summer	Winter
Mackey Court	47	46
McKenzie Avenue	50	48
Jefferson Street	49	48
St. Peter's School	42	41
Marina	43	40

3.3.2 Octave Band Data

L_{90} octave band data measurements were performed at each location during the day and late at night for each program. Further, in order to determine the presence of possible existing pure tone noises, 1/3 octave band measurements were conducted during the winter program. Because intrusive sounds are at a minimum late at night, the nighttime data should be considered more representative of the tonal nature of the background noise. These data are presented graphically in Appendix A as Figures A-9 through A-23. The collected data did not reveal any distinct pure tone noises.

4.0 ACOUSTIC DESIGN GOALS

As discussed previously, the NYSDPS requires that the sound emitted by operation of the proposed plant must, when evaluated through the modified CNR method, result in a ranking of "C" or better at any residential receptors. This rating method utilizes the measured residual octave band levels measured during the summer and winter noise monitoring programs, which were presented in Table 4. In order to remain conservative in the analysis, the L_{90} octave band levels measured during the late night hours, when ambient noise sources are typically lowest, were used.

The design goals for the Project will differ at each location, and will be a function of the various correction factors required in the modified CNR method. In order to determine the design goals, it was necessary to first calculate the correction factors, and then determine the initial ranking which would be required in order that the final rank result in a rating of "C".

Further, however, the project must also comply with the Rockland County Noise Standard. This standard limits project noise levels from operation to no greater than 55 dBA at night at any residential lot line. The most stringent of the two are the design goals are presented in Table 5 below.

TABLE 5

ACOUSTIC DESIGN GOALS (dBA)

Mackey Court	50
McKenzie Avenue	50
Jefferson Street	50
Saint Peter's School and Church	50
Haverstraw Marina	46

5.0 CALCULATED IMPACTS AND MITIGATION

Construction and operation of the Project will result in the generation of noise. The potential impact of these noise emissions is a function of the magnitude of the generated noise and the existing residual noise levels. As noted previously, the late night residual noise levels were used in the impact analysis in order to remain conservative. The modified CNR method was used to estimate these potential impacts.

The noise modeling analysis revealed that mitigation measures will be required in order to achieve the design goal. Incorporating these mitigation measures will reduce operational noise levels such that no significant noise impacts are expected to occur.

Construction noise will generate short-term, temporary increases in ambient noise levels but, because of the temporary nature, will not result in significant impacts.

5.1 Operational Noise

The NOISECALC computer model, developed by the New York State Department of Public Service, was used to predict noise levels expected from operation of the Project. The model was developed for predicting noise levels from power plants. NOISECALC is a Hemispherical Free Field (HFF) noise prediction model.

The Project will consist of three GE Frame 7FA gas-fired combustion turbines, a steam turbine, boiler feedwater pumps, and air compressors all housed within a turbine building. Transformers, the turbine air inlets three heat recovery steam generators (HRSG), the exhaust stacks and a cooling tower will be located outdoors. Estimated octave band noise level data for the combustion turbines and HRSGs were obtained from GE. Estimated octave band data for the cooling tower were obtained from a potential vendor. Detailed data for the transformers, boiler feedwater pumps, cooling tower circulation pumps and steam turbine were not available. For these components, data were developed following industry accepted procedures found in *Electric Power Plant Environmental Noise Guide (1984)*. Estimated performance data for the equipment (MVA, horsepower ratings) were some of the parameters considered in developing the noise data.

NOISECALC accepts a variety of attenuation factors under varying meteorological conditions. The model was configured to accept hemispherical spreading and atmospheric absorption for this analysis based on values from the *Electric Power Plant Environmental Noise Guide (1984).* Standard conditions of 59^0 F and 70 percent relative humidity were assumed. Directivity effects for noise from the stacks were also considered. No credit was taken for ground absorption. Modeling receptors were chosen in the same locations as where background monitoring was performed.

The noise modeling was used as a design tool in order to determine the degree of silencing required on individual noise sources. Thus, several modeling runs were made, with noise control added as required, until the required design goals were achieved. As previously discussed, significant noise mitigation measures were required in order to achieve these goals. These include the following:

- Tuned HRSG stack silencers
- Enclosures on the boiler feedwater pumps
- Acoustically treated turbine building
- Specially designed quieted main transformers
- Specially designed low noise cooling tower

The results of the computer modeling, with the above mentioned noise mitigation measures, are presented in Table 6. Also presented in this table are the design goals for the Project. A review of the data in this table reveals that the calculated noise levels from facility operation will be within the design goals and will further be well below the Rockland County noise standard. The additional analysis performed indicates that these levels will also achieve a modified CNR rating of "C" or better. Therefore, no significant noise impacts are anticipated.

TABLE 6
CALCULATED FACILITY OPERATIONAL NOISE LEVELS COMPARED TO DESIGN GOALS (dBA)

Receptor Location	Acoustic Design Goal	Calculated Facility Level
Mackey Court	50	49
McKenzie Avenue	50	50
Jefferson Street	50	47
Saint Peter's School and Church	50	47
Haverstraw Marina	46	45

Detailed supporting data for the operational noise modeling analysis are provided in Appendix B.

5.2 Construction Noise

The construction process for power plant construction projects generally occurs in the following phases:

- Initial Grading and Excavation,
- Concrete Pouring
- Building Assembly
- Siding and machinery installation
- Exterior finish and cleanup

Construction equipment utilized will differ from phase to phase. In general, heavy equipment (bulldozers, dump trucks, cement mixers) will be used during excavation and concrete pouring activities.

Estimated octave band noise levels for the expected construction equipment were incorporated into the NOISECALC computer model. Modeling, using the same assumptions and receptors as was performed for the operational noise assessment, was then performed at the same receptor locations.

As is typically done for construction noise analyses, average noise levels were calculated for each construction phase. This was performed by incorporating the usage factor, which is a factor of the average time a piece of construction equipment is expected to be in use for any given construction phase (Barnes, 1977).

The calculated construction noise levels were then compared to the existing daytime L_{eq} noise levels. The L_{eq} level, which represents a measure of the average of all the noise present, was used rather than the L_{90} because the L_{90} only represents the baseline noise levels, whereas construction noise is a combination of varying noises, more closely represented by the L_{eq}. Further, because continuous data are available for four of the locations, a range of existing Leq levels were evaluated, rather than a single average. The calculated average construction noise levels are compared to the existing L_{eq} noise levels in Table 7 below.

TABLE 7

COMPARISON OF CALCULATED AVERAGE CONSTRUCTION PHASE NOISE LEVELS TO EXISTING DAYTIME L_{EQ} NOISE LEVELS (dBA)

Construction Phase	Distance (Ft)	Mackey Ct	McKenzie Ave	Jefferson St.	St. Peter's	Marina
		ACN / Leq	ACN / Leq	ACN / Leq	ACN / Leq	ACN / Leq
Initial Grading and Excavation	1600	60/50-55	56/53-57	55/50-55	55/50-55	57/50
Concrete Pouring	1800	58/50-55	55/53-57	54/50-55	54/50-55	55/50
Building Assembly.	2800	53/50-55	50/53-57	49/50-55	49/50-55	51/50
Siding and Machinery Installation	2300	55/50-55	52/53-57	51/50-55	51/50-55	52/50
Exterior Finish and Cleanup	2700	55/50-55	52/53-57	51/50-55	51/50-55	52/50

A review of the data presented in this table reveals that, in general, the calculated average construction noise levels will be fairly similar to the existing daytime L_{eq} levels. While construction noise will be audible, the varying nature of construction, combined with its short-term nature, should minimize any noise impacts. As such, other than requiring the use of functional exhaust mufflers on all diesel powered construction equipment, no mitigation measures are proposed.

Detailed supporting data for the operational noise modeling analysis are provided in Appendix C.

5.3 Cumulative Effects

The NYSDPS is requiring for this project that the cumulative effect of noise generated by other proposed major electric generating facilities be evaluated. The nearest proposed projects, which include the Bethlehem, Torne Valley, Ramapo and Athens projects, are well over five miles away. As such, no cumulative noise impacts due to these proposed projects are expected.

6.0 COMPLIANCE WITH APPLICABLE STANDARDS AND CRITERIA

6.1 Rockland County Noise Standard

Computer modeling of the major facility sources has revealed that the facility can be designed such that operational noise levels at any residence will not exceed 50 dBA. As such facility noise levels will be well below the Rockland County Noise standard.

6.2 NYSDPS Modified CNR Analysis

Operational Noise

The Project noise levels were input to the modified CNR analysis as required by the NYSDPS. The results of that analysis, provided in Appendix D, has revealed that the facility can be designed such that the resulting CNR rating at any residential area will be "C" or less, in compliance with the NYSDPS requirement.

Construction Noise

Calculated construction noise levels, by phase, were also incorporated into the modified CNR analysis. The results of that analysis are also provided in Appendix D. The resulting analysis demonstrated that, for the majority of phases, CNR impacts of "C" or less will occur. Calculated impacts of "D" were found for a few receptors during the initial grading and excavation phase.

6.3 Assessment of Potential Impacts In Accordance with Stipulation 6.2.h

- Hearing Damage - Hearing damage will not occur as a result of this Project. Noise levels of 70 dBA or lower are recommended in order to prevent hearing damage (EPA, 1974). Facility noise levels at any sensitive receptors will be well below 70 dBA.

- Sleep Interference - Studies have shown that there are no subjective effects on sleep at noise levels of 60 dBA when the number of noise events are below eight. A noise event is considered to be a sudden occurrence of a noise level of a given magnitude. Further, sound levels of 45 dBA should not occur more than 10 to 15 times per night in order to avoid sleep interference (Berglund, 1995). Facility operation should not result in sleep interference for the following reasons:

  - facility sound levels are steady in nature
  - facility noise levels will be well below 40 dBA indoors
  - normal facility operations will not result in "noise events"

- Indoor and Outdoor Speech Interference

  Relaxed conversation occurs with a voice level of 54-56 dBA at a distance of one meter. When background noise is equal to the speech level, sentence intelligibility is at 95 percent (Berglund, 1995). Ninety five percent sentence intelligibility usually permits reliable communication because of the redundancy in normal conversation (EPA, 1974). Facility noise levels will be well below the relaxed conversation level of 54-56 dBA. Sentence intelligibility will therefore approach 100 percent, and speech interference, indoors or outdoors, is not anticipated due to normal plant operation.

- Low Frequency Noise Annoyance

  Low frequency noise levels will not be significant due to the nature of combined cycle operation. The majority of low frequency noise generated by the turbine will be effectively attenuated inside the HRSG units.

- Community Complaint Potential

  The modified CNR analysis was conducted for the purpose of estimating community reaction to facility generated noise. This resulting rating of "C" calculated for the facility results in an expected response of "no reaction". Therefore, no community annoyance is expected due to normal facility operation.

- Potential for Structural Damage Due to Vibration or Infrasound

  Combustion turbines are well balanced and do not normally generate ground borne vibration. As noted above, because of the combined cycle configuration, low frequency sound will be effectively attenuated by the HRSG units, thereby eliminating the potential for infrasound vibration.

7.0 POST CONSTRUCTION COMPLIANCE MONITORING

An ambient noise monitoring program is proposed to be performed within six months following commercial startup to confirm that the calculated noise levels are achieved. Any deficiencies shall be noted, and a schedule to correct them shall be developed.

8.0 REFERENCES

Barnes, J.D., L. Miller, E. Wood. 1977. Prediction of Noise from Power Plant Construction. Prepared for Empire State Electric Energy Research Company.

Berglund, B., and T. Lindvall. 1995. Community Noise. Prepared for the World Health Organization. ISSN 1400-2817. ISBN 91-887-8402-9.

Bolt, Beranek and Newman, Inc. 1971. Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances.

Miller, L.N., E.W. Wood, R.M. Hoover, A.R. Thompson, and S.L. Patterson. 1984. Electric Power Plant Environmental Noise Guide. Prepared for Edison Electric Institute by Bolt, Beranek and Newman, Inc., Cambridge, Massachusetts

United States Environmental Protection Agency, 1978. Protective Noise Levels. Office of Noise Abatement & Control. Report Number EPA 550/9-79-100. Washington, D. C. 20460.

United States Environmental Protection Agency, 1975. Model Community Noise Control Ordinance. Office of Noise Abatement & Control. Report Number EPA 550/9-76-003. Washington, D. C. 20460.

Appendix A
Background Noise Monitoring Data

Figure 3

Measured Sound Levels
Location 2 - McKenzie Avenue
Winter and Summer 1999

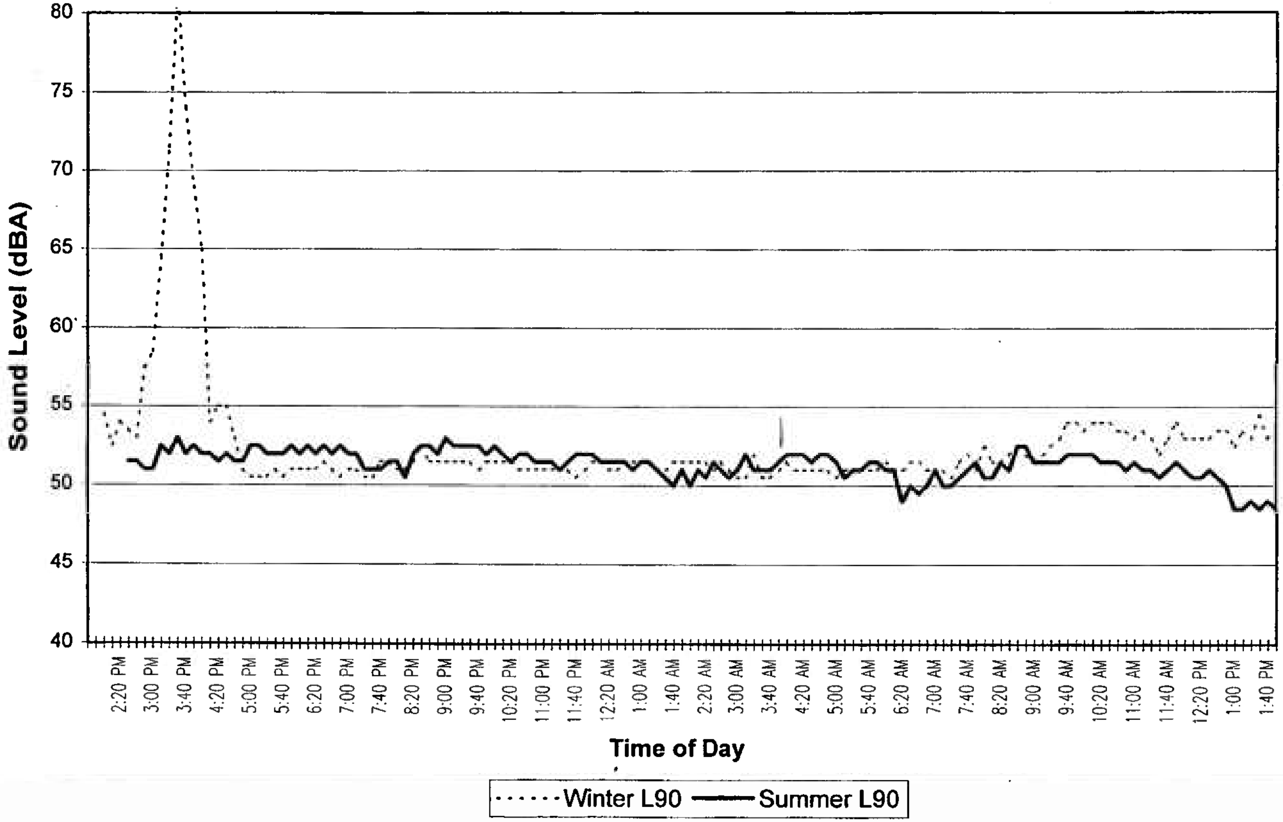
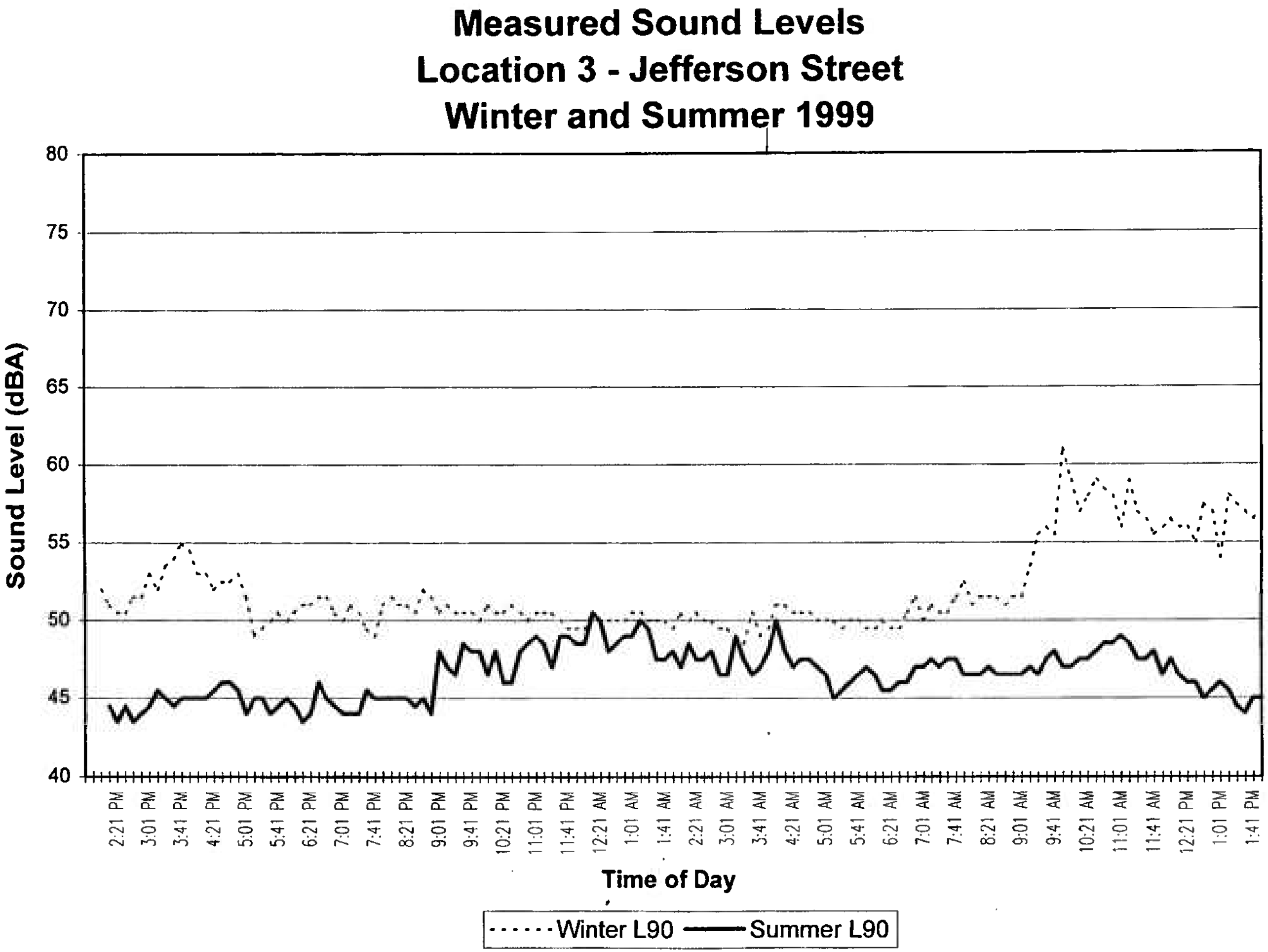


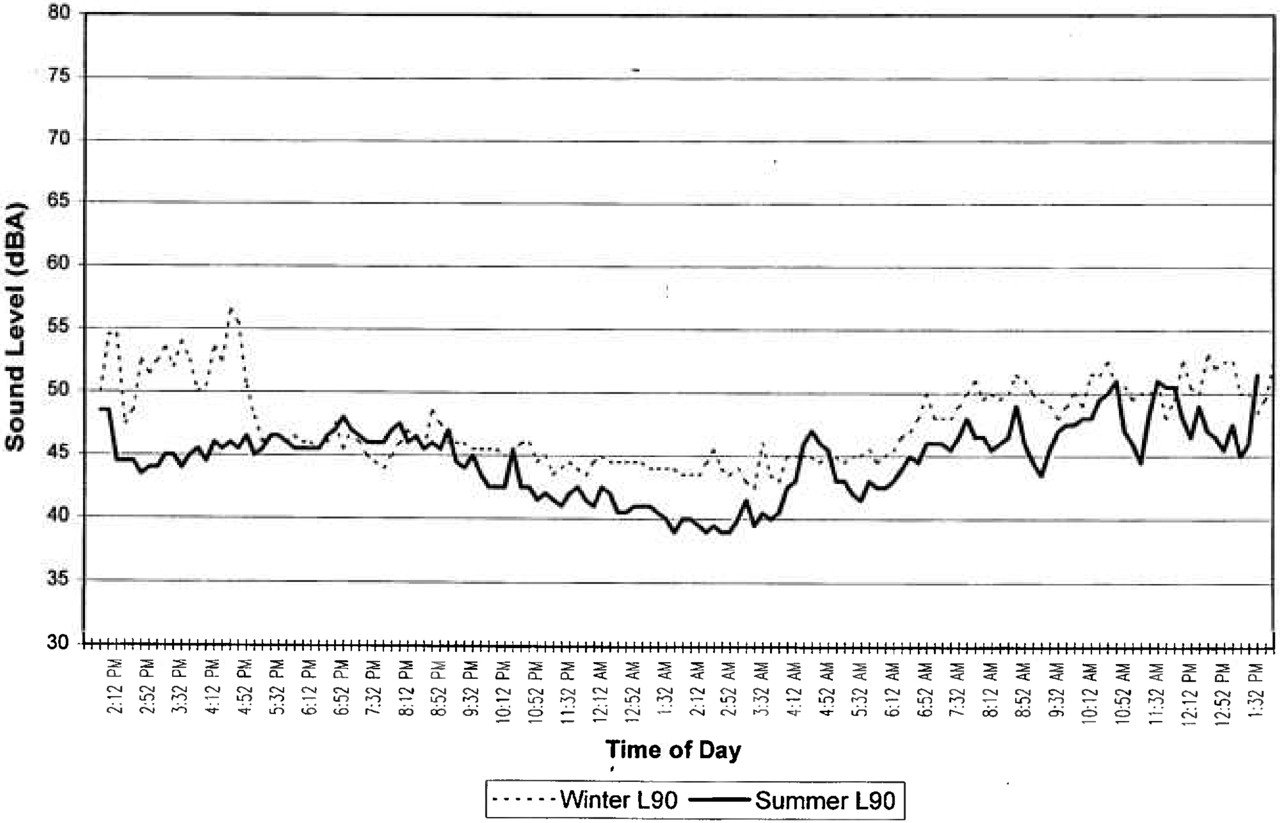
Figure 4



Measured Sound Levels
Location 3 - Jefferson Street
Winter and Summer 1999
80
75
70
65
60
55
50
45
40
Sound Level (dBA)
2:21 PM
3:01 PM
3:41 PM
4:21 PM
5:01 PM
5:41 PM
6:21 PM
7:01 PM
7:41 PM
8:21 PM
9:01 PM
9:41 PM
10:21 PM
11:01 PM
11:41 PM
12:21 AM
1:01 AM
1:41 AM
2:21 AM
3:01 AM
3:41 AM
4:21 AM
5:01 AM
5:41 AM
6:21 AM
7:01 AM
7:41 AM
8:21 AM
9:01 AM
9:41 AM
10:21 AM
11:01 AM
11:41 AM
12:21 PM
1:01 PM
1:41 PM
Time of Day
Winter L90
Summer L90

