GPU Nuclear Corporation

Update of Alternate Cooling Water System Study

For

Oyster Creek Nuclear Generating Station

Volume 2
Environmental Effects and Cost Analyses

August 1992

EBASCO

An ENSERCH® Engineering and Construction Company

GPU NUCLEAR CORPORATION

OYSTER CREEK NUCLEAR GENERATING STATION

UPDATE OF ALTERNATIVE COOLING WATER SYSTEM STUDY

VOLUME II

ENVIRONMENTAL EFFECTS AND COST ANALYSES

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VOLUME II - ENVIRONMENTAL EFFECTS AND COST ANALYSES

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1.0 INTRODUCTION

An Alternative Cooling Water System Study was prepared for the Oyster Creek Nuclear Generating Station in September 1977. That study presented the technical, economic and general environmental features of alternative cooling water systems. The alternatives evaluated in that study included Open Cycle (Once-Thru) Cooling Systems and Closed Cycle (Circulating) Cooling Systems.

This document presents an updated analysis of the environmental, economic and regulatory findings of the original study with respect to two cooling system alternatives: A natural draft cooling tower and round mechanical draft cooling towers. Based on revised technical data presented in Volume 1, this updated analysis is focused on atmospheric effects, noise effects, visual effects, terrestrial effects and socioeconomic effects. A review of pertinent environmental statutes and regulations is also presented to provide an outline of the potential licensing requirements for each of the two cooling system alternatives.

2.0 ATMOSPHERIC EFFECTS

Ebasco Environmental performed a cooling tower modeling analysis for the Oyster Creek Nuclear Generating Station (NGS) located in Forked River, New Jersey. The analysis was performed to determine the extent, duration and distribution of the following effects arising from operation of an on-site cooling tower:

1. Elevated Visible Plumes
2. Ground Level Fogging and Icing
3. Salt Deposition and Drift
4. Convective Instability, Cloud Growth and Precipitation Augmentation

These effects were evaluated for two alternative cooling tower designs: natural draft and round mechanical draft configurations. These cooling towers would be generally arranged about 300-500 feet west of US Route 9 and 7,000 feet east of the Garden State Parkway.

The effects of these cooling towers were evaluated using EPRI Seasonal/Annual Cooling Tower Impacts (SACTI) model code for fogging and icing effects and deposition of salts from cooling tower exhaust. This modeling methodology is discussed in Section 2.2.

2.1 COOLING TOWER DESIGN DATA

2.1.1 Round Mechanical Draft Cooling Towers

One alternative facility design utilizes two round mechanical draft cooling towers. Each tower would be designed to accommodate 12 cells for a total of 24 cells. The maximum heat rejection rate is 51.5 megawatts (MW) per cell which converts to 175.7 MMBtu/hr (1,236 MW per total system). Table 2-1 provides cooling tower design information and model input data for this system.

2.1.2 Natural Draft Cooling Towers

The other alternative configuration utilizes a single 600-foot-tall natural draft cooling tower. This one tower would cool with approximately the same heat rejection rate as the combined 24 mechanical draft cells. Table 2-2 provides cooling tower design information and model input data for this system. Appendix A contains the data sheets and water analysis used for performing this analysis.

TABLE 2-1

Oyster Creek Nuclear Generating Station
Cooling Tower Design

TYPE: ROUND MECHANICAL DRAFT

Seasonal Parameters	Winter	Spring/ Autumn	Summer
Total Heat Rejection Rate (MMBtu/hr)	4216	4216	4216
Cells Operating	24	24	24

Common Parameters (per cell):

Type	Round Mechanical Draft
Circulating Water	15,546 gpm
Makeup at rated capacity	557 gpm
Drift Rate	0.001%
Total Dissolved Solids	4.68% by mass (recirculating sea water)
Volume Flow	1,388,850 ACFM
Site Coordinates	39.81° N Latitude 74.21° W Longitude
Effective Air Flow*	741.3 kg/s
Tower Height	18.9 m
Tower Diameter	64.0 m
Cell Dimensions	14.1m-ht, 19.4m x 14.6m
Cell Fan Diameter	9.1
Time Zone	Eastern
Meteorological data reference height	10 m
Roughness height	10 cm
Mixing height type	Rural
Monthly Clearness Index	Atlantic City, NJ data
Daily Solar Energy Deposition	Atlantic City, NJ data

* *Model was run using worst-case effective air flow of 741.3 kg/s for all seasons.*

TABLE 2-2

Oyster Creek Nuclear Generating Station
Cooling Tower Design Data

TYPE: NATURAL DRAFT

Seasonal Parameters	Winter	Spring/ Autumn	Summer
Heat Rejection Rate (MMBtu/hr)*	4204	4204	4204

Common Parameters:

Type	Natural Draft
Circulating Water	416,200 gpm
Makeup at rated capacity	13,978 gpm
Drift Rate	0.001%
Total Dissolved Solids	4.68% by mass (recirculating sea water)
Volume Flow	31,676,526 ACFM
Site Coordinates	39.81 °N Latitude, 74.21 °W Longitude
Effective Air Flow	33,189 kg/s
Tower Height	182.9 m
Tower Diameter	72.2 m
Time Zone	Eastern
Meteorological data reference height	10 m
Roughness height	10 cm
Mixing height type	Rural
Monthly Clearness Index	Atlantic City, NJ data
Daily Solar Energy Deposition	Atlantic City, NJ data

* Model was run with worst-case effective air flow of 33,189 kg/s for all seasons.