Figure 5

Measured Sound Levels
Location 4 - St. Peter's School
Winter and Summer 1999



Appendix A
Background Noise Monitoring Data

Figure A-1

Measured Sound Levels
Location 1 - Mackey Court

June 21-22, 1999

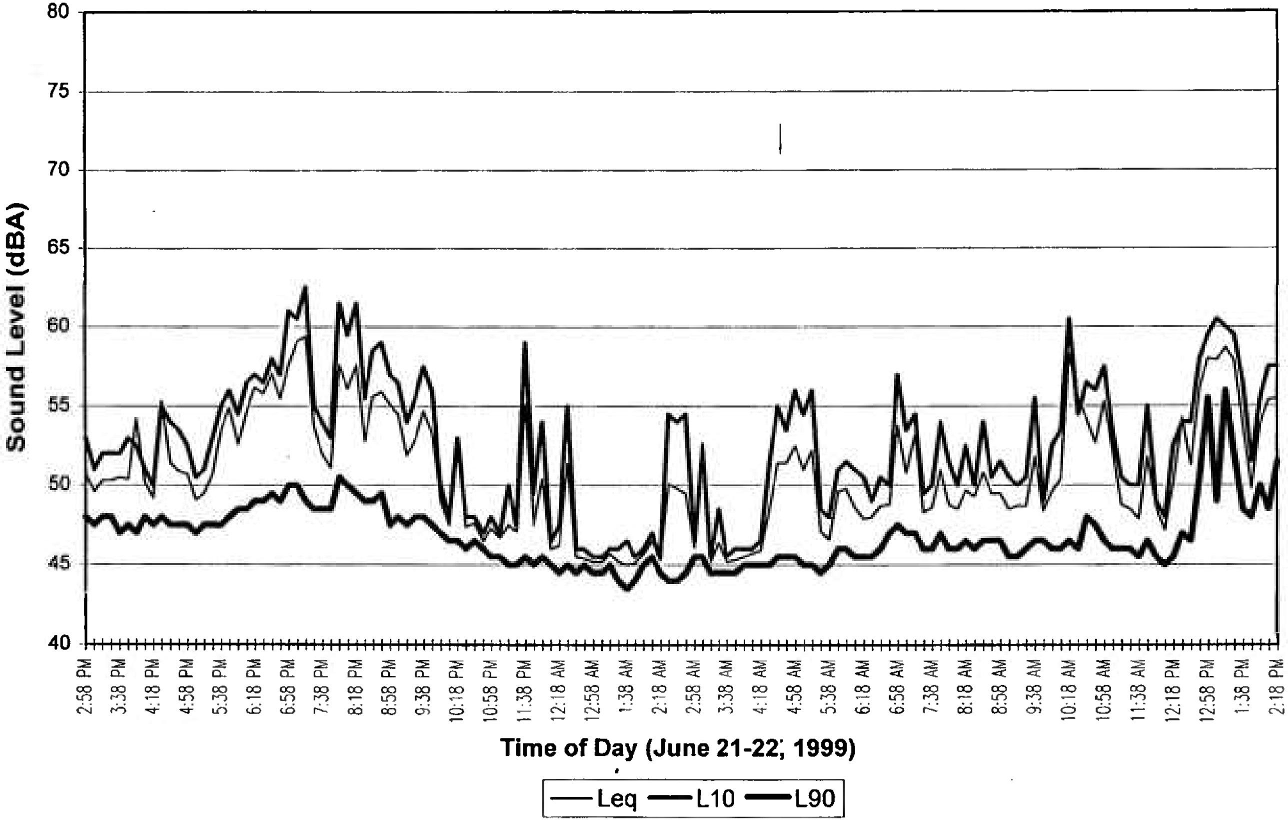


Figure A-2

Measured Sound Levels
Location 2 - McKenzie Avenue

June 21-22, 1999

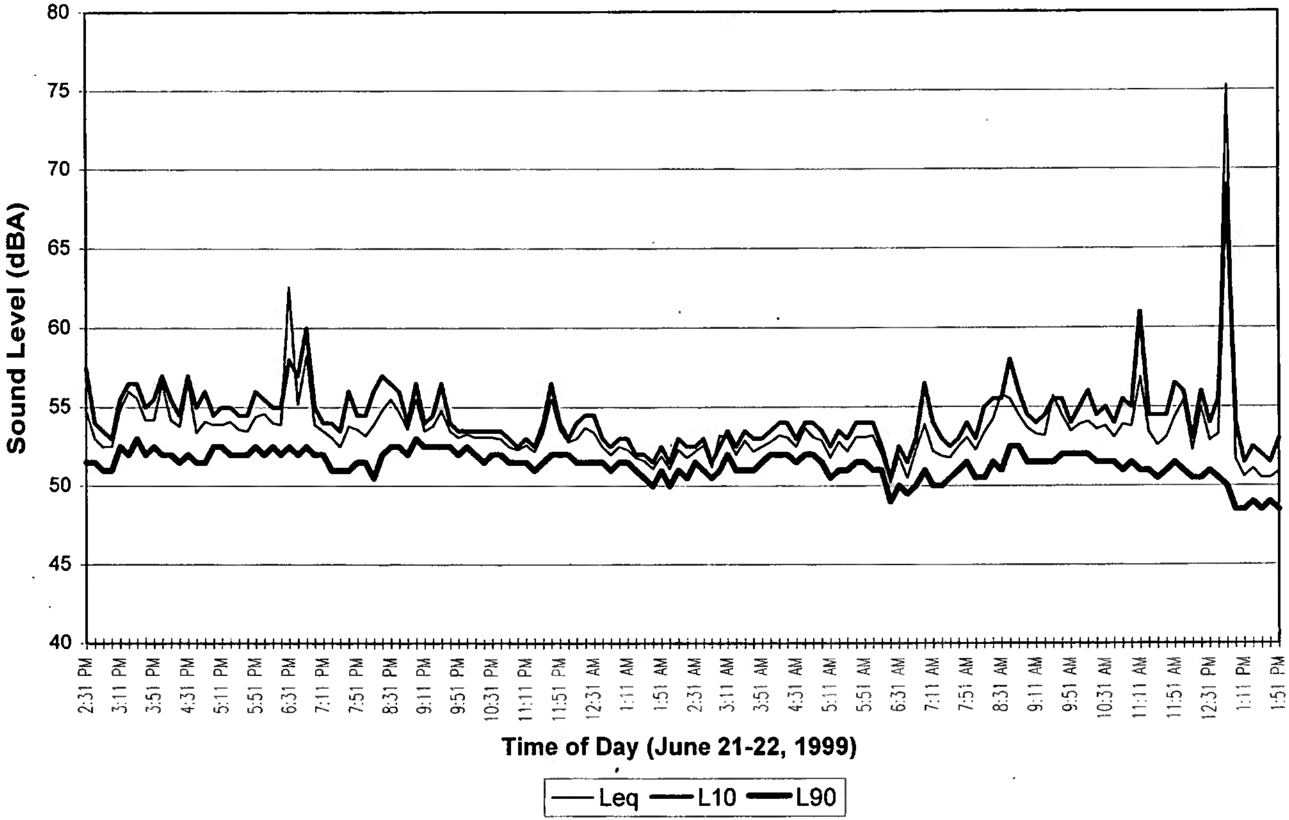
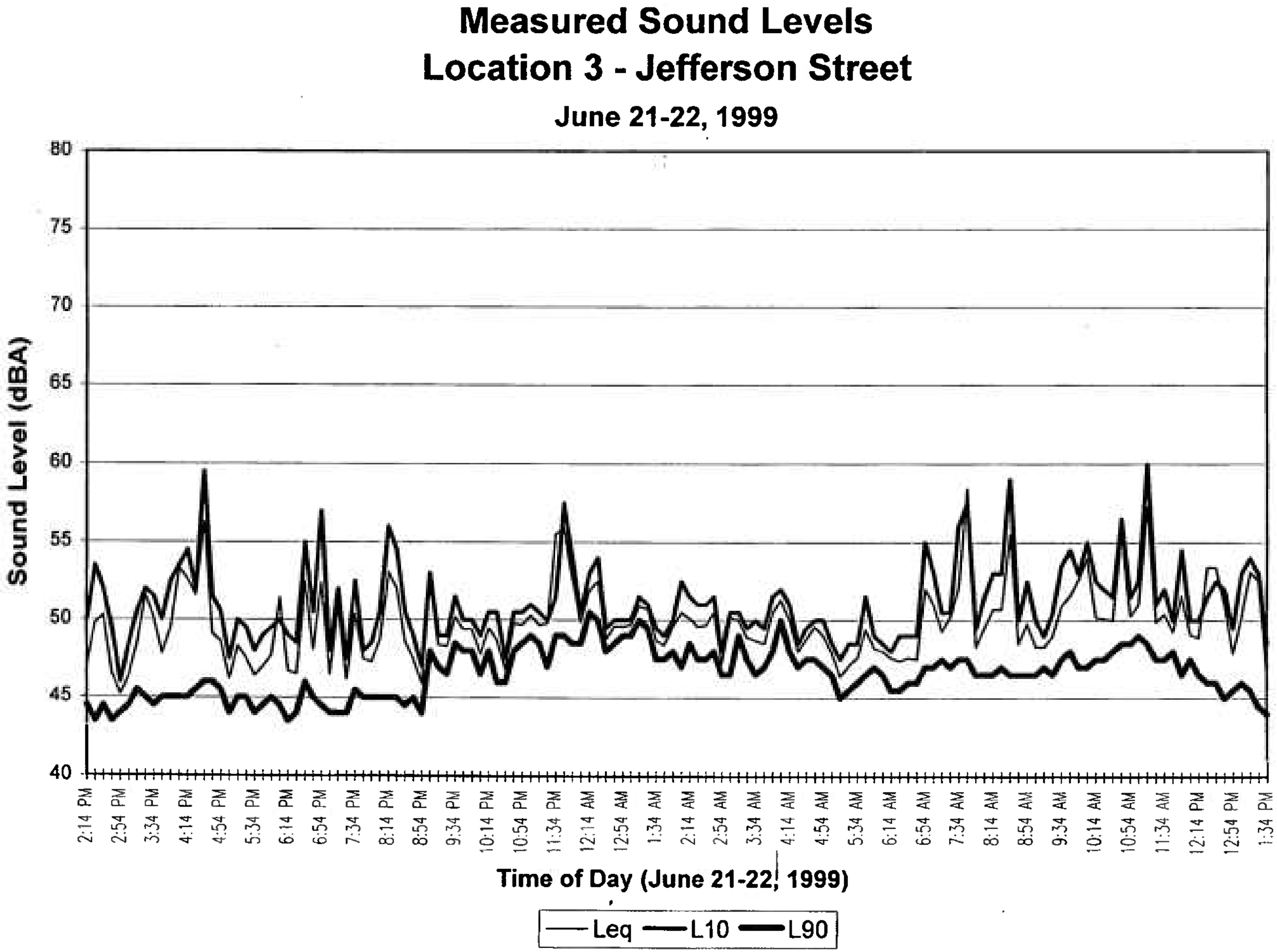


Figure A-3



Measured Sound Levels
Location 3 - Jefferson Street
June 21-22, 1999
Sound Level (dBA)
80
75
70
65
60
55
50
45
40
2:14 PM
2:54 PM
3:34 PM
4:14 PM
4:54 PM
5:34 PM
6:14 PM
6:54 PM
7:34 PM
8:14 PM
8:54 PM
9:34 PM
10:14 PM
10:54 PM
11:34 PM
12:14 AM
12:54 AM
1:34 AM
2:14 AM
2:54 AM
3:34 AM
4:14 AM
4:54 AM
5:34 AM
6:14 AM
6:54 AM
7:34 AM
8:14 AM
8:54 AM
9:34 AM
10:14 AM
10:54 AM
11:34 AM
12:14 PM
12:54 PM
1:34 PM
Time of Day (June 21-22, 1999)
Leq
L10
L90

Figure A-4

Measured Sound Levels
Location 4 - St. Peter's School

June 21-22, 1999

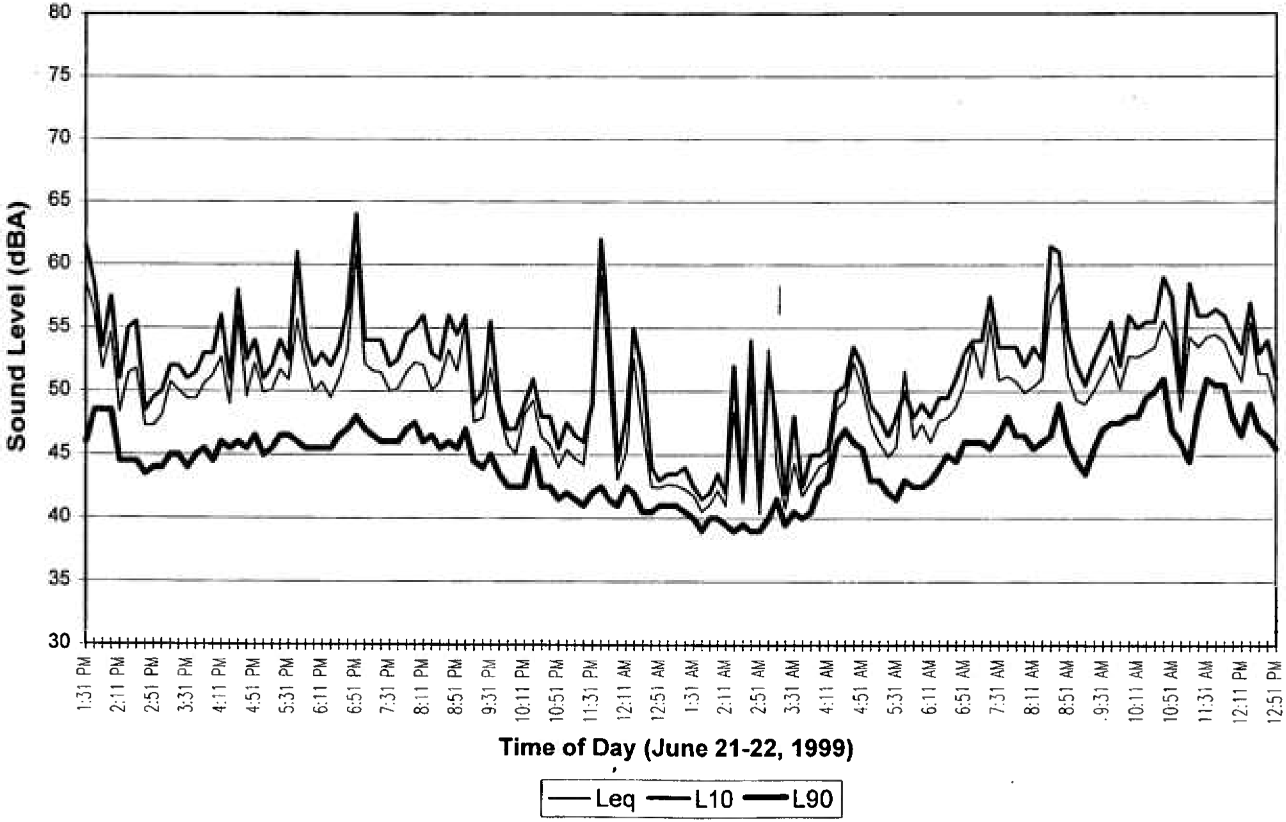


Figure A-5

Measured Sound Levels
Location 1 - Mackey Court

November 29-30, 1999

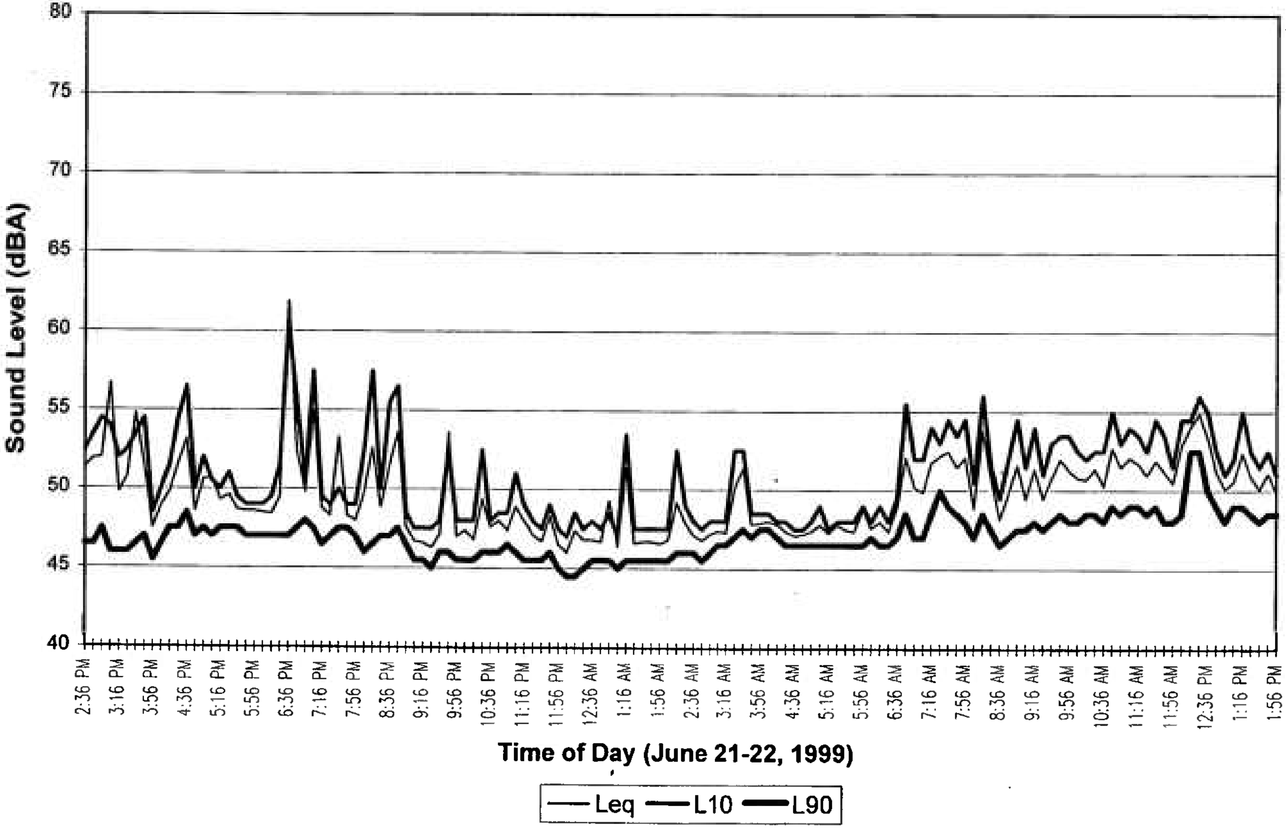


Figure A-6

Measured Sound Levels
Location 2 - McKenzie Avenue

November 29-30, 1999

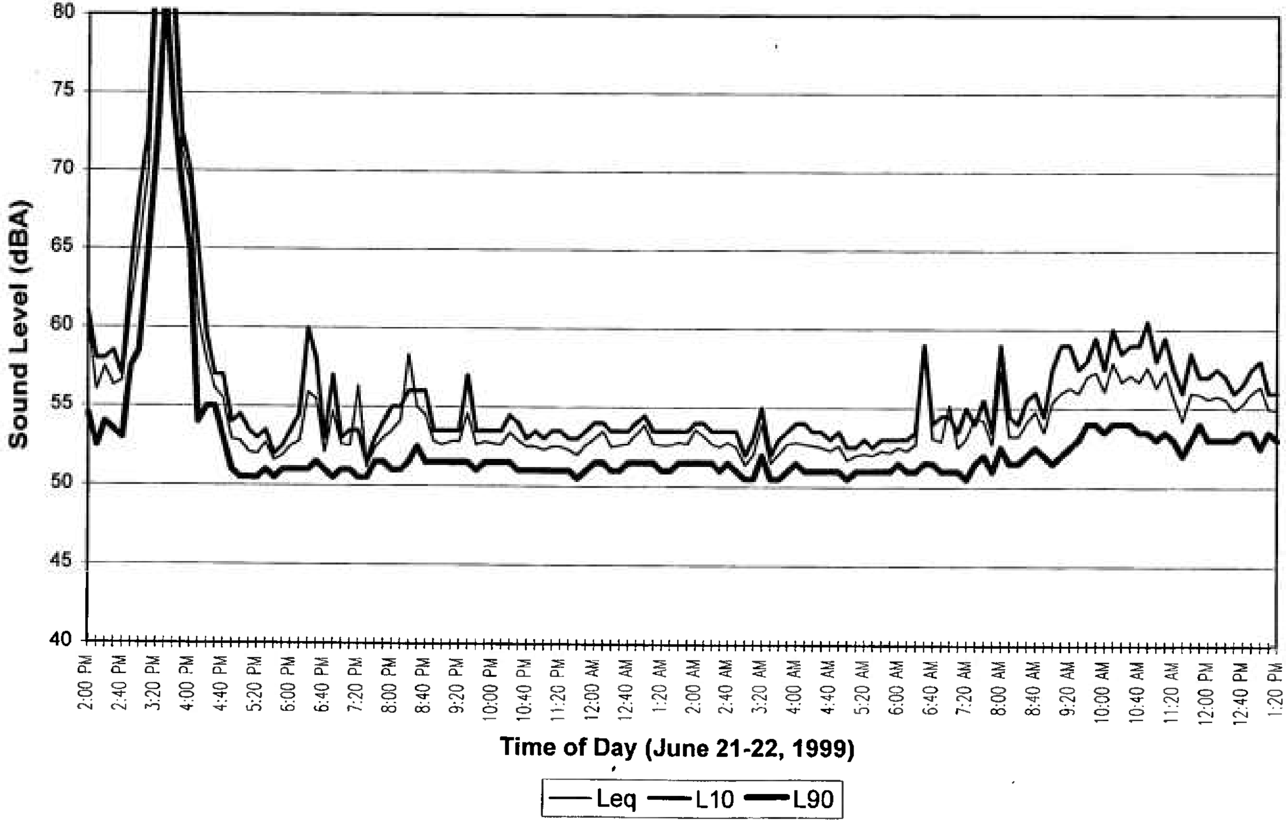


Figure A-7

Measured Sound Levels
Location 3 - Jefferson Street

November 29-30, 1999

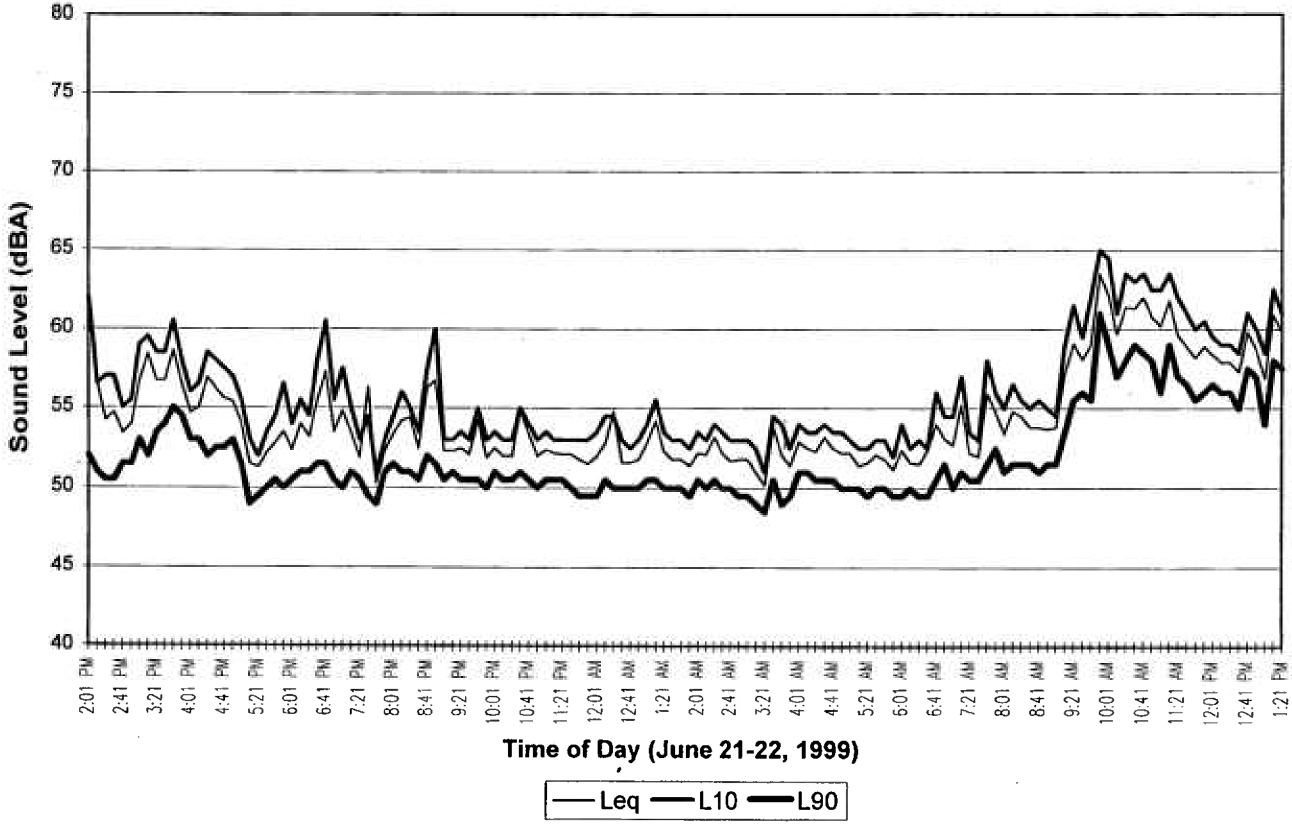


Figure A-8

Measured Sound Levels
Location 4 - St. Peter's School

November 29-30, 1999

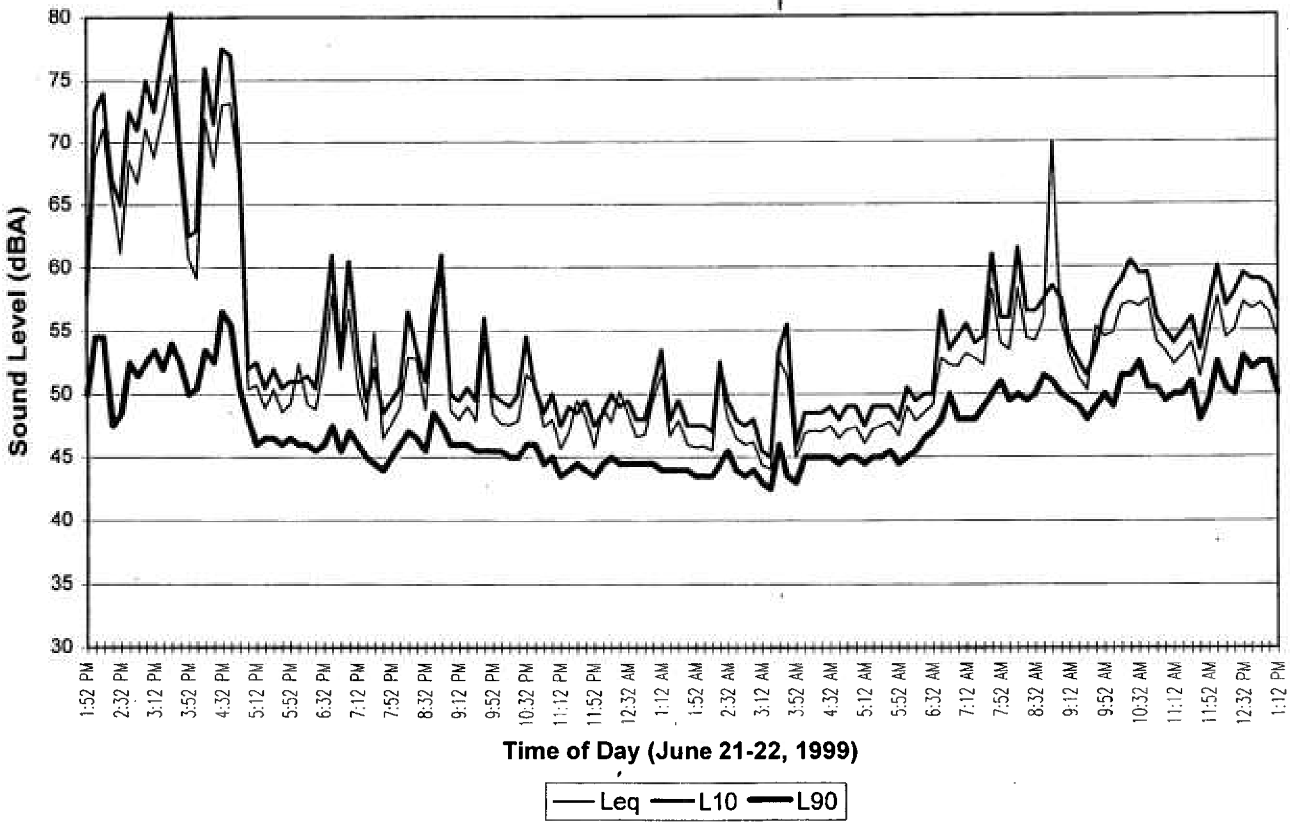


Figure A-9

Measured Octave Band Sound Pressure Levels
Location 1 - Mackey Court
June 21-22, 1999

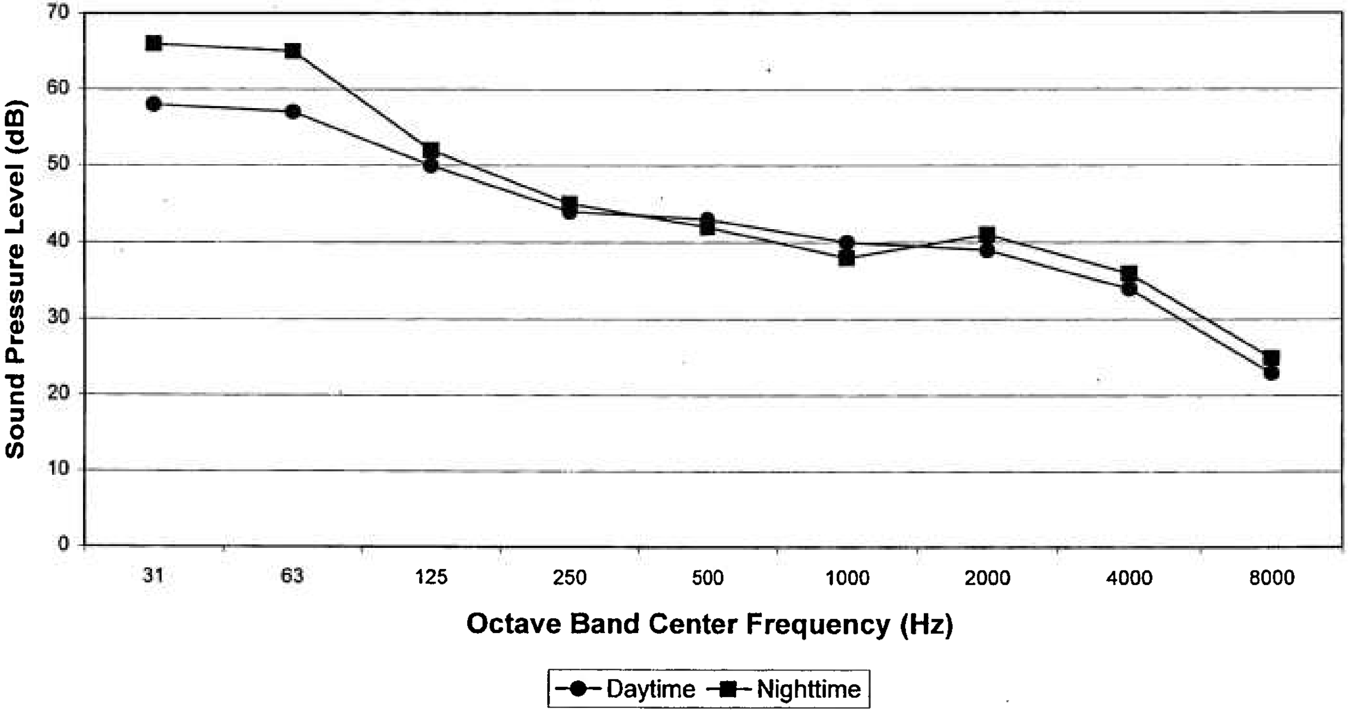


Figure A-10

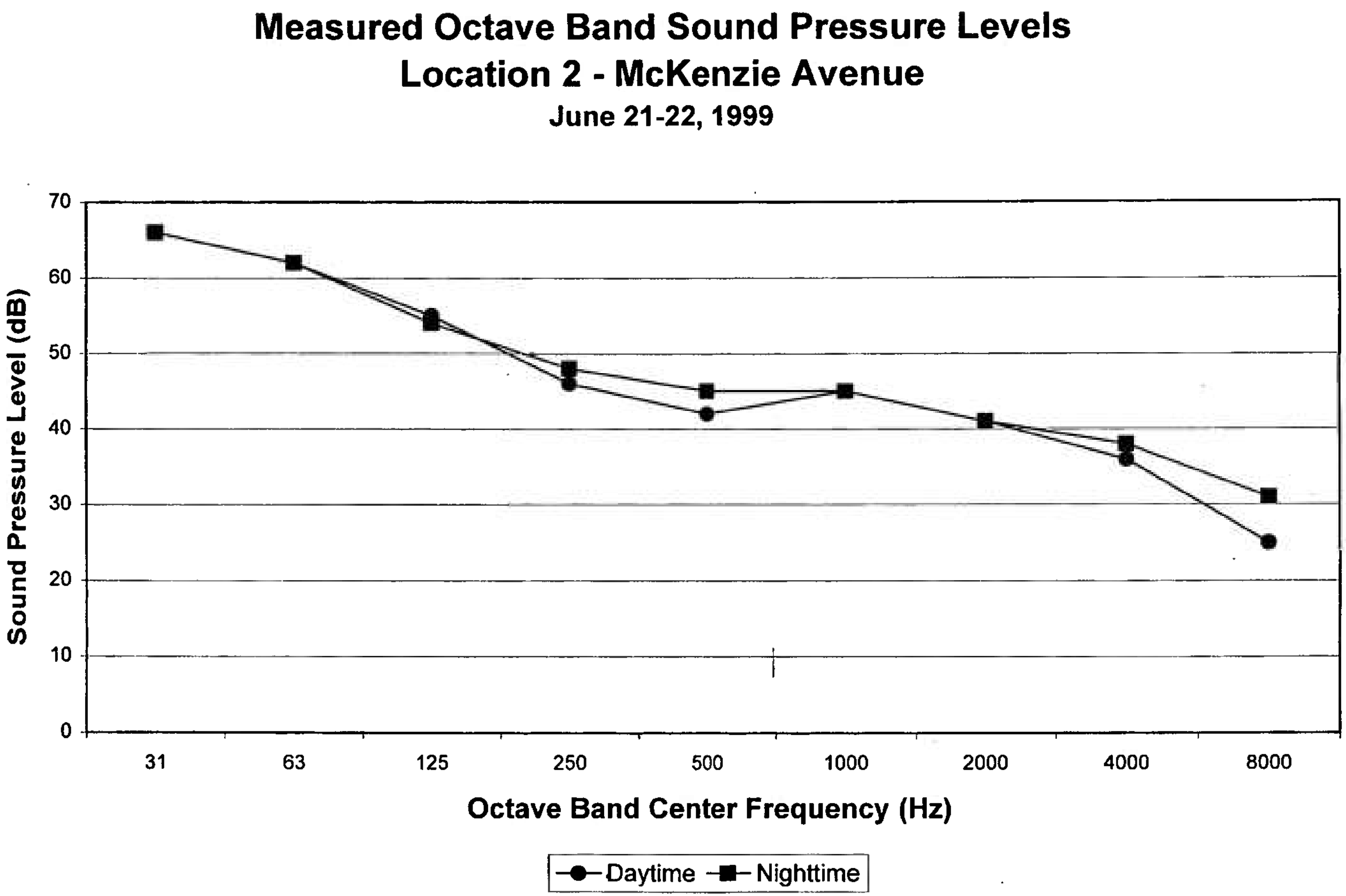

Measured Octave Band Sound Pressure Levels
Location 2 - McKenzie Avenue
June 21-22, 1999
70
60
50
40
30
20
10
0
Sound Pressure Level (dB)
31
63
125
250
500
1000
2000
4000
8000
Octave Band Center Frequency (Hz)
Daytime
Nighttime

Figure A-11

Measured Octave Band Sound Pressure Levels
Location 3 - Jefferson Street
June 21-22, 1999

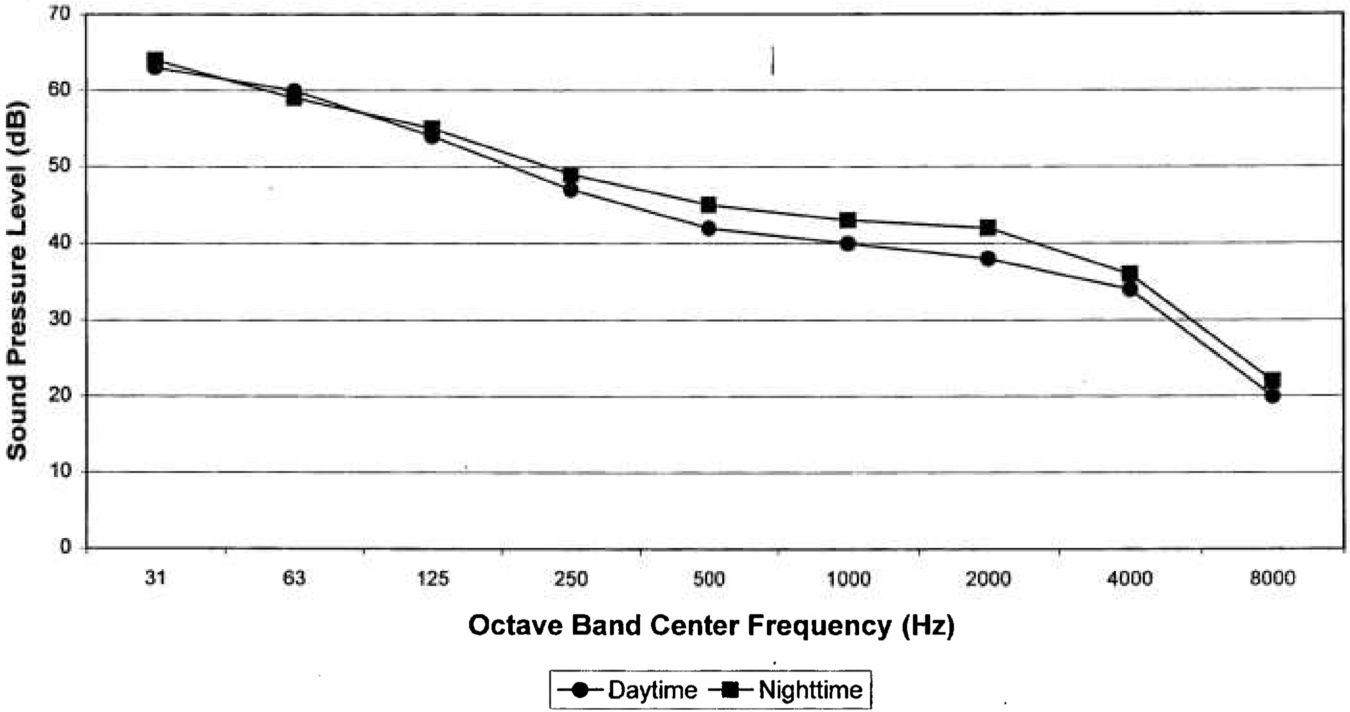


Figure A-12

Measured Octave Band Sound Pressure Levels
Location 4 - St. Peter's School
June 21-22, 1999