2.2 MODEL DESCRIPTION

The Seasonal/Annual Cooling Tower (SACTI) computer program is a mathematical model for the prediction of the seasonal/annual physical impacts of cooling tower plumes, drift, fogging, icing, and shadowing. The SACTI model is aimed at providing predictions that may be used in the licensing of power plants with cooling towers. The submodels were based on the Argonne National Laboratory (ANL) cooling tower model, and provide improvements in theory and performance compared to other existing cooling tower plume prediction methods. Validation with field and laboratory data has been done in all situations where good quality data exist. The seasonal/annual methodology employs a technique which reduces the available meteorological record at a site to approximately 30-100 categories. The plume submodels are then run once for a representative of each category and results are summed to provide predictions for a season or a year.

The SACTI code provides estimates of potential adverse impacts which include:

- occurrence (frequency) of ground fogging,
- occurrence of rime icing,
- plume shadowing and solar energy loss,
- drift water deposition,
- dissolved minerals (salt) deposition, and,
- plume length frequency.

The model will calculate these impacts using a number of meteorological and operational parameters. Some of the more critical parameters include:

- wind speed and direction,
- dry bulb temperature and dew point depression,
- dry bulb and dew point temperature lapse rates,
- tower exit diameter, velocity and mixing ratio,
- tower heat rejection rating and mass of air flow,
- tower dimensions and orientation.

The SACTI code performs its calculations by numerically integrating a set of ordinary differential equations governing the tower plume properties such as mass flow rate, temperature and water vapor content, as a function of downwind distance along the plume trajectory. The diffusion of the plume in the atmosphere is assumed to be Gaussian in nature except where the plume is affected by the turbulence in the wake of the cooling tower structure itself. In the building wake, the SACTI code employs the downwash entrainment methodology as presented by J Halitsky,

"Wake and Dispersion Models for the EBR-II Building Complex", Atmospheric Environment Vol. 11 No. 7, pp-577-596, 1977.

The visible plume rise prediction algorithms were developed on a general Morton-Taylor-Turner model for a moist (i.e. saturated) buoyant plume. This plume rise model is presented in "Turbulent Gravitational Convection from Maintained and Instantaneous Sources", B Morton, G Taylor, J Turner, Proc. of Royal Society of London, Ser. A Vol. 234, pp 1-23, 1956. The plume rise algorithm considers both momentum and buoyant fluxes as well as the moisture flux.

The SACTI code handles drift deposition from a cooling tower using four basic sub-models. These sub-models account for plume dispersion, droplet breakaway from the saturated plume, and droplet evaporation and deposition. The SACTI code incorporates droplet dynamics and thermodynamics which include the evaporative loss from drift droplets, changing salinity (i.e. concentration of dissolved solids), and droplet transport and diffusion by the atmosphere.

The SACTI code also handles ground-level fogging and icing. The model, however, assumes that the tower will add negligible impact during conditions of natural fogging and/or icing, and therefore only addresses these conditions when the natural events are not occurring. Fogging occurs when the condensed plume from the cooling tower comes in contact with the ground level. Since the tower outlet is elevated, the point where ground fogging may occur will be some distance downwind. Icing occurs when the ambient temperature is at or below 32°F, and the cooling tower plume comes in contact with the ground. There are two general ways in which icing can occur; 1) Glaze icing occurs when the cooling tower drift droplets fall out of the plume and deposit as ice on a surface; and 2) Rime icing occurs when the saturated plume contacts the ground and forms a frost on a surface. This model does not address the occurrence of glaze ice, but only that of rime ice. However, the rate of drift from the tower is expected to be very low, due to high efficiency drift eliminators. Thus, the probability of occurrence of glace ice is expected to be very low and if it actually did occur, would impact an area smaller than that predicted for rime ice.

The model allows the treatment of any number of natural- or mechanical-draft cooling towers in any geometric orientation and requires a minimal amount of user input. The model encompasses four computer codes in which the output of one is the input for the next. The use of a sequence of four separate programs permits more flexibility to the user allowing the opportunity to better define the type and scale of printed output.

A more complete discussion of the SACTI code may be found in the "User's Manual: Cooling-Tower-Plume Prediction Code" prepared by Argonne National Laboratory, Argonne, Illinois;

Document Reference EPRI CS-3403-CCM, Project 906-1, April 1984 and Revision 1 - September 1987.

The potential for cooling tower impacts was assessed using a one-year meteorological record (on-site Oyster Creek NGS, surface data and Atlantic City moisture parameters and mixing heights for 1988). Exhibit 2-1 presents an annual windrose developed for the Oyster Creek NGS data. This figure indicates that, on an annual basis, westerly component winds predominate and a smaller directional peak of east-northeast winds is noticeable. These less common easterly winds are associated with storms originating from the northern Atlantic Ocean especially during the winter months (known as Northeasters). The model was run for the worst-case operating condition for the winter, spring, summer, and autumn seasons.