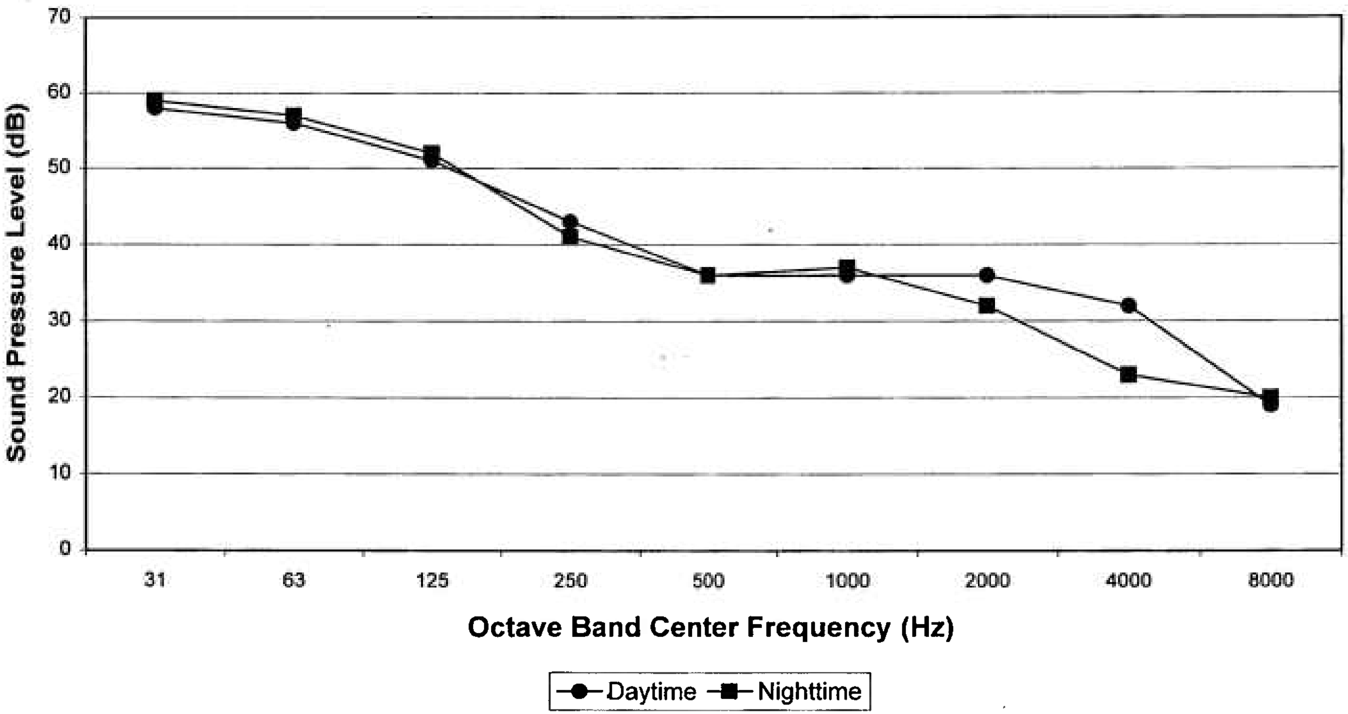


Figure A-13

Measured Octave Band Sound Pressure Levels
Location 5 - Haverstraw Marina

June 21-22, 1999

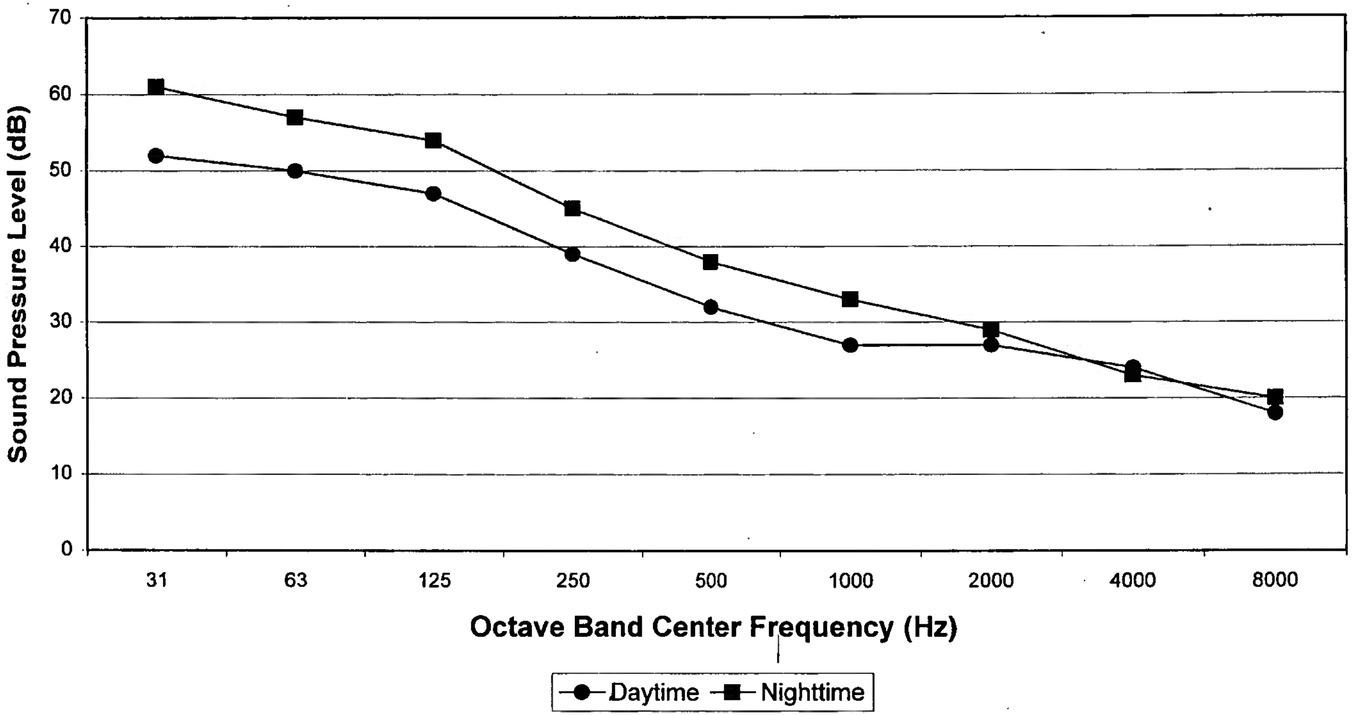


Figure A-14

Measured Octave Band Sound Pressure Levels
Location 1 - Mackey Court
November 29-30, 1999

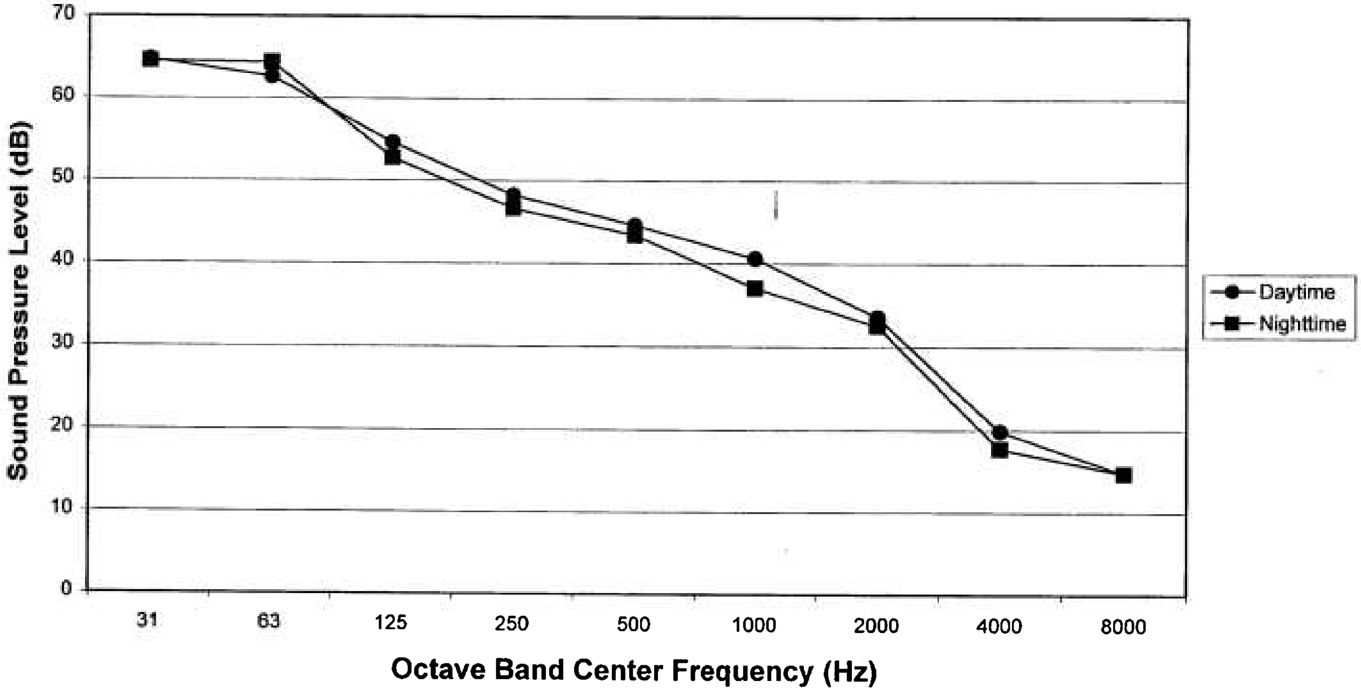


Figure A-15

Measured Octave Band Sound Pressure Levels
Location 2 - McKenzie Avenue
November 29-30, 1999

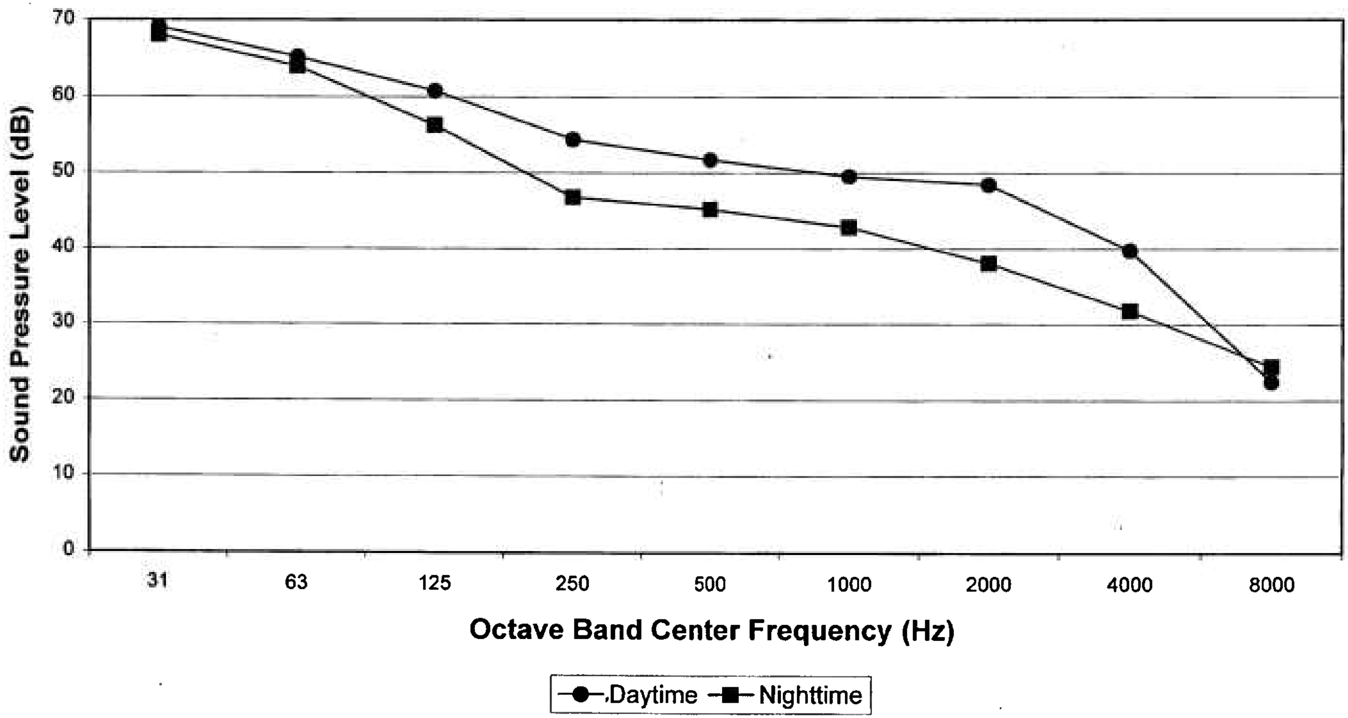


Figure A-16

Measured Octave Band Sound Pressure Levels
Location 3 - Jefferson Street
November 29-30, 1999

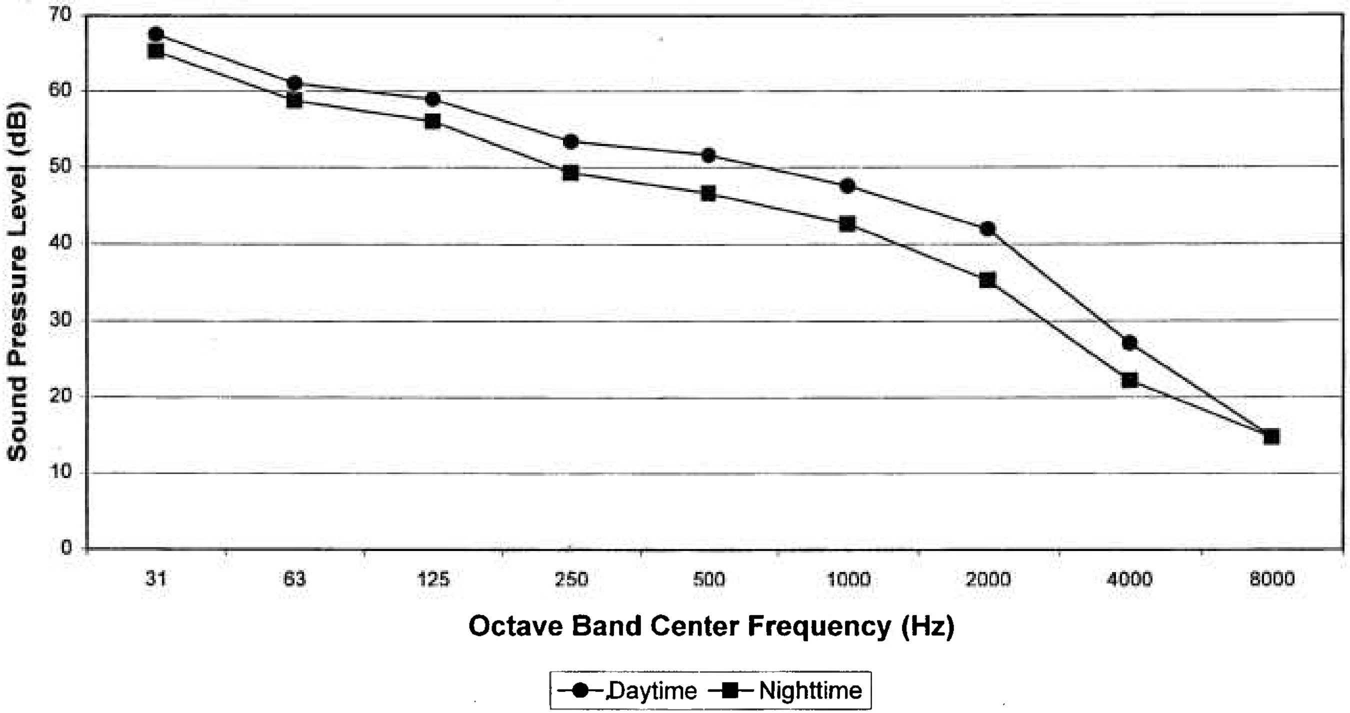


Figure A-17

Measured Octave Band Sound Pressure Levels
Location 4 - St. Peters School
November 29-30, 1999

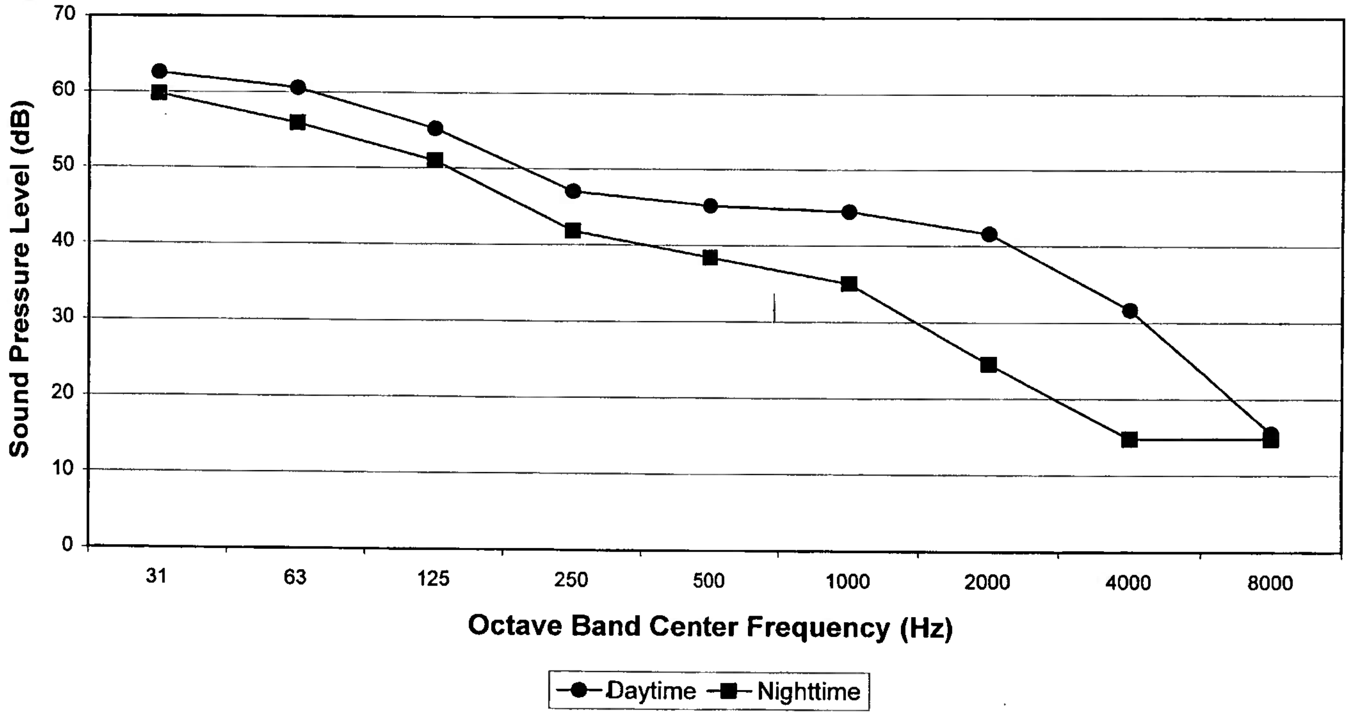


Figure A-18

Measured Octave Band Sound Pressure Levels
Location 5 - Haverstraw Marina
November 29-30, 1999

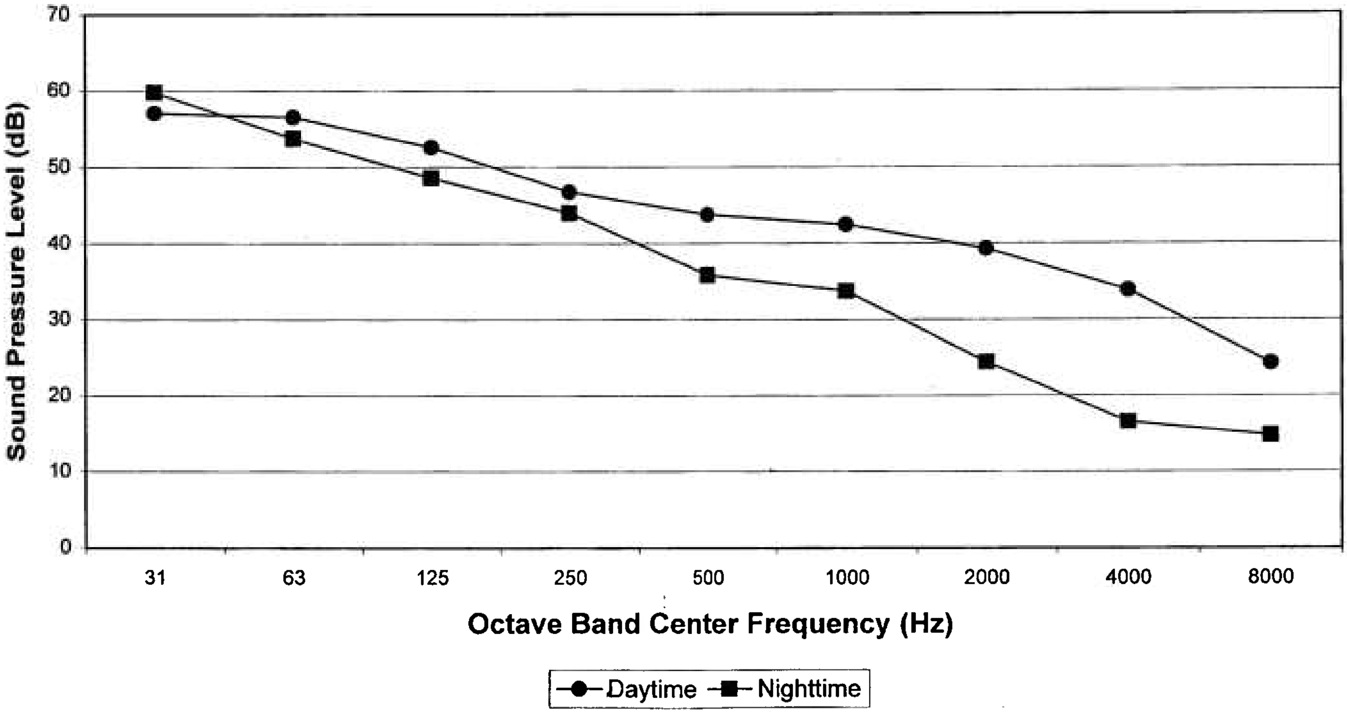


Figure A-19

Measured 1/3 Octave Band Levels
Location 1 - Mackey Court

November 29-30, 1999

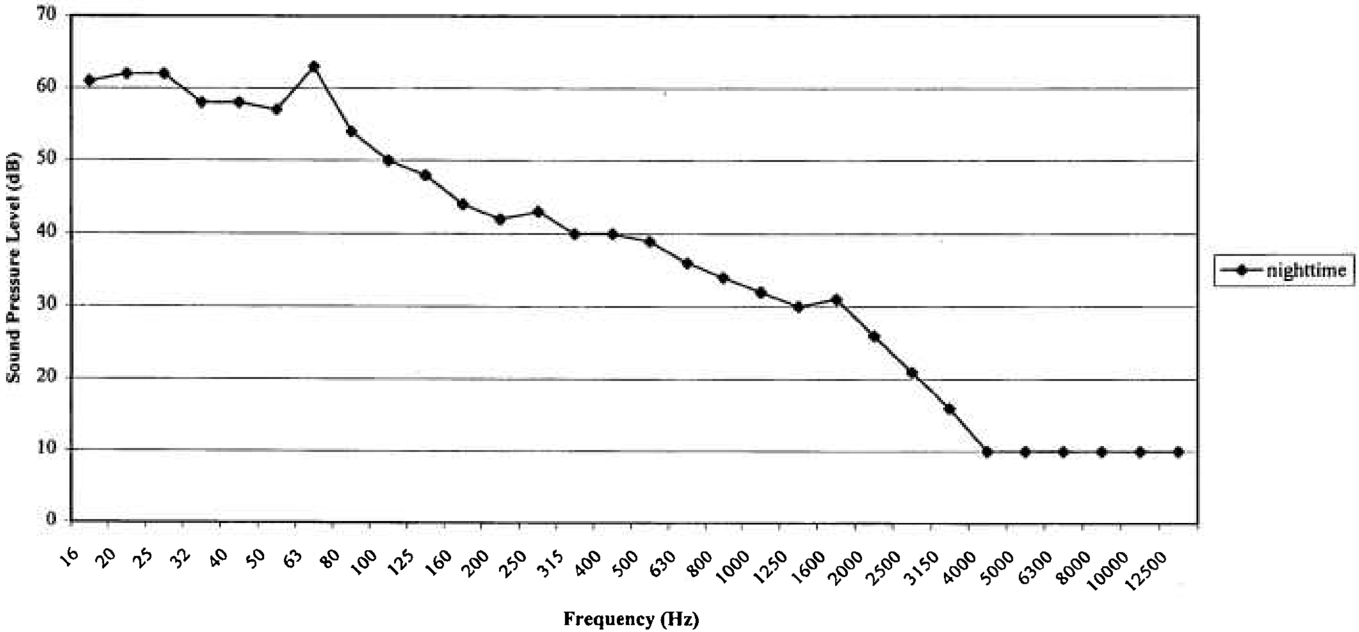


Figure A-20

Measured 1/3 Octave Band Levels
Location 2 - McKenzie Avenue
November 29-30, 1999

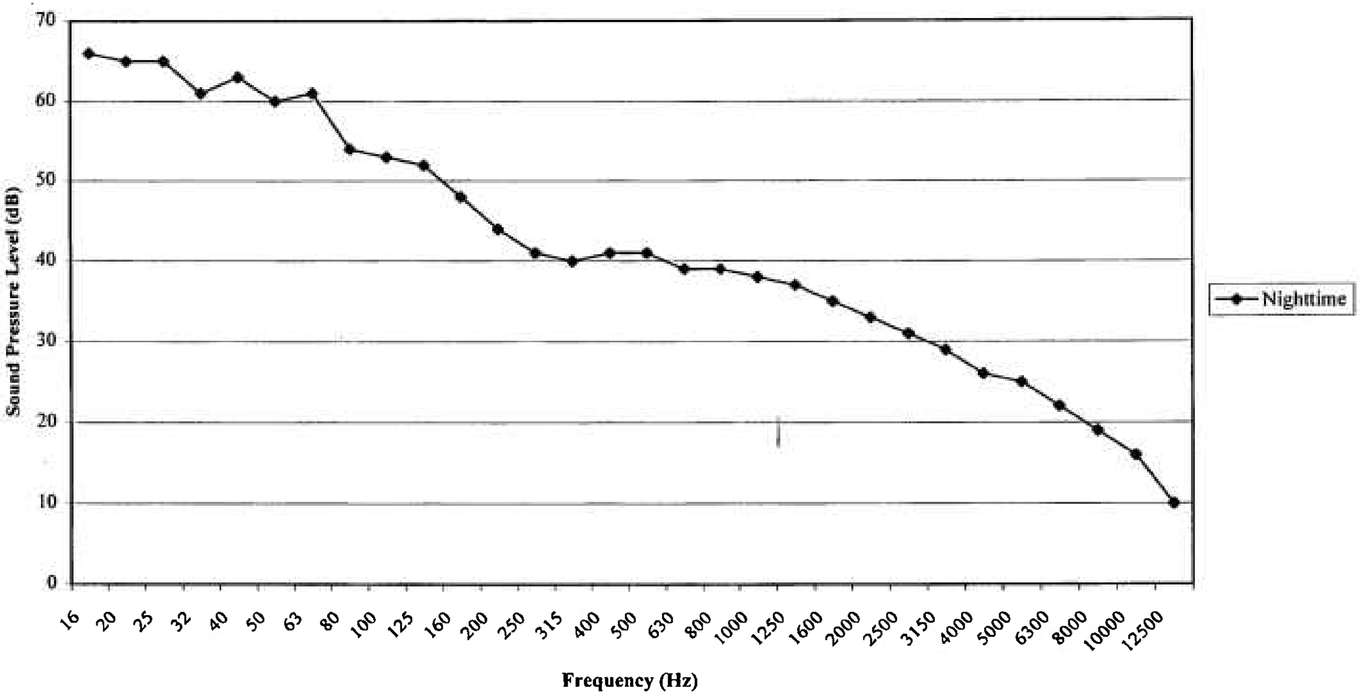


Figure A-21

Measured 1/3 Octave Band Levels
Location 3 - Jefferson Street
November 29-30, 1999

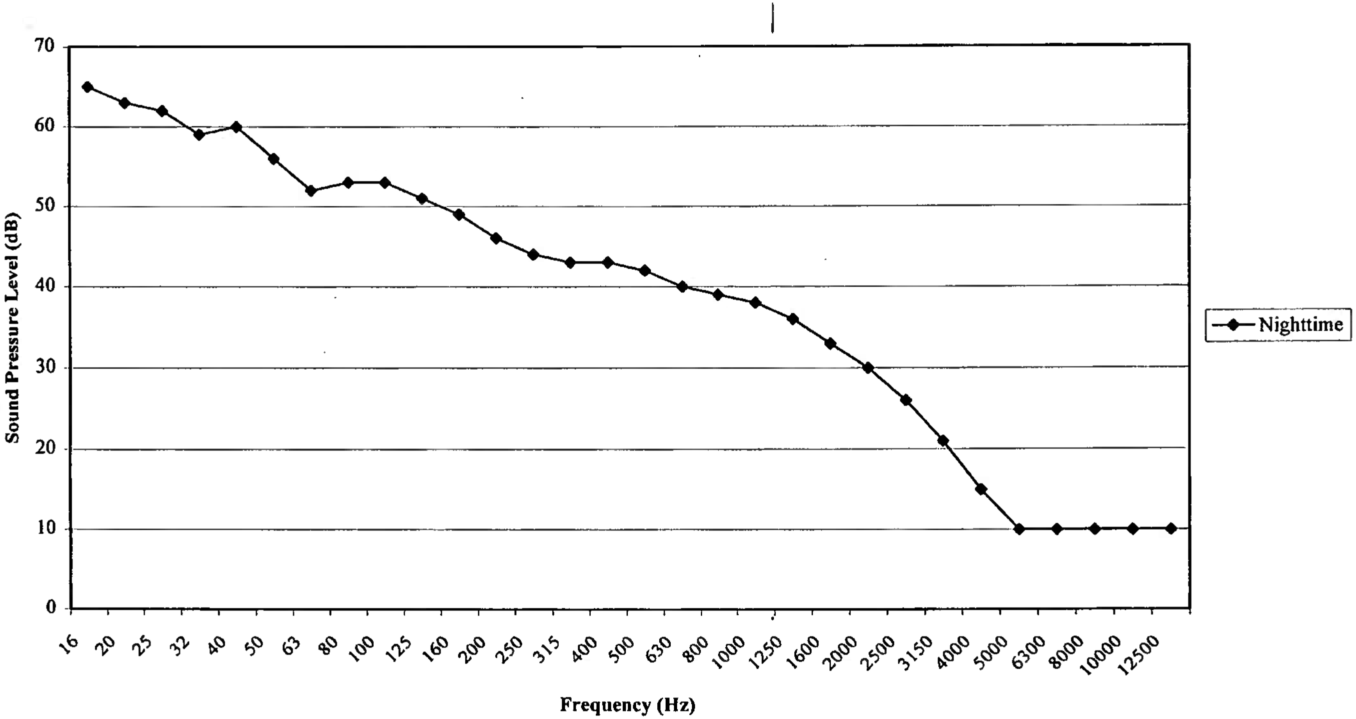
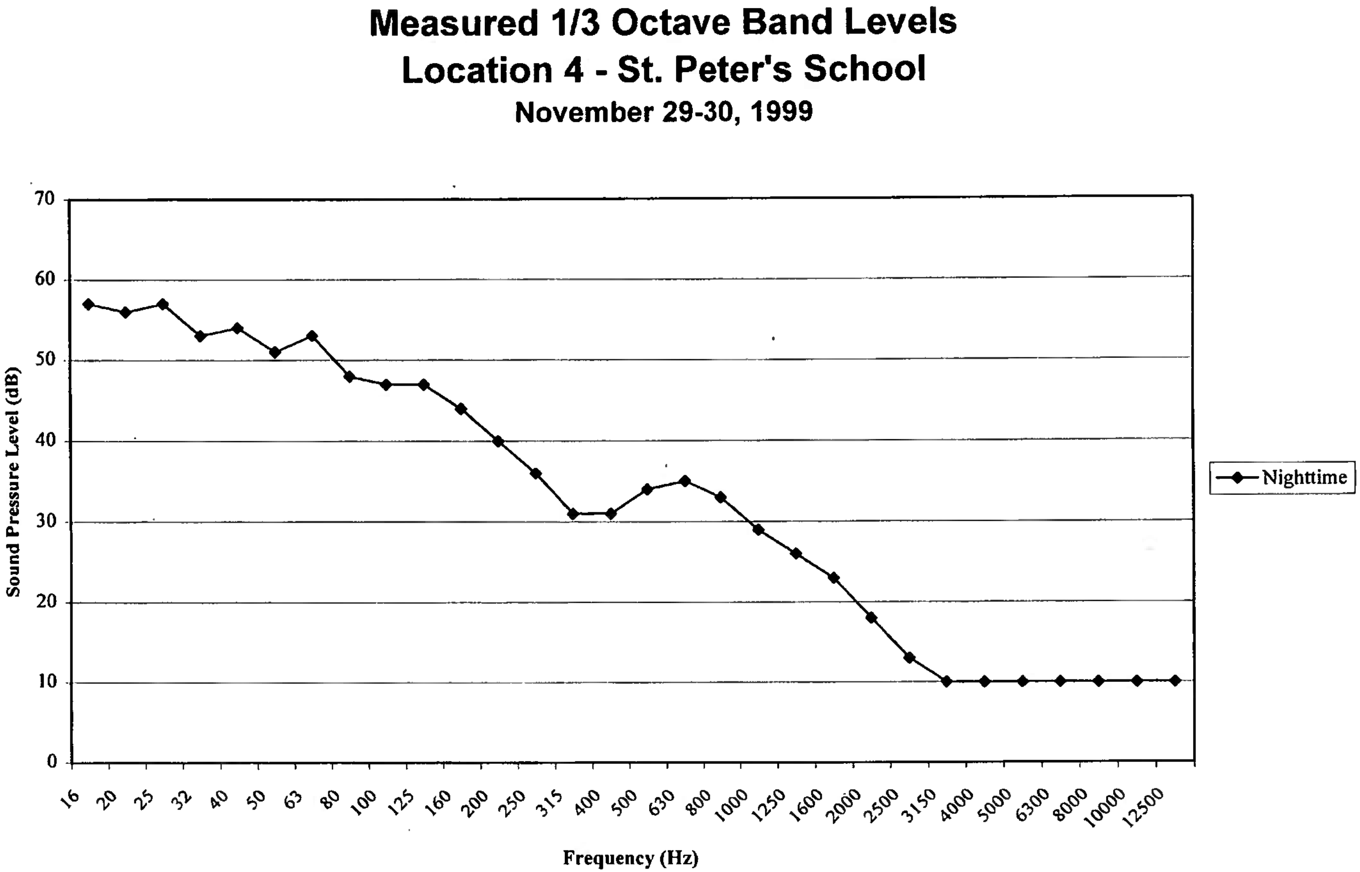


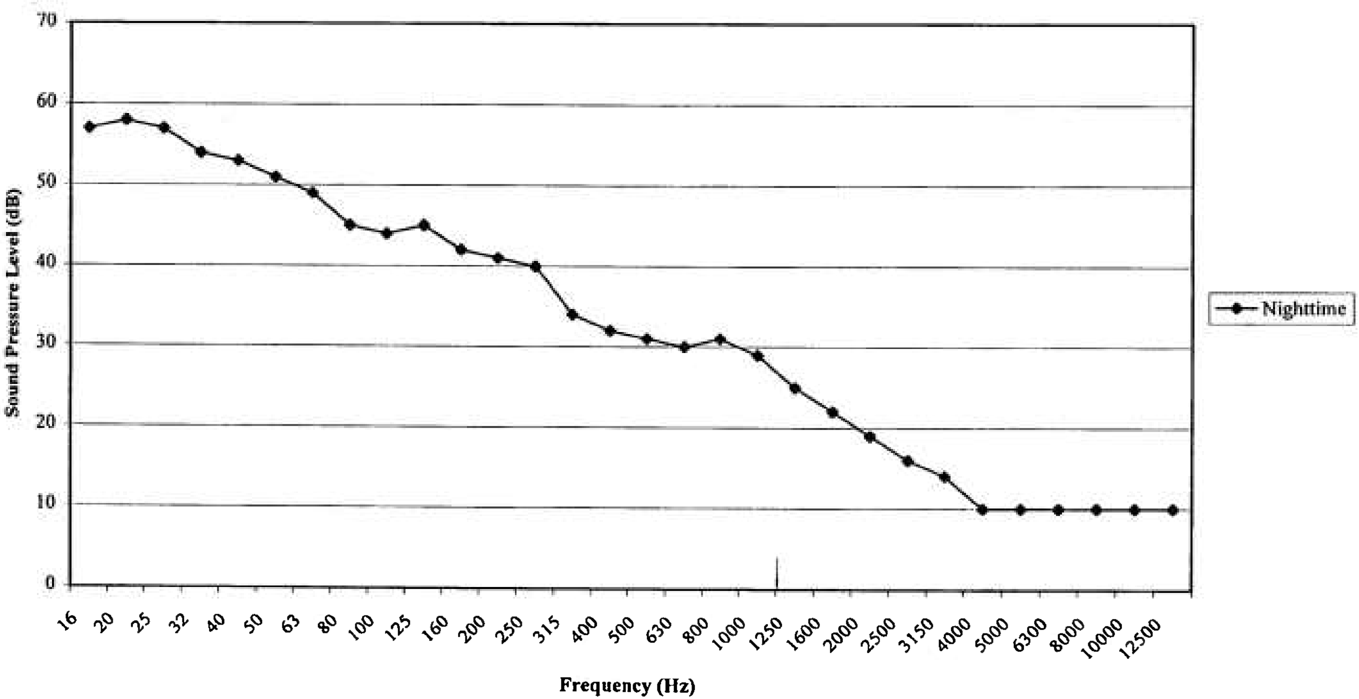
Figure A-22



Measured 1/3 Octave Band Levels
Location 4 - St. Peter's School
November 29-30, 1999
70
60
50
40
30
20
10
0
Sound Pressure Level (dB)
16
20
25
32
40
50
63
80
100
125
160
200
250
315
400
500
630
800
1000
1250
1600
2000
2500
3150
4000
5000
6300
8000
10000
12500
Frequency (Hz)
Nighttime

Figure A-23

Measured 1/3 Octave Band Levels
Location 5 - Haverstraw Marina
November 29-30, 1999



Appendix B

Operational Noise Modeling Support Data

Figure B-1

Project: Bowline

All data are sound power levels (dB)

Source (per source unless noted)	32	63	125	250	500	1k	2k	4k	8k	16k	Overall PWL (dB)	Overall PWL (dBA)
	Octave Band (Hz)											
HRSG Casing	116	111	107	103	101	97	93	88	81	76	118	103
Stack Exit (per stack)	115	113	113	112	110	103	95	87	75	70	120	110
Control (15 dBA based on consultant's files)	-1	-5	-11	-20	-24	-20	-10	-3	0	0		
Final Stack Exit	114	108	102	92	86	83	85	84	75	70	115	93
Transformers (Gas Turbine)	100	106	108	103	103	97	92	87	80	75	112	103
Control ("Quieted design - 5 dBA based on consultants files)	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5		
Final Transformer (Gas Turbine)	95	101	103	98	98	92	87	82	75	70	107	98
Transformers (Steam Turbine)	104	110	112	107	107	101	96	91	84	79	116	107
Control ("Quieted design - 5 dBA based on consultants files)	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5		
Final Transformer (Steam Turbine)	99	105	107	102	102	96	91	86	79	74	111	102
Transformers (Service Station)	70	76	78	73	73	67	62	57	50	45	82	74
Boiler Feedwater Pumps	93	97	96	97	99	100	99	96	93	88	107	105
Control (Enclosure - 22 ga steel w/louvers)	-1	-6	-11	-15	-19	-21	-22	-23	-24	-26		
Final Boiler Feedwater Pumps	92	91	85	82	80	79	77	73	69	62	96	84
Turbine Air Inlet	96	95	88	90	88	83	82	82	85	80	100	91
Circulation Pumps	94	96	98	98	98	98	98	95	88	83	106	104
Make-Up Water Pumps	91	93	95	95	95	95	95	92	85	80	103	101
Turbine Building* (see breakdown below)												

* Turbine Building Sources	31	63	125	250	500	1000	2000	4000	8000	16000	Overall PWL (dB)	Overall PWL (dBA)
	Octave Band (Hz)											
Gas Turbine Casing (Total for 3)	118	122	120	114	113	112	111	107	104	99	126	117
Steam Turbine (one)	104	108	109	106	105	105	103	102	98	93	115	110
Condensate Pumps (Total for 2)	94	96	98	98	98	98	98	95	88	83	106	104
Sum of Net PWL	118	122	120	115	114	113	111	108	105	100	126	118
Composite Transmission Loss**	-3	-8	-8	-13	-18	-21	-22	-23	-24	-26		
Effective PWL of Turbine Building***	115	114	112	102	96	92	89	85	81	74	119	101
North Wall	105	104	102	92	86	82	79	75	71	64	109	91
East Wall	111	110	108	98	92	88	85	81	77	70	115	97
South Wall	105	104	102	92	86	82	79	75	71	64	109	91
West Wall	111	110	108	98	92	88	85	81	77	70	115	97

** Based on panel wall from "Compendium of Materials for Noise Control" p.239 and 0.5% openings

*** Broke up building into four walls. Bases on area of building.

-1

PWL =spl +10log(area in m2).

Wall	Area in ft2	Area in m2	10*log(area)
North	10800	1003	30
East	38400	3567	36
South	10800	1003	30
West	38400	3567	36

Large walls will be 6 dB greater than short walls. Therefore, subtract
10 dB from short walls and 4 dB from long walls (e.g., total =100; then
90+90=93
96+96=99 (long wall 6 dB greater than short wall)
99+93=100(total equals 100 dB)

Figure B-2

Sound Power Calculation Based on EEI, 1984

Source: Boiler Feedwater Pump (Pumps will be outdoors next to HRSG casing - six in total)
Data below are from EEI. Sulzer Pumps provided a PWL of 105 dBA. Will use Sulzer SPL spectrum (90 dBA) and add 15 dB to each band.

Horsepower Rating: 1000

	31	63	125	250	500	1000	2000	4000	8000	Overall PWL (dBA)
Initial PWL (from below)	108	108	108	108	108	108	108	108	108	
Correction by HP	-11	-5	-7	-8	-9	-10	-11	-12	-16	
PWL per pump (EEI)	**97**	**103**	**101**	**100**	**99**	**98**	**97**	**96**	**92**	103.9
PWL per pump (Sulzer)	93	97	96	97	99	100	99	96	93	105.0

Initial PWL by HP

HP	dB
1300	108
2700	110
5300	112
8000	113
12000	115
12600	113
16000	115
20000	119
24000	123

Corrections by Octave Band based on HP rating

	31	63	125	250	500	1000	2000	4000	8000
1300-12000 hp	-11	-5	-7	-8	-9	-10	-11	-12	-16
12600-24000 hp	-19	-13	-15	-11	-5	-5	-7	-19	-23

Figure B-3

Sound Power Calculation Based on EEI, 1984

Source: in Transformer (GT - Standard) (Three of these)

MVA Rating:	220
NEMA Rating	83
10*log(S) where S=area in m2	20

	31	63	125	250	500	1000	2000	4000	8000	Overall PWL
NEMA Rating	83	83	83	83	83	83	83	83	83	
close in SPL	-3	3	5	0	0	-6	-11	-16	-23	
10logS	20	20	20	20	20	20	20	20	20	
Final PWL	**100**	**106**	**108**	**103**	**103**	**97**	**92**	**87**	**80**	

Figure B-4

Sound Power Calculation Based on EEI, 1984

Source: in Transformer (ST - Standard) (One of these)

MVA Rating:	400
NEMA Rating	86
10*log(S) where S=area in m2	21

	31	63	125	250	500	1000	2000	4000	8000	Overall PWL
NEMA Rating	86	86	86	86	86	86	86	86	86	
close in SPL	-3	3	5	0	0	-6	-11	-16	-23	
10logS	21	21	21	21	21	21	21	21	21	
Final PWL	**104**	**110**	**112**	**107**	**107**	**101**	**96**	**91**	**84**	

Figure B-5

Sound Power Calculation Based on EEI, 1984

Source: Transformer (Svc. Sta. - Std) (Two of these)

MVA Rating:	2
NEMA Rating	59
10*log(S) where S=area in m2	15

	31	63	125	250	500	1000	2000	4000	8000	Overall PWL
NEMA Rating	59	59	59	59	59	59	59	59	59	
close in SPL	-3	3	5	0	0	-6	-11	-16	-23	
10logS	15	15	15	15	15	15	15	15	15	
Final PWL	**70**	**76**	**78**	**73**	**73**	**67**	**62**	**57**	**50**	

Figure B-6

Sound Power Calculation Based on EEI, 1984

Source: Steam Turbine (One of these - indoor)

MW Rating: 250
HP Rating: 335250
Initial PWL: 115

	31	63	125	250	500	1000	2000	4000	8000	Overall PWL
Initial PWL	115	115	115	115	115	115	115	115	115	
Correction	-11	-7	-6	-9	-10	-10	-12	-13	-17	
Final PWL	**104**	**108**	**109**	**106**	**105**	**105**	**103**	**102**	**98**	115.1

Figure B-7

Sound Power Calculation Based on EEI, 1984

Source: Circulation Pump

* Levels here are loudest provided on p. 4-19.