On-site Oyster Creek NGS data utilized in this analysis included wind speed, wind direction and dry bulb temperature. Because wet-bulb temperature was unavailable from the Oyster Creek NGS, wet-bulb temperature was used from Atlantic City located along the coast approximately 35 miles to the south. The SACTI model calculated Pasquill stability classes based upon these hybrid data from the two locations.

2.3 IMPACT ASSESSMENT/COOLING TOWER RESULTS

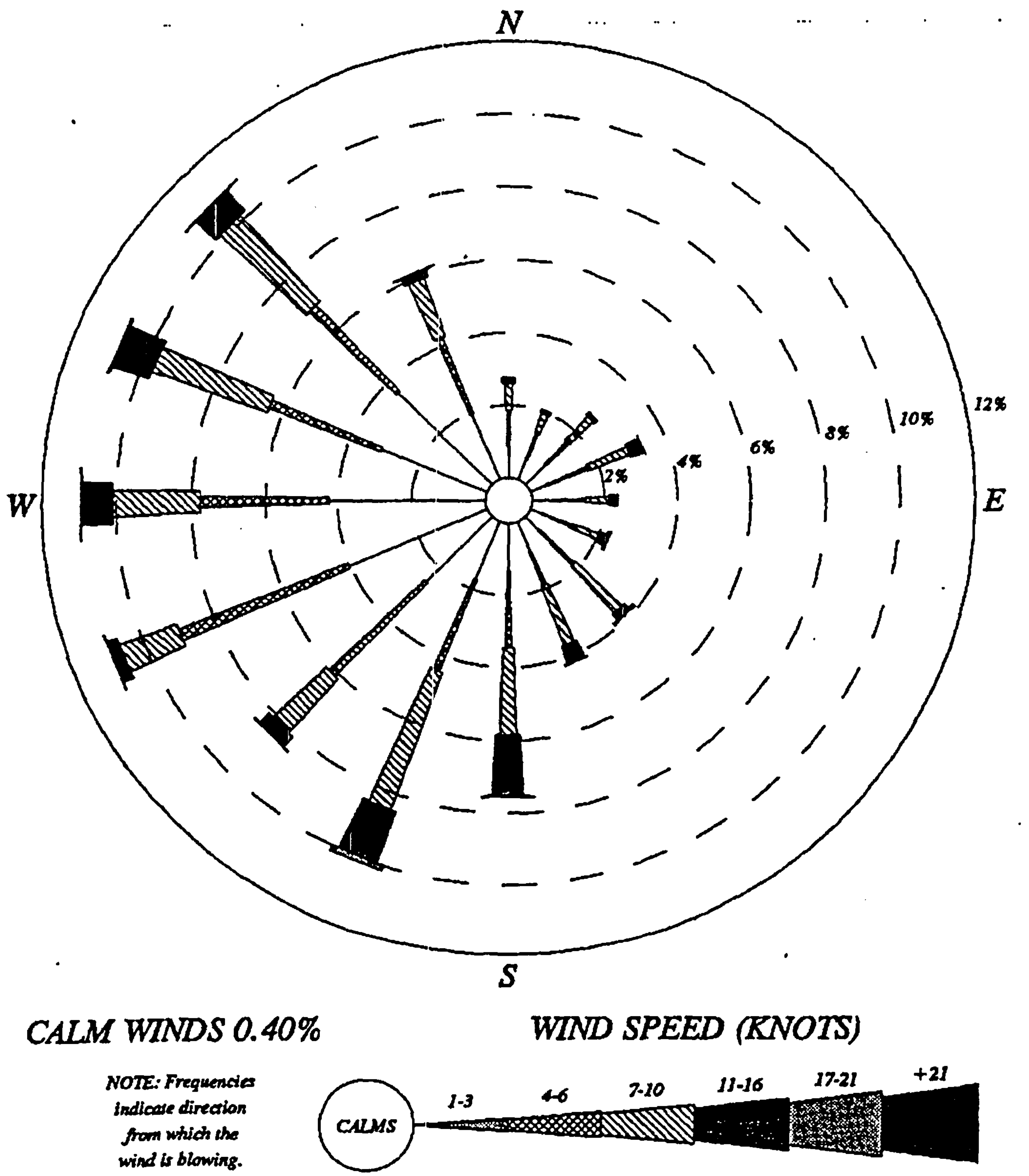
2.3.1 Round Mechanical Draft Cooling Towers

Fogging and Icing

The SACTI model was run with the round mechanical draft tower configuration for two towers. The towers' elevated plume length was predicted to exceed a distance of 400 meters 27 percent of the time (99 days). The direction of this plume is typically distributed in the easterly directions where public beaches are located, a function of the predominant westerly winds. The model also predicts that 20 percent of plumes exceed 3,000 meters and 13.5 percent will exceed 10,000 meters.

Plume shadowing occurs when the plume is of sufficient density to block sunlight and a discernible shadow is produced. At 1,000 meters from the towers, 48 hours/year of plume shadowing