Notes: Four pumps on west center of tower. 1500 hp each.

	31	63	125	250	500	1000	2000	4000	8000	Overall PWL
Initial PWL	94	96	98	98	98	98	98	95	88	
Correction**	0	0	0	0	0	0	0	0	0	
Final PWL	94	96	98	98	98	98	98	95	88	106.2

** Corrections to use

For motors > 5000 hp	3	3	3	3	3	3	3	3	3
1000 to 5000 hp	0	0	0	0	0	0	0	0	0
For motors > 200 to 1000 hp	-3	-3	-3	-3	-3	-3	-3	-3	-3
Motors < 200 hp see p.4-19									

Figure B-8

Sound Power Calculation Based on EEI, 1984

Source: Condensate Pump * Levels here are loudest provided on p. 4-19.

Notes: Two pumps, indoors. 200 hp each

	31	63	125	250	500	1000	2000	4000	8000	Overall PWL
Initial PWL	94	96	98	98	98	98	98	95	88	
Correction**	-3	-3	-3	-3	-3	-3	-3	-3	-3	
Final PWL	91	93	95	95	95	95	95	92	85	103.2

** Corrections to use

For motors > 5000 hp	3	3	3	3	3	3	3	3	3
1000 to 5000 hp	0	0	0	0	0	0	0	0	0
For motors > 200 to 1000 hp	-3	-3	-3	-3	-3	-3	-3	-3	-3
Motors < 200 hp see p.4-19									

Figure B-9

Sound Power Calculation Based on EEI, 1984

Source: Makeup Water Pump * Levels here are loudest provided on p. 4-19.

Notes: Two pumps on south side of tower. 100 hp each

	31	63	125	250	500	1000	2000	4000	8000	Overall PWL
Initial PWL	94	96	98	98	98	98	98	95	88	
Correction**	-3	-3	-3	-3	-3	-3	-3	-3	-3	
Final PWL	91	93	95	95	95	95	95	92	85	103.2

** Corrections to use

For motors > 5000 hp	3	3	3	3	3	3	3	3	3
1000 to 5000 hp	0	0	0	0	0	0	0	0	0
For motors > 200 to 1000 hp	-3	-3	-3	-3	-3	-3	-3	-3	-3
Motors < 200 hp see p.4-19									

Figure B-10

Final Calculated Sound Levels - Mackey Court

	Octave Band (Hz) 31	63	125	250	500	1000	2000	4000	8000	Overall (dB)	Overall (dBA)
Plant Sources	60	57	55	48	46	40	35	23	0	63	47
Max. Allowable for "D" Rating	74	66	58	52	47	43	40	37	35	75	51
Max. Allowable for "E" Rating	78	70	63	57	52	48	45	41	40	79	55
Max Cooling Twr to meet "D"	**74**	**65**	**55**	**50**	**40**	**40**	**38**	**37**	**35**	74	48
Max Cooling Twr to meet "E"	**78**	**70**	**62**	**56**	**51**	**47**	**45**	**41**	**40**	79	55
Cooling Tower	54	57	52	46	40	38	33	22	0	60	44
Total Plant	**61**	**60**	**57**	**50**	**47**	**42**	**37**	**26**	**3**	**65**	**49**

Results based on plant sources modeling run #3 and cooling tower run #2

Figure B-11

Final Calculated Sound Levels - McKenzie Avenue

	Octave Band (Hz) 31	63	125	250	500	1000	2000	4000	8000	Overall (dB)	Overall (dBA)
Plant Sources	60	56	53	47	45	41	37	27	0	62	47
Max. Allowable for "D" Rating	74	66	58	52	47	43	40	37	35	75	51
Max. Allowable for "E" Rating	78	70	63	57	52	48	45	41	40	79	55
Max Cooling Twr to meet "D"	**74**	**66**	**56**	**50**	**43**	**39**	**37**	**37**	**35**	75	48
Max Cooling Twr to meet "E"	**78**	**70**	**63**	**57**	**51**	**47**	**44**	**41**	**40**	79	55
Initial Cooling Tower	57	59	54	47	42	41	37	30	1	62	46
Total Plant	**62**	**61**	**57**	**50**	**47**	**44**	**40**	**32**	**4**	**65**	**50**

Results based on plant sources modeling run #3 and cooling tower run #2

Figure B-12

Final Calculated Sound Levels - Jefferson Street

	Octave Band (Hz) 31	63	125	250	500	1000	2000	4000	8000	Overall (dB)	Overall (dBA)
Plant Sources	56	52	49	43	41	36	31	16	0	58	42
Max. Allowable for "D" Rating	74	66	58	52	47	43	40	37	35	75	51
Max. Allowable for "E" Rating	78	70	63	57	52	48	45	41	40	79	55
Max Cooling Twr to meet "D"	**74**	**66**	**57**	**51**	**46**	**42**	**39**	**37**	**35**	75	50
Max Cooling Twr to meet "E"	**78**	**70**	**63**	**57**	**52**	**48**	**45**	**41**	**40**	79	55
Cooling Tower	54	57	53	46	40	39	34	23	0	60	44
Total Plant	**58**	**58**	**54**	**48**	**44**	**41**	**36**	**24**	**3**	**62**	**47**

Results based on plant sources modeling run #3 and cooling tower run #2

Figure B-13

Final Calculated Sound Levels - St Peters

	Octave Band (Hz) 31	63	125	250	500	1000	2000	4000	8000	Overall (dB)	Overall (dBA)
Plant Sources	58	54	51	45	42	37	31	15	0	60	44
Max. Allowable for "D" Rating	74	66	58	52	47	43	40	37	35	75	51
Max. Allowable for "E" Rating	78	70	63	57	52	48	45	41	40	79	55
Max Cooling Twr to meet "D"	**74**	**66**	**57**	**51**	**45**	**42**	**39**	**37**	**35**	75	50
Max Cooling Twr to meet "E"	**78**	**70**	**63**	**57**	**52**	**48**	**45**	**41**	**40**	79	55
Cooling Tower	53	56	52	46	40	38	33	21	0	59	44
Total Plant	**59**	**58**	**55**	**49**	**44**	**41**	**35**	**22**	**3**	**63**	**47**

Results based on plant sources modeling run #3 and cooling tower run #2

Figure B-14

Final Calculated Sound Levels - Marina

	Octave Band (Hz) 31	63	125	250	500	1000	2000	4000	8000	Overall (dB)	Overall (dBA)
Plant Sources	58	54	51	44	41	36	29	11	0	60	43
Max. Allowable for "D" Rating	74	66	58	52	47	43	40	37	35	75	51
Max. Allowable for "E" Rating	78	70	63	57	52	48	45	41	40	79	55
Max Cooling Twr to meet "D"	**74**	**66**	**57**	**51**	**46**	**42**	**40**	**37**	**35**	75	50
Max Cooling Twr to meet "E"	**78**	**70**	**63**	**57**	**52**	**48**	**45**	**41**	**40**	79	55
Cooling Tower	51	54	50	43	37	35	29	14	0	57	41
Total Plant	**59**	**57**	**54**	**47**	**42**	**39**	**32**	**16**	**3**	**62**	**45**

Results based on plant sources modeling run #3 and cooling tower run #2

PLANT (w/o COOLING TOWER)

SOURCE	1	stack 1	SOUND PWR LEVEL=	+115.2 DB
SOURCE	2	stack 2	SOUND PWR LEVEL=	+115.2 DB
SOURCE	3	stack 3	SOUND PWR LEVEL=	+115.2 DB
SOURCE	4	hrsg 1	SOUND PWR LEVEL=	+117.9 DB
SOURCE	5	hrsg 2	SOUND PWR LEVEL=	+117.9 DB
SOURCE	6	hrsg 3	SOUND PWR LEVEL=	+117.9 DB
SOURCE	7	bfw pump 1	SOUND PWR LEVEL=	+95.5 DB
SOURCE	8	bfw pump 2	SOUND PWR LEVEL=	+95.5 DB
SOURCE	9	bfw pump 3	SOUND PWR LEVEL=	+95.5 DB
SOURCE	10	bfw pump 4	SOUND PWR LEVEL=	+95.5 DB
SOURCE	11	bfw pump 5	SOUND PWR LEVEL=	+95.5 DB
SOURCE	12	bfw pump 6	SOUND PWR LEVEL=	+95.5 DB
SOURCE	13	turbine bldg east wall	SOUND PWR LEVEL=	+114.7 DB
SOURCE	14	turbine bldg south wall	SOUND PWR LEVEL=	+108.7 DB
SOURCE	15	turbine bldg west wall	SOUND PWR LEVEL=	+114.7 DB
SOURCE	16	turbine bldg north wall	SOUND PWR LEVEL=	+108.7 DB
SOURCE	17	air inlet gt1	SOUND PWR LEVEL=	+100.1 DB
SOURCE	18	air inlet gt2	SOUND PWR LEVEL=	+100.1 DB
SOURCE	19	air inlet gt3	SOUND PWR LEVEL=	+100.1 DB
SOURCE	20	transformer (gt1)	SOUND PWR LEVEL=	+107.0 DB
SOURCE	21	transformer (gt2)	SOUND PWR LEVEL=	+107.0 DB
SOURCE	22	transformer (gt3)	SOUND PWR LEVEL=	+107.0 DB
SOURCE	23	transformer (st)	SOUND PWR LEVEL=	+111.0 DB
SOURCE	24	transformer (svc sta)	SOUND PWR LEVEL=	+82.0 DB
SOURCE	25	transformer (svc sta 2)	SOUND PWR LEVEL=	+82.0 DB
SOURCE	26	circ. pumps (combined)	SOUND PWR LEVEL=	+106.2 DB
SOURCE	27	makeup water pumps (combine	SOUND PWR LEVEL=	+103.2 DB

```
* RESULTS *

Program  <NCALC591>
[illegible]0-2000   11:53:21
INPUT FILES
 SOURCE - bowline.sou  RECEPTOR - bowline.rec   BARRIER - bowline.bar
bowline noise
run #3
contains turbine building as a barrier for Mackey Ct
15 dBA control on stacks
5 dBA control on transformers (quieted design)
enclosures on bfw pumps (21 dBA control)
```

02-10-2000 11:53:24
bowline noise
run #3
contains turbine building as a barrier for Mackey Ct
[illegible]dBA control on stacks
[illegible]A control on transformers (quieted design)
Program <NCALC591>
INPUT FILES
SOURCE - bowline.sou RECEPTOR - bowline.rec BARRIER - bowline.bar

AT RECEIVER # 1 Mackey Court

WITH THE BACKGROUND NOISE (IF ANY)
SOUND PRESSURE LEVEL = +62.7 DB SOUND LEVEL = +46.9 DBA

WITHOUT THE BACKGROUND NOISE
SOUND PRESSURE LEVEL = +62.7 DB SOUND LEVEL = +46.9 DBA

THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+60.0	+56.8	+54.6	+47.8	+45.9	+40.0	+34.5	+22.9	+0.0	+0.0

RECEIVER # 1 Mackey Court
SOURCE # 23 , transformer (st), CONTRIBUTES:
SOUND PRESSURE LEVEL = +50.8 DB SOUND LEVEL = +41.2 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+39.1	+45.1	+47.0	+41.7	+41.2	+34.4	+27.6	+16.2	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 1 Mackey Court
SOURCE # 22 , transformer (gt3), CONTRIBUTES:
SOUND PRESSURE LEVEL = +46.4 DB SOUND LEVEL = +36.7 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
[illegible].7	+40.7	+42.6	+37.3	+36.7	+29.9	+23.1	+11.4	+0.0	+0.0

[illegible] BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 1 Mackey Court
SOURCE # 21 , transformer (gt2), CONTRIBUTES:
SOUND PRESSURE LEVEL = +46.2 DB SOUND LEVEL = +36.5 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+34.5	+40.4	+42.3	+37.0	+36.4	+29.6	+22.7	+10.8	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 1 Mackey Court
SOURCE # 20 , transformer (gt1), CONTRIBUTES:
SOUND PRESSURE LEVEL = +45.8 DB SOUND LEVEL = +36.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+34.1	+40.0	+41.9	+36.6	+36.0	+29.1	+22.2	+9.9	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 1 Mackey Court
SOURCE # 15 , turbine bldg west wall, CONTRIBUTES:
SOUND PRESSURE LEVEL = +54.2 DB SOUND LEVEL = +35.2 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+50.5	+49.5	+47.4	+37.1	+30.5	+25.6	+20.8	+9.9	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

[illegible]IVER # 1 Mackey Court
[illegible]RCE # 6 , hrsg 3, CONTRIBUTES:
SOUND PRESSURE LEVEL = +51.5 DB SOUND LEVEL = +34.5 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+49.7	+44.6	+40.5	+36.1	+33.4	+28.2	+21.8	+8.5	+0.0	+0.0

```
ANGLE BETWEEN SOURCE, RECEPTOR AND BARRIER #:
BARRIER:  1  ,  IS  82


RECEIVER # 1   Mackey Court
SOURCE # 13 , turbine bldg east wall, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +53.4 DB           SOUND LEVEL =  +34.4 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +49.8 +48.7 +46.6 +36.3 +29.7 +24.7 +19.7  +8.2  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 1   Mackey Court
SOURCE # 5 , hrsg 2, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +51.2 DB           SOUND LEVEL =  +34.4 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +49.5 +44.4 +40.3 +35.9 +33.2 +28.1 +21.8  +8.6  +0.0  +0.0
ANGLE BETWEEN SOURCE, RECEPTOR AND BARRIER #:
BARRIER:  1  ,  IS  19


RECEIVER # 1   Mackey Court
SOURCE # 4 , hrsg 1, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +50.9 DB           SOUND LEVEL =  +33.8 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +49.1 +44.1 +39.9 +35.5 +32.6 +27.3 +20.5  +6.4  +0.0  +0.0
ANGLE BETWEEN SOURCE, RECEPTOR AND BARRIER #:
BARRIER:  1  ,  IS  48


RECEIVER # 1   Mackey Court
SOURCE # 26 , circ. pumps (combined), CONTRIBUTES:
SOUND PRESSURE LEVEL =  +38.8 DB           SOUND LEVEL =  +33.5 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 [illegible]8.6 +30.5 +32.4 +31.9 +30.8 +29.3 +26.1 +11.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 1   Mackey Court
SOURCE # 27 , makeup water pumps (combined), CONTRIBUTES:
SOUND PRESSURE LEVEL =  +35.8 DB           SOUND LEVEL =  +30.5 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +25.6 +27.5 +29.3 +28.8 +27.8 +26.3 +23.0  +7.8  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 1   Mackey Court
SOURCE # 14 , turbine bldg south wall, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +48.3 DB           SOUND LEVEL =  +29.4 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +44.6 +43.6 +41.5 +31.2 +24.6 +19.8 +14.9  +4.1  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 1   Mackey Court
SOURCE # 3 , stack 3, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +53.0 DB           SOUND LEVEL =  +28.5 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +51.8 +45.8 +39.7 +29.3 +22.6 +18.6 +18.3  +9.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 1   Mackey Court
SOURCE # 2 , stack 2, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +53.0 DB           SOUND LEVEL =  +28.5 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +51.8 +45.7 +39.6 +29.3 +22.5 +18.5 +18.2  +8.9  +0.0  +0.0
```

```
NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 1   Mackey Court
SOURCE # 1 , stack 1, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +53.0 DB          SOUND LEVEL =  +28.4 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +51.8 +45.7 +39.6 +29.2 +22.5 +18.5 +18.2  +8.8  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 1   Mackey Court
SOURCE # 16 , turbine bldg north wall, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +47.2 DB          SOUND LEVEL =  +28.2 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +43.6 +42.5 +40.4 +30.1 +23.4 +18.5 +13.4  +1.7  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 1   Mackey Court
SOURCE # 19 , air inlet gt3, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +39.6 DB          SOUND LEVEL =  +27.9 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +35.9 +34.9 +27.8 +29.5 +26.9 +21.1 +18.4 +11.8  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 1   Mackey Court
SOURCE # 18 , air inlet gt2, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +39.3 DB          SOUND LEVEL =  +27.5 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 [illegible]5.6 +34.5 +27.4 +29.2 +26.6 +20.7 +17.9 +11.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 1   Mackey Court
SOURCE # 17 , air inlet gt1, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +38.9 DB          SOUND LEVEL =  +27.1 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +35.2 +34.2 +27.1 +28.8 +26.2 +20.3 +17.4 +10.2  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 1   Mackey Court
SOURCE # 25 , transformer (svc sta 2), CONTRIBUTES:
SOUND PRESSURE LEVEL =  +21.4 DB          SOUND LEVEL =  +11.7 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
  +9.7 +15.7 +17.6 +12.3 +11.7  +4.9  +0.0  +0.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 1   Mackey Court
SOURCE # 24 , transformer (svc sta), CONTRIBUTES:
SOUND PRESSURE LEVEL =  +21.1 DB          SOUND LEVEL =  +11.4 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
  +9.4 +15.3 +17.2 +11.9 +11.3  +4.5  +0.0  +0.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 1   Mackey Court
SOURCE # 24 , transformer (svc sta), CONTRIBUTES:
SOUND PRESSURE LEVEL =  +21.1 DB          SOUND LEVEL =   +0.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
  +9.4 +15.3 +17.2 +11.9 +11.3  +4.5  +0.0  +0.0  +0.0  +0.0
```

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 1 Mackey Court
RCE # 24 , transformer (svc sta), CONTRIBUTES:
D PRESSURE LEVEL = +21.1 DB SOUND LEVEL = +0.0 DBA
E OCTAVE BAND SOUND PRESSURE LEVELS ARE:
31.5 63 125 250 500 1K 2K 4K 8K 16K HERTZ
+9.4 +15.3 +17.2 +11.9 +11.3 +4.5 +0.0 +0.0 +0.0 +0.0
NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 1 Mackey Court
SOURCE # 24 , transformer (svc sta), CONTRIBUTES:
SOUND PRESSURE LEVEL = +21.1 DB SOUND LEVEL = +0.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
31.5 63 125 250 500 1K 2K 4K 8K 16K HERTZ
+9.4 +15.3 +17.2 +11.9 +11.3 +4.5 +0.0 +0.0 +0.0 +0.0
NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 1 Mackey Court
SOURCE # 24 , transformer (svc sta), CONTRIBUTES:
SOUND PRESSURE LEVEL = +21.1 DB SOUND LEVEL = +0.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
31.5 63 125 250 500 1K 2K 4K 8K 16K HERTZ
+9.4 +15.3 +17.2 +11.9 +11.3 +4.5 +0.0 +0.0 +0.0 +0.0
NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 1 Mackey Court
SOURCE # 24 , transformer (svc sta), CONTRIBUTES:
SOUND PRESSURE LEVEL = +21.1 DB SOUND LEVEL = +0.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
31.5 63 125 250 500 1K 2K 4K 8K 16K HERTZ
+9.4 +15.3 +17.2 +11.9 +11.3 +4.5 +0.0 +0.0 +0.0 +0.0
BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 1 Mackey Court
SOURCE # 24 , transformer (svc sta), CONTRIBUTES:
SOUND PRESSURE LEVEL = +21.1 DB SOUND LEVEL = +0.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
31.5 63 125 250 500 1K 2K 4K 8K 16K HERTZ
+9.4 +15.3 +17.2 +11.9 +11.3 +4.5 +0.0 +0.0 +0.0 +0.0
NO BARRIER FOR THIS RECPT./SOURCE

02-10-2000 11:53:27
bowline noise
run #3
contains turbine building as a barrier for Mackey Ct
dBA control on stacks
A control on transformers (quieted design)
gram <NCALC591>
INPUT FILES
SOURCE - bowline.sou RECEPTOR - bowline.rec BARRIER - bowline.bar

AT RECEIVER # 2 Nearest Residential South

WITH THE BACKGROUND NOISE (IF ANY)
SOUND PRESSURE LEVEL = +62.3 DB SOUND LEVEL = +46.8 DBA

WITHOUT THE BACKGROUND NOISE
SOUND PRESSURE LEVEL = +62.3 DB SOUND LEVEL = +46.8 DBA

THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+60.0	+56.0	+53.1	+47.2	+45.0	+40.8	+37.2	+26.7	+0.0	+0.0

RECEIVER # 2 Nearest Residential South
SOURCE # 26 , circ. pumps (combined), CONTRIBUTES:
SOUND PRESSURE LEVEL = +43.6 DB SOUND LEVEL = +39.2 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+32.9	+34.8	+36.7	+36.4	+35.8	+34.9	+32.9	+22.4	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 27 , makeup water pumps (combined), CONTRIBUTES:
SOUND PRESSURE LEVEL = +42.8 DB SOUND LEVEL = +38.7 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
31.8	+33.8	+35.7	+35.5	+35.0	+34.2	+32.6	+23.7	+0.0	+0.0

BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 6 , hrsg 3, CONTRIBUTES:
SOUND PRESSURE LEVEL = +54.7 DB SOUND LEVEL = +37.7 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+52.9	+47.8	+43.7	+39.3	+36.5	+31.4	+24.9	+10.6	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 23 , transformer (st), CONTRIBUTES:
SOUND PRESSURE LEVEL = +47.6 DB SOUND LEVEL = +37.5 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+35.9	+41.9	+43.8	+38.4	+37.6	+30.4	+22.9	+8.7	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 5 , hrsg 2, CONTRIBUTES:
SOUND PRESSURE LEVEL = +54.1 DB SOUND LEVEL = +37.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+52.3	+47.3	+43.2	+38.7	+35.9	+30.7	+24.0	+9.1	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

EIVER # 2 Nearest Residential South
RCE # 4 , hrsg 1, CONTRIBUTES:
SOUND PRESSURE LEVEL = +53.6 DB SOUND LEVEL = +36.4 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+51.8	+46.8	+42.7	+38.2	+35.3	+30.0	+23.2	+7.7	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 22 , transformer (gt3), CONTRIBUTES:
SOUND PRESSURE LEVEL = +42.8 DB SOUND LEVEL = +32.7 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+31.2	+37.2	+39.1	+33.6	+32.8	+25.5	+17.8	+2.8	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 21 , transformer (gt2), CONTRIBUTES:
SOUND PRESSURE LEVEL = +42.5 DB SOUND LEVEL = +32.3 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+30.9	+36.8	+38.7	+33.2	+32.3	+25.1	+17.2	+1.8	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 13 , turbine bldg east wall, CONTRIBUTES:
SOUND PRESSURE LEVEL = +51.1 DB SOUND LEVEL = +31.9 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+47.4	+46.4	+44.3	+33.8	+27.0	+21.8	+16.2	+2.4	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 20 , transformer (gt1), CONTRIBUTES:
SOUND PRESSURE LEVEL = +42.0 DB SOUND LEVEL = +31.7 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+30.4	+36.3	+38.2	+32.7	+31.8	+24.4	+16.5	+0.4	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 15 , turbine bldg west wall, CONTRIBUTES:
SOUND PRESSURE LEVEL = +50.9 DB SOUND LEVEL = +31.7 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+47.2	+46.2	+44.1	+33.6	+26.8	+21.5	+15.8	+1.8	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 14 , turbine bldg south wall, CONTRIBUTES:
SOUND PRESSURE LEVEL = +46.1 DB SOUND LEVEL = +27.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+42.4	+41.4	+39.3	+28.9	+22.2	+17.1	+11.7	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 3 , stack 3, CONTRIBUTES:
SOUND PRESSURE LEVEL = +51.7 DB SOUND LEVEL = +27.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+50.5	+44.4	+38.3	+27.9	+21.1	+16.9	+16.2	+5.5	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 2 , stack 2, CONTRIBUTES:
SOUND PRESSURE LEVEL = +51.7 DB SOUND LEVEL = +27.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+50.5	+44.4	+38.3	+27.9	+21.0	+16.8	+16.2	+5.4	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 1 , stack 1, CONTRIBUTES:
SOUND PRESSURE LEVEL = +51.6 DB SOUND LEVEL = +26.9 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
31.5 63 125 250 500 1K 2K 4K 8K 16K HERTZ
+50.4 +44.3 +38.2 +27.8 +20.9 +16.7 +16.1 +5.2 +0.0 +0.0
NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 16 , turbine bldg north wall, CONTRIBUTES:
SOUND PRESSURE LEVEL = +44.1 DB SOUND LEVEL = +24.8 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
31.5 63 125 250 500 1K 2K 4K 8K 16K HERTZ
+40.5 +39.4 +37.3 +26.8 +19.9 +14.5 +8.6 +0.0 +0.0 +0.0
NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 19 , air inlet gt3, CONTRIBUTES:
SOUND PRESSURE LEVEL = +36.2 DB SOUND LEVEL = +23.9 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
31.5 63 125 250 500 1K 2K 4K 8K 16K HERTZ
+32.6 +31.5 +24.4 +26.0 +23.2 +17.0 +13.4 +3.8 +0.0 +0.0
NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 18 , air inlet gt2, CONTRIBUTES:
SOUND PRESSURE LEVEL = +35.7 DB SOUND LEVEL = +23.3 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
31.5 63 125 250 500 1K 2K 4K 8K 16K HERTZ
+32.1 +31.0 +23.9 +25.4 +22.6 +16.3 +12.6 +2.3 +0.0 +0.0
NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 17 , air inlet gt1, CONTRIBUTES:
SOUND PRESSURE LEVEL = +35.2 DB SOUND LEVEL = +22.7 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
31.5 63 125 250 500 1K 2K 4K 8K 16K HERTZ
+31.6 +30.5 +23.4 +24.9 +22.0 +15.7 +11.8 +1.0 +0.0 +0.0
NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 11 , bfw pump 5, CONTRIBUTES:
SOUND PRESSURE LEVEL = +32.1 DB SOUND LEVEL = +17.9 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
31.5 63 125 250 500 1K 2K 4K 8K 16K HERTZ
+28.8 +27.7 +21.6 +18.2 +15.4 +13.2 +8.7 +0.0 +0.0 +0.0
NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 12 , bfw pump 6, CONTRIBUTES:
SOUND PRESSURE LEVEL = +32.1 DB SOUND LEVEL = +17.9 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
31.5 63 125 250 500 1K 2K 4K 8K 16K HERTZ
+28.8 +27.7 +21.6 +18.2 +15.4 +13.2 +8.7 +0.0 +0.0 +0.0
NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 9 , bfw pump 3, CONTRIBUTES:
SOUND PRESSURE LEVEL = +31.6 DB SOUND LEVEL = +17.3 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
31.5 63 125 250 500 1K 2K 4K 8K 16K HERTZ
+28.3 +27.2 +21.1 +17.6 +14.8 +12.6 +7.8 +0.0 +0.0 +0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 10 , bfw pump 4, CONTRIBUTES:
SOUND PRESSURE LEVEL = +31.5 DB SOUND LEVEL = +17.2 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+28.2	+27.2	+21.1	+17.6	+14.8	+12.5	+7.8	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 7 , bfw pump 1, CONTRIBUTES:
SOUND PRESSURE LEVEL = +31.3 DB SOUND LEVEL = +17.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+28.0	+27.0	+20.9	+17.4	+14.5	+12.3	+7.5	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 8 , bfw pump 2, CONTRIBUTES:
SOUND PRESSURE LEVEL = +31.3 DB SOUND LEVEL = +17.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+28.0	+27.0	+20.8	+17.4	+14.5	+12.3	+7.5	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 25 , transformer (svc sta 2), CONTRIBUTES:
SOUND PRESSURE LEVEL = +17.8 DB SOUND LEVEL = +7.7 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+6.2	+12.2	+14.0	+8.6	+7.7	+0.5	+0.0	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 2 Nearest Residential South
SOURCE # 24 , transformer (svc sta), CONTRIBUTES:
SOUND PRESSURE LEVEL = +17.3 DB SOUND LEVEL = +7.2 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+5.8	+11.7	+13.6	+8.1	+7.2	+0.0	+0.0	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

```
02-10-2000  11:53:30
bowline noise
run #3
contains turbine building as a barrier for Mackey Ct
 dBA control on stacks
 A control on transformers (quieted design)
Program <NCALC591>
INPUT FILES
 SOURCE - bowline.sou  RECEPTOR - bowline.rec   BARRIER - bowline.bar

AT RECEIVER # 3  Jefferson Street

WITH THE BACKGROUND NOISE (IF ANY)
SOUND PRESSURE LEVEL =  +58.7 DB          SOUND LEVEL =  +42.1 DBA

WITHOUT THE BACKGROUND NOISE
SOUND PRESSURE LEVEL =  +58.7 DB          SOUND LEVEL =  +42.1 DBA

THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +56.4 +52.3 +49.4 +43.2 +40.5 +35.6 +30.7 +15.9  +0.0  +0.0


RECEIVER # 3   Jefferson Street
SOURCE # 26 , circ. pumps (combined), CONTRIBUTES:
SOUND PRESSURE LEVEL =  +39.2 DB          SOUND LEVEL =  +34.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +28.9 +30.9 +32.7 +32.2 +31.2 +29.8 +26.7 +12.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 3   Jefferson Street
SOURCE # 6 , hrsg 3, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +50.8 DB          SOUND LEVEL =  +33.1 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +49.1 +44.0 +39.8 +35.2 +32.0 +26.2 +18.3  +0.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 3   Jefferson Street
SOURCE # 23 , transformer (st), CONTRIBUTES:
SOUND PRESSURE LEVEL =  +43.5 DB          SOUND LEVEL =  +32.9 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +32.1 +38.0 +39.8 +34.2 +33.0 +25.2 +16.3  +0.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 3   Jefferson Street
SOURCE # 27 , makeup water pumps (combined), CONTRIBUTES:
SOUND PRESSURE LEVEL =  +37.6 DB          SOUND LEVEL =  +32.7 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +27.2 +29.2 +31.0 +30.6 +29.7 +28.5 +25.8 +12.7  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 3   Jefferson Street
SOURCE # 5 , hrsg 2, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +50.5 DB          SOUND LEVEL =  +32.6 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +48.8 +43.7 +39.5 +34.8 +31.5 +25.7 +17.7  +0.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 3   Jefferson Street
SOURCE # 4 , hrsg 1, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +50.2 DB          SOUND LEVEL =  +32.2 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +48.4 +43.3 +39.1 +34.5 +31.1 +25.2 +17.0  +0.0  +0.0  +0.0
```

```
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 3   Jefferson Street
SOURCE # 22 , transformer (gt3), CONTRIBUTES:
SOUND PRESSURE LEVEL =  +39.1 DB          SOUND LEVEL =  +28.3 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +27.6 +33.6 +35.4 +29.7 +28.4 +20.6 +11.5  +0.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 3   Jefferson Street
SOURCE # 21 , transformer (gt2), CONTRIBUTES:
SOUND PRESSURE LEVEL =  +38.8 DB          SOUND LEVEL =  +28.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +27.4 +33.3 +35.1 +29.5 +28.1 +20.2 +11.0  +0.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 3   Jefferson Street
SOURCE # 13 , turbine bldg east wall, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +47.4 DB          SOUND LEVEL =  +27.8 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +43.8 +42.7 +40.5 +29.9 +22.6 +16.8  +9.8  +0.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 3   Jefferson Street
SOURCE # 15 , turbine bldg west wall, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +47.3 DB          SOUND LEVEL =  +27.7 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +43.7 +42.6 +40.4 +29.7 +22.4 +16.6  +9.5  +0.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 3   Jefferson Street
SOURCE # 20 , transformer (gt1), CONTRIBUTES:
SOUND PRESSURE LEVEL =  +38.5 DB          SOUND LEVEL =  +27.7 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +27.1 +33.0 +34.8 +29.1 +27.7 +19.7 +10.4  +0.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 3   Jefferson Street
SOURCE # 3 , stack 3, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +48.1 DB          SOUND LEVEL =  +22.8 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +46.9 +40.8 +34.6 +24.0 +16.7 +11.9  +9.9  +0.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 3   Jefferson Street
SOURCE # 2 , stack 2, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +48.1 DB          SOUND LEVEL =  +22.8 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +46.9 +40.8 +34.6 +24.0 +16.7 +11.9  +9.9  +0.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 3   Jefferson Street
SOURCE # 1 , stack 1, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +48.0 DB          SOUND LEVEL =  +22.8 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +46.8 +40.7 +34.6 +23.9 +16.7 +11.8  +9.8  +0.0  +0.0  +0.0
```

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 3 Jefferson Street
SOURCE # 14 , turbine bldg south wall, CONTRIBUTES:
SOUND PRESSURE LEVEL = +42.0 DB SOUND LEVEL = +22.5 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
31.5 63 125 250 500 1K 2K 4K 8K 16K HERTZ
+38.4 +37.3 +35.2 +24.6 +17.4 +11.7 +4.9 +0.0 +0.0 +0.0
NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 3 Jefferson Street
SOURCE # 16 , turbine bldg north wall, CONTRIBUTES:
SOUND PRESSURE LEVEL = +40.8 DB SOUND LEVEL = +21.1 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
31.5 63 125 250 500 1K 2K 4K 8K 16K HERTZ
+37.2 +36.1 +33.9 +23.2 +15.8 +9.8 +2.5 +0.0 +0.0 +0.0
NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 3 Jefferson Street
SOURCE # 19 , air inlet gt3, CONTRIBUTES:
SOUND PRESSURE LEVEL = +32.4 DB SOUND LEVEL = +19.2 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
31.5 63 125 250 500 1K 2K 4K 8K 16K HERTZ
+28.9 +27.8 +20.6 +22.0 +18.7 +11.9 +6.9 +0.0 +0.0 +0.0
NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 3 Jefferson Street
SOURCE # 18 , air inlet gt2, CONTRIBUTES:
SOUND PRESSURE LEVEL = +32.1 DB SOUND LEVEL = +18.8 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
31.5 63 125 250 500 1K 2K 4K 8K 16K HERTZ
+28.5 +27.4 +20.3 +21.6 +18.3 +11.4 +6.2 +0.0 +0.0 +0.0
NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 3 Jefferson Street
SOURCE # 17 , air inlet gt1, CONTRIBUTES:
SOUND PRESSURE LEVEL = +31.7 DB SOUND LEVEL = +18.4 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
31.5 63 125 250 500 1K 2K 4K 8K 16K HERTZ
+28.2 +27.1 +19.9 +21.2 +17.9 +10.9 +5.6 +0.0 +0.0 +0.0
NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 3 Jefferson Street
SOURCE # 11 , bfw pump 5, CONTRIBUTES:
SOUND PRESSURE LEVEL = +28.3 DB SOUND LEVEL = +13.1 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
31.5 63 125 250 500 1K 2K 4K 8K 16K HERTZ
+25.0 +23.9 +17.8 +14.1 +10.9 +8.1 +2.2 +0.0 +0.0 +0.0
NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 3 Jefferson Street
SOURCE # 12 , bfw pump 6, CONTRIBUTES:
SOUND PRESSURE LEVEL = +28.3 DB SOUND LEVEL = +13.1 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
31.5 63 125 250 500 1K 2K 4K 8K 16K HERTZ
+25.0 +23.9 +17.8 +14.1 +10.9 +8.1 +2.2 +0.0 +0.0 +0.0
NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 3 Jefferson Street
SOURCE # 9 , bfw pump 3, CONTRIBUTES:
SOUND PRESSURE LEVEL = +27.9 DB SOUND LEVEL = +12.6 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
31.5 63 125 250 500 1K 2K 4K 8K 16K HERTZ
+24.7 +23.6 +17.4 +13.8 +10.5 +7.6 +1.6 +0.0 +0.0 +0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 3 Jefferson Street
SOURCE # 10 , bfw pump 4, CONTRIBUTES:
SOUND PRESSURE LEVEL = +27.9 DB SOUND LEVEL = +12.6 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+24.7	+23.6	+17.4	+13.8	+10.5	+7.6	+1.5	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 3 Jefferson Street
SOURCE # 7 , bfw pump 1, CONTRIBUTES:
SOUND PRESSURE LEVEL = +27.8 DB SOUND LEVEL = +12.4 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+24.6	+23.5	+17.3	+13.6	+10.3	+7.4	+1.3	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 3 Jefferson Street
SOURCE # 8 , bfw pump 2, CONTRIBUTES:
SOUND PRESSURE LEVEL = +27.8 DB SOUND LEVEL = +12.4 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+24.5	+23.5	+17.3	+13.6	+10.3	+7.4	+1.3	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 3 Jefferson Street
SOURCE # 25 , transformer (svc sta 2), CONTRIBUTES:
SOUND PRESSURE LEVEL = +14.0 DB SOUND LEVEL = +3.3 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+2.6	+8.5	+10.4	+4.7	+3.4	+0.0	+0.0	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 3 Jefferson Street
SOURCE # 24 , transformer (svc sta), CONTRIBUTES:
SOUND PRESSURE LEVEL = +13.7 DB SOUND LEVEL = +2.9 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+2.3	+8.2	+10.0	+4.4	+3.0	+0.0	+0.0	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

```
02-10-2000  11:53:34
bowline noise
run #3
contains turbine building as a barrier for Mackey Ct
 dBA control on stacks
 A control on transformers (quieted design)
rogram <NCALC591>
INPUT FILES
 SOURCE - bowline.sou  RECEPTOR - bowline.rec   BARRIER - bowline.bar

AT RECEIVER # 4  St Peters School/Church

WITH THE BACKGROUND NOISE (IF ANY)
SOUND PRESSURE LEVEL =  +60.1 DB          SOUND LEVEL =  +43.5 DBA

WITHOUT THE BACKGROUND NOISE
SOUND PRESSURE LEVEL =  +60.1 DB          SOUND LEVEL =  +43.5 DBA

THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +57.9 +53.8 +51.0 +44.7 +42.2 +36.8 +31.1 +15.4  +0.0  +0.0


RECEIVER # 4   St Peters School/Church
SOURCE # 23 , transformer (st), CONTRIBUTES:
SOUND PRESSURE LEVEL =  +45.7 DB          SOUND LEVEL =  +35.4 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +34.1 +40.0 +41.9 +36.4 +35.4 +28.0 +20.0  +3.5  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 4   St Peters School/Church
SOURCE # 6 , hrsg 3, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +52.4 DB          SOUND LEVEL =  +35.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
   0.7 +45.6 +41.4 +36.9 +33.9 +28.4 +21.2  +4.1  +0.0  +0.0
    BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 4   St Peters School/Church
SOURCE # 5 , hrsg 2, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +52.0 DB          SOUND LEVEL =  +34.5 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +50.2 +45.1 +41.0 +36.4 +33.4 +27.8 +20.4  +2.7  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 4   St Peters School/Church
SOURCE # 4 , hrsg 1, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +51.6 DB          SOUND LEVEL =  +34.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +49.8 +44.7 +40.6 +36.0 +32.9 +27.2 +19.7  +1.4  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 4   St Peters School/Church
SOURCE # 26 , circ. pumps (combined), CONTRIBUTES:
SOUND PRESSURE LEVEL =  +38.5 DB          SOUND LEVEL =  +33.1 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +28.3 +30.3 +32.1 +31.6 +30.5 +29.0 +25.6 +10.1  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


   IVER # 4   St Peters School/Church
   RCE # 27 , makeup water pumps (combined), CONTRIBUTES:
SOUND PRESSURE LEVEL =  +36.5 DB          SOUND LEVEL =  +31.4 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +26.2 +28.2 +30.0 +29.5 +28.6 +27.2 +24.1  +9.9  +0.0  +0.0
```

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 4 St Peters School/Church
SOURCE # 22 , transformer (gt3), CONTRIBUTES:
SOUND PRESSURE LEVEL = +41.0 DB SOUND LEVEL = +30.6 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+29.5	+35.4	+37.3	+31.7	+30.7	+23.2	+14.9	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 4 St Peters School/Church
SOURCE # 21 , transformer (gt2), CONTRIBUTES:
SOUND PRESSURE LEVEL = +40.7 DB SOUND LEVEL = +30.2 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+29.2	+35.1	+36.9	+31.4	+30.3	+22.7	+14.3	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 4 St Peters School/Church
SOURCE # 20 , transformer (gt1), CONTRIBUTES:
SOUND PRESSURE LEVEL = +40.2 DB SOUND LEVEL = +29.7 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+28.8	+34.7	+36.5	+30.9	+29.8	+22.2	+13.6	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 4 St Peters School/Church
SOURCE # 15 , turbine bldg west wall, CONTRIBUTES:
SOUND PRESSURE LEVEL = +49.1 DB SOUND LEVEL = +29.7 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+45.4	+44.4	+42.2	+31.7	+24.6	+19.1	+12.8	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 4 St Peters School/Church
SOURCE # 13 , turbine bldg east wall, CONTRIBUTES:
SOUND PRESSURE LEVEL = +49.0 DB SOUND LEVEL = +29.6 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+45.4	+44.3	+42.1	+31.6	+24.5	+19.0	+12.7	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 4 St Peters School/Church
SOURCE # 14 , turbine bldg south wall, CONTRIBUTES:
SOUND PRESSURE LEVEL = +44.0 DB SOUND LEVEL = +24.7 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+40.3	+39.3	+37.1	+26.7	+19.7	+14.3	+8.3	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 4 St Peters School/Church
SOURCE # 3 , stack 3, CONTRIBUTES:
SOUND PRESSURE LEVEL = +49.3 DB SOUND LEVEL = +24.3 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+48.2	+42.1	+35.9	+25.4	+18.3	+13.7	+12.3	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 4 St Peters School/Church
SOURCE # 2 , stack 2, CONTRIBUTES:
SOUND PRESSURE LEVEL = +49.3 DB SOUND LEVEL = +24.3 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+48.1	+42.0	+35.9	+25.3	+18.2	+13.7	+12.2	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 4 St Peters School/Church
SOURCE # 1 , stack 1, CONTRIBUTES:
SOUND PRESSURE LEVEL = +49.3 DB SOUND LEVEL = +24.2 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+48.1	+42.0	+35.8	+25.3	+18.2	+13.6	+12.1	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 4 St Peters School/Church
SOURCE # 16 , turbine bldg north wall, CONTRIBUTES:
SOUND PRESSURE LEVEL = +42.3 DB SOUND LEVEL = +22.8 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+38.7	+37.6	+35.4	+24.8	+17.7	+12.0	+5.4	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 4 St Peters School/Church
SOURCE # 19 , air inlet gt3, CONTRIBUTES:
SOUND PRESSURE LEVEL = +34.4 DB SOUND LEVEL = +21.7 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+30.8	+29.7	+22.6	+24.1	+21.1	+14.6	+10.4	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 4 St Peters School/Church
SOURCE # 18 , air inlet gt2, CONTRIBUTES:
SOUND PRESSURE LEVEL = +33.9 DB SOUND LEVEL = +21.1 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+30.3	+29.3	+22.1	+23.6	+20.5	+14.0	+9.6	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 4 St Peters School/Church
SOURCE # 17 , air inlet gt1, CONTRIBUTES:
SOUND PRESSURE LEVEL = +33.5 DB SOUND LEVEL = +20.6 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+29.9	+28.8	+21.7	+23.1	+20.0	+13.4	+8.9	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 4 St Peters School/Church
SOURCE # 12 , bfw pump 6, CONTRIBUTES:
SOUND PRESSURE LEVEL = +29.8 DB SOUND LEVEL = +15.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+26.5	+25.4	+19.3	+15.7	+12.7	+10.2	+4.9	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 4 St Peters School/Church
SOURCE # 11 , bfw pump 5, CONTRIBUTES:
SOUND PRESSURE LEVEL = +29.8 DB SOUND LEVEL = +15.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+26.5	+25.4	+19.3	+15.7	+12.7	+10.2	+4.9	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 4 St Peters School/Church
SOURCE # 10 , bfw pump 4, CONTRIBUTES:
SOUND PRESSURE LEVEL = +29.3 DB SOUND LEVEL = +14.4 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+26.1	+25.0	+18.8	+15.3	+12.2	+9.6	+4.1	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 4 St Peters School/Church
SOURCE # 9 , bfw pump 3, CONTRIBUTES:
SOUND PRESSURE LEVEL = +29.3 DB SOUND LEVEL = +14.4 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+26.1	+25.0	+18.8	+15.3	+12.2	+9.6	+4.1	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 4 St Peters School/Church
SOURCE # 8 , bfw pump 2, CONTRIBUTES:
SOUND PRESSURE LEVEL = +29.2 DB SOUND LEVEL = +14.2 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+25.9	+24.8	+18.7	+15.1	+12.0	+9.4	+3.8	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 4 St Peters School/Church
SOURCE # 7 , bfw pump 1, CONTRIBUTES:
SOUND PRESSURE LEVEL = +29.2 DB SOUND LEVEL = +14.2 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+25.9	+24.8	+18.7	+15.1	+12.0	+9.3	+3.8	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 4 St Peters School/Church
SOURCE # 25 , transformer (svc sta 2), CONTRIBUTES:
SOUND PRESSURE LEVEL = +16.0 DB SOUND LEVEL = +5.6 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+4.5	+10.4	+12.3	+6.7	+5.7	+0.0	+0.0	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 4 St Peters School/Church
SOURCE # 24 , transformer (svc sta), CONTRIBUTES:
SOUND PRESSURE LEVEL = +15.6 DB SOUND LEVEL = +5.1 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+4.1	+10.0	+11.8	+6.3	+5.2	+0.0	+0.0	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

```
02-10-2000  11:53:37
bowline noise
run #3
contains turbine building as a barrier for Mackey Ct
  BA control on stacks
  A control on transformers (quieted design)
Program <NCALC591>
INPUT FILES
 SOURCE - bowline.sou  RECEPTOR - bowline.rec   BARRIER - bowline.bar

AT RECEIVER # 5  Haverstraw Marina

WITH THE BACKGROUND NOISE (IF ANY)
SOUND PRESSURE LEVEL =  +59.8 DB          SOUND LEVEL =  +42.5 DBA

WITHOUT THE BACKGROUND NOISE
SOUND PRESSURE LEVEL =  +59.8 DB          SOUND LEVEL =  +42.5 DBA

THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +57.6 +53.5 +50.5 +44.1 +41.3 +35.5 +28.8 +11.3  +0.0  +0.0


RECEIVER # 5   Haverstraw Marina
SOURCE # 4 , hrsg 1, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +52.2 DB          SOUND LEVEL =  +34.7 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +50.5 +45.4 +41.2 +36.7 +33.6 +28.1 +20.8  +3.5  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 5   Haverstraw Marina
SOURCE # 5 , hrsg 2, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +51.8 DB          SOUND LEVEL =  +34.2 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
   0.0 +44.9 +40.8 +36.2 +33.1 +27.5 +20.0  +2.1  +0.0  +0.0
    BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 5   Haverstraw Marina
SOURCE # 6 , hrsg 3, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +51.4 DB          SOUND LEVEL =  +33.7 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +49.6 +44.5 +40.4 +35.8 +32.6 +27.0 +19.3  +0.7  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 5   Haverstraw Marina
SOURCE # 23 , transformer (st), CONTRIBUTES:
SOUND PRESSURE LEVEL =  +43.7 DB          SOUND LEVEL =  +33.1 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +32.3 +38.2 +40.0 +34.4 +33.2 +25.5 +16.7  +0.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 5   Haverstraw Marina
SOURCE # 20 , transformer (gt1), CONTRIBUTES:
SOUND PRESSURE LEVEL =  +41.1 DB          SOUND LEVEL =  +30.7 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +29.5 +35.5 +37.3 +31.8 +30.8 +23.3 +15.0  +0.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


   EIVER # 5   Haverstraw Marina
   RCE # 26 , circ. pumps (combined), CONTRIBUTES:
SOUND PRESSURE LEVEL =  +36.1 DB          SOUND LEVEL =  +30.2 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +26.3 +28.2 +30.0 +29.3 +28.0 +26.0 +21.8  +2.9  +0.0  +0.0
```

```
NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 5   Haverstraw Marina
SOURCE # 21 , transformer (gt2), CONTRIBUTES:
SOUND PRESSURE LEVEL =  +40.6 DB          SOUND LEVEL =  +30.2 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +29.1 +35.0 +36.9 +31.3 +30.2 +22.7 +14.2  +0.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 5   Haverstraw Marina
SOURCE # 22 , transformer (gt3), CONTRIBUTES:
SOUND PRESSURE LEVEL =  +40.3 DB          SOUND LEVEL =  +29.8 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +28.8 +34.7 +36.6 +31.0 +29.9 +22.2 +13.6  +0.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 5   Haverstraw Marina
SOURCE # 13 , turbine bldg east wall, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +48.5 DB          SOUND LEVEL =  +29.1 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +44.9 +43.8 +41.7 +31.1 +24.0 +18.3 +11.8  +0.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 5   Haverstraw Marina
SOURCE # 15 , turbine bldg west wall, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +48.5 DB          SOUND LEVEL =  +29.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +44.9 +43.8 +41.6 +31.0 +23.9 +18.3 +11.7  +0.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 5   Haverstraw Marina
SOURCE # 27 , makeup water pumps (combined), CONTRIBUTES:
SOUND PRESSURE LEVEL =  +32.2 DB          SOUND LEVEL =  +26.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +22.5 +24.4 +26.2 +25.4 +23.9 +21.8 +17.1  +0.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 5   Haverstraw Marina
SOURCE # 1 , stack 1, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +49.2 DB          SOUND LEVEL =  +24.1 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +48.0 +41.9 +35.8 +25.2 +18.1 +13.5 +12.0  +0.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 5   Haverstraw Marina
SOURCE # 2 , stack 2, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +49.1 DB          SOUND LEVEL =  +24.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +47.9 +41.9 +35.7 +25.1 +18.0 +13.4 +11.9  +0.0  +0.0  +0.0
 NO BARRIER FOR THIS RECPT./SOURCE


RECEIVER # 5   Haverstraw Marina
SOURCE # 3 , stack 3, CONTRIBUTES:
SOUND PRESSURE LEVEL =  +49.1 DB          SOUND LEVEL =  +24.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:
 31.5    63   125   250   500    1K    2K    4K    8K   16K HERTZ
 +47.9 +41.8 +35.7 +25.1 +18.0 +13.4 +11.9  +0.0  +0.0  +0.0
```

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 5 Haverstraw Marina
SOURCE # 16 , turbine bldg north wall, CONTRIBUTES:
SOUND PRESSURE LEVEL = +43.3 DB SOUND LEVEL = +23.9 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+39.6	+38.6	+36.4	+25.9	+18.9	+13.4	+7.1	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 5 Haverstraw Marina
SOURCE # 14 , turbine bldg south wall, CONTRIBUTES:
SOUND PRESSURE LEVEL = +41.7 DB SOUND LEVEL = +22.1 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+38.1	+37.0	+34.8	+24.2	+17.0	+11.2	+4.3	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 5 Haverstraw Marina
SOURCE # 17 , air inlet gt1, CONTRIBUTES:
SOUND PRESSURE LEVEL = +34.0 DB SOUND LEVEL = +21.2 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+30.4	+29.3	+22.1	+23.6	+20.5	+14.0	+9.7	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 5 Haverstraw Marina
SOURCE # 18 , air inlet gt2, CONTRIBUTES:
SOUND PRESSURE LEVEL = +33.5 DB SOUND LEVEL = +20.6 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+30.0	+28.9	+21.7	+23.2	+20.0	+13.4	+8.9	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 5 Haverstraw Marina
SOURCE # 19 , air inlet gt3, CONTRIBUTES:
SOUND PRESSURE LEVEL = +33.1 DB SOUND LEVEL = +20.1 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+29.5	+28.4	+21.3	+22.7	+19.5	+12.8	+8.1	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 5 Haverstraw Marina
SOURCE # 7 , bfw pump 1, CONTRIBUTES:
SOUND PRESSURE LEVEL = +29.6 DB SOUND LEVEL = +14.8 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+26.3	+25.3	+19.1	+15.6	+12.5	+10.0	+4.6	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 5 Haverstraw Marina
SOURCE # 8 , bfw pump 2, CONTRIBUTES:
SOUND PRESSURE LEVEL = +29.6 DB SOUND LEVEL = +14.8 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+26.3	+25.3	+19.1	+15.6	+12.5	+10.0	+4.6	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 5 Haverstraw Marina
SOURCE # 9 , bfw pump 3, CONTRIBUTES:
SOUND PRESSURE LEVEL = +29.4 DB SOUND LEVEL = +14.6 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+26.2	+25.1	+18.9	+15.4	+12.3	+9.7	+4.3	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 5 Haverstraw Marina
SOURCE # 10 , bfw pump 4, CONTRIBUTES:
SOUND PRESSURE LEVEL = +29.4 DB SOUND LEVEL = +14.6 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+26.2	+25.1	+18.9	+15.4	+12.3	+9.7	+4.3	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 5 Haverstraw Marina
SOURCE # 11 , bfw pump 5, CONTRIBUTES:
SOUND PRESSURE LEVEL = +29.0 DB SOUND LEVEL = +14.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+25.8	+24.7	+18.5	+14.9	+11.8	+9.1	+3.5	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 5 Haverstraw Marina
SOURCE # 12 , bfw pump 6, CONTRIBUTES:
SOUND PRESSURE LEVEL = +29.0 DB SOUND LEVEL = +14.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+25.8	+24.7	+18.5	+14.9	+11.8	+9.1	+3.5	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 5 Haverstraw Marina
SOURCE # 24 , transformer (svc sta), CONTRIBUTES:
SOUND PRESSURE LEVEL = +15.7 DB SOUND LEVEL = +5.3 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+4.2	+10.1	+12.0	+6.4	+5.4	+0.0	+0.0	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

RECEIVER # 5 Haverstraw Marina
SOURCE # 25 , transformer (svc sta 2), CONTRIBUTES:
SOUND PRESSURE LEVEL = +15.3 DB SOUND LEVEL = +4.8 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+3.8	+9.7	+11.6	+6.0	+4.9	+0.0	+0.0	+0.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

bowline noise
run #3
contains turbine building as a barrier for Mackey Ct
15 dBA control on stacks
[illegible]A control on transformers (quieted design)
program <NCALC591>

02-10-2000 11:53:37
bowline noise
run #3
contains turbine building as a barrier for Mackey Ct
[illegible]dBA control on stacks
[illegible]BA control on transformers (quieted design)
INPUT FILES
SOURCE - bowline.sou RECEPTOR - bowline.rec BARRIER - bowline.bar

RESULTS SUMMARY

RECEIVER	S.PRESSURE LEV.(DB) W/ BCKGND	S.PRESSURE LEV.(DB) W/O BCKGRN	SOUND LEVEL (DBA) W/ BCKGND	SOUND LEVEL (DBA) W/O BCKGND
# 1 Mackey Court	+62.7	+62.7	+46.9	+46.9
# 2 Nearest Residential South	+62.3	+62.3	+46.8	+46.8
# 3 Jefferson Street	+58.7	+58.7	+42.1	+42.1
# 4 St Peters School/Church	+60.1	+60.1	+43.5	+43.5
# 5 Haverstraw Marina	+59.8	+59.8	+42.5	+42.5

SOURCE 1 cooling tower SOUND PWR LEVEL= +125.3 DB

COOLING TOWER

* RESULTS *

Program <NCALC591>
10-2000 11:59:00
UT FILES
SOURCE - bowcool.sou RECEPTOR - bowline.rec BARRIER - bowline.bar
bowline cooling tower noise
run #2
cooling tower with some control and with path specific attenuation
at McKenzie Ave to account for short end of tower (3 dB)
no barrier effects

02-10-2000 11:59:03
bowline cooling tower noise
run #2
cooling tower with some control and with path specific attenuation
McKenzie Ave to account for short end of tower (3 dB)
arrier effects
Program <NCALC591>
INPUT FILES
SOURCE - bowcool.sou RECEPTOR - bowline.rec BARRIER - bowline.bar

AT RECEIVER # 1 Mackey Court

WITH THE BACKGROUND NOISE (IF ANY)
SOUND PRESSURE LEVEL = +59.6 DB SOUND LEVEL = +44.0 DBA

WITHOUT THE BACKGROUND NOISE
SOUND PRESSURE LEVEL = +59.6 DB SOUND LEVEL = +44.0 DBA

THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+53.6	+56.5	+52.4	+45.9	+39.8	+38.3	+33.1	+21.9	+0.0	+0.0

RECEIVER # 1 Mackey Court
SOURCE # 1 , cooling tower, CONTRIBUTES:
SOUND PRESSURE LEVEL = +59.6 DB SOUND LEVEL = +44.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+53.6	+56.5	+52.4	+45.9	+39.8	+38.3	+33.1	+21.9	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

02-10-2000 11:59:06
bowline cooling tower noise
run #2
cooling tower with some control and with path specific attenuation
cKenzie Ave to account for short end of tower (3 dB)
arrier effects
Program <NCALC591>
INPUT FILES
SOURCE - bowcool.sou RECEPTOR - bowline.rec BARRIER - bowline.bar

AT RECEIVER # 2 Nearest Residential South

WITH THE BACKGROUND NOISE (IF ANY)
SOUND PRESSURE LEVEL = +62.0 DB SOUND LEVEL = +46.3 DBA

WITHOUT THE BACKGROUND NOISE
SOUND PRESSURE LEVEL = +62.0 DB SOUND LEVEL = +46.3 DBA

THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+56.9	+58.8	+53.7	+47.4	+41.8	+40.8	+36.8	+30.4	+0.9	+0.0

RECEIVER # 2 Nearest Residential South
SOURCE # 1 , cooling tower, CONTRIBUTES:
SOUND PRESSURE LEVEL = +62.0 DB SOUND LEVEL = +46.3 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+56.9	+58.8	+53.7	+47.4	+41.8	+40.8	+36.8	+30.4	+0.9	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

02-10-2000 11:59:09
bowline cooling tower noise
run #2
cooling tower with some control and with path specific attenuation
cKenzie Ave to account for short end of tower (3 dB)
arrier effects
Program <NCALC591>
INPUT FILES
SOURCE - bowcool.sou RECEPTOR - bowline.rec BARRIER - bowline.bar

AT RECEIVER # 3 Jefferson Street

WITH THE BACKGROUND NOISE (IF ANY)
SOUND PRESSURE LEVEL = +59.9 DB SOUND LEVEL = +44.4 DBA

WITHOUT THE BACKGROUND NOISE
SOUND PRESSURE LEVEL = +59.9 DB SOUND LEVEL = +44.4 DBA

THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+53.9	+56.9	+52.7	+46.2	+40.2	+38.8	+33.7	+23.0	+0.0	+0.0

RECEIVER # 3 Jefferson Street
SOURCE # 1 , cooling tower, CONTRIBUTES:
SOUND PRESSURE LEVEL = +59.9 DB SOUND LEVEL = +44.4 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+53.9	+56.9	+52.7	+46.2	+40.2	+38.8	+33.7	+23.0	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

```
02-10-2000  11:59:12
bowline cooling tower noise
run #2
cooling tower with some control and with path specific attenuation
McKenzie Ave to account for short end of tower (3 dB)
barrier effects
Program <NCALC591>
INPUT FILES
 SOURCE - bowcool.sou  RECEPTOR - bowline.rec   BARRIER - bowline.bar

AT RECEIVER # 4  St Peters School/Church

WITH THE BACKGROUND NOISE (IF ANY)
SOUND PRESSURE LEVEL =  +59.3 DB         SOUND LEVEL =  +43.6 DBA
```

WITHOUT THE BACKGROUND NOISE
SOUND PRESSURE LEVEL = +59.3 DB   SOUND LEVEL = +43.6 DBA

OCTAVE BAND SOUND PRESSURE LEVELS ARE:

5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
3.3	+56.2	+52.1	+45.6	+39.5	+37.9	+32.6	+21.1	+0.0	+0.0

RECEIVER # 4   St Peters School/Church
SOURCE # 1 , cooling tower, CONTRIBUTES:
SOUND PRESSURE LEVEL = +59.3 DB   SOUND LEVEL = +43.6 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+53.3	+56.2	+52.1	+45.6	+39.5	+37.9	+32.6	+21.1	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

02-10-2000 11:59:15
bowline cooling tower noise
run #2
cooling tower with some control and with path specific attenuation
cKenzie Ave to account for short end of tower (3 dB)
arrier effects
Program <NCALC591>
INPUT FILES
SOURCE - bowcool.sou RECEPTOR - bowline.rec BARRIER - bowline.bar

AT RECEIVER # 5 Haverstraw Marina

WITH THE BACKGROUND NOISE (IF ANY)
SOUND PRESSURE LEVEL = +57.2 DB SOUND LEVEL = +41.0 DBA

WITHOUT THE BACKGROUND NOISE
SOUND PRESSURE LEVEL = +57.2 DB SOUND LEVEL = +41.0 DBA

THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+51.3	+54.2	+50.0	+43.3	+37.0	+35.0	+28.7	+13.9	+0.0	+0.0

RECEIVER # 5 Haverstraw Marina
SOURCE # 1 , cooling tower, CONTRIBUTES:
SOUND PRESSURE LEVEL = +57.2 DB SOUND LEVEL = +41.0 DBA
THE OCTAVE BAND SOUND PRESSURE LEVELS ARE:

31.5	63	125	250	500	1K	2K	4K	8K	16K HERTZ
+51.3	+54.2	+50.0	+43.3	+37.0	+35.0	+28.7	+13.9	+0.0	+0.0

NO BARRIER FOR THIS RECPT./SOURCE

bowline cooling tower noise
run #2
cooling tower with some control and with path specific attenuation
at McKenzie Ave to account for short end of tower (3 dB)
[illegible] barrier effects
program <NCALC591>

02-10-2000 11:59:15
bowline cooling tower noise
run #2
cooling tower with some control and with path specific attenuation
McKenzie Ave to account for short end of tower (3 dB)
barrier effects
INPUT FILES
SOURCE - bowcool.sou RECEPTOR - bowline.rec BARRIER - bowline.bar

RESULTS SUMMARY

RECEIVER	S.PRESSURE LEV.(DB) W/ BCKGND	S.PRESSURE LEV.(DB) W/O BCKGRN	SOUND LEVEL (DBA) W/ BCKGND	SOUND LEVEL (DBA) W/O BCKGND
# 1 Mackey Court	+59.6	+59.6	+44.0	+44.0
# 2 Nearest Residential South	+62.0	+62.0	+46.3	+46.3
# 3 Jefferson Street	+59.9	+59.9	+44.4	+44.4
# 4 St Peters School/Church	+59.3	+59.3	+43.6	+43.6
# 5 Haverstraw Marina	+57.2	+57.2	+41.0	+41.0

Figure C-1

Project: Bowline Construction Noise Sources

Construction Phase: Grading and Excavation

All data are sound pressure levels at 50 feet

Source	Initial SPL(50ft)*	# On-site	Corr. For #	Usage Factor**	Adjusted dBA	Octave Band (Hz)*** 32	63	125	250	500	1k	2k	4k	8k	16k	Overall SPL (dBA)
Scraper	85	2	3.0	9	79.0	67	73	78	81	76	74	71	65	59	50	79
Bulldozer	85	3	4.8	8	81.8	70	76	81	84	79	77	74	68	62	53	82
Pickup Truck	65	8	9.0	8	66.0	54	60	65	68	63	61	58	52	46	37	66
Pile Driver	101	2	3.0	14	90.0	78	84	89	92	87	85	82	76	70	61	90
Grader	86	1	0.0	13	73.0	61	67	72	75	70	68	65	59	53	44	73
Loader	86	1	0.0	8	78.0	66	72	77	80	75	73	70	64	58	49	78
Backhoe	85	2	3.0	8	80.0	68	74	79	82	77	75	72	66	60	51	80
Dump Truck	85	3	4.8	8	81.8	70	76	81	84	79	77	74	68	62	53	82
Diesel Engine Spectrum Correction						-18	-12	-7	-4	-9	-11	-14	-20	-26	-35	

* From BBN, 1977 "Prediction of Noise from Power Plant Construction"
** From BBN, 1971 "Noise from Construction Equipment and Operations...."
*** Octave band data developed by applying the spectrum shape for diesel engine noise from BBN, 1977 and adjusting to obtain overall SPL at 50 feet.

Figure C-2

Project: Bowline Construction Noise Sources

Construction Phase: Concrete Pouring

All data are sound pressure levels at 50 feet

Source	Initial SPL(50ft)*	# On-site	Corr. For #	Usage Factor**	Adjusted dBA	Octave Band (Hz)*** 32	63	125	250	500	1k	2k	4k	8k	16k	Overall SPL (dBA)
Pickup Truck	65	8	9.0	8	66.0	54	60	65	68	63	61	58	52	46	37	66
Air Compressor	86	1	0.0	4	82.0	70	76	81	84	79	77	74	68	62	53	82
Concrete Mixer	85	4	6.0	4	87.0	75	81	86	89	84	82	79	73	67	58	87
Concrete Pump	82	1	0.0	4	78.0	66	72	77	80	75	73	70	64	58	49	78
Jack Hammer	88	0	#NUM!	14	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
Diesel Engine Spectrum Correction						-18	-12	-7	-4	-9	-11	-14	-20	-26	-35	

* From BBN, 1977 "Prediction of Noise from Power Plant Construction"
** From BBN, 1971 "Noise from Construction Equipment and Operations...."
*** Octave band data developed by applying the spectrum shape for diesel engine noise from BBN, 1977 and adjusting to obtain overall SPL at 50 feet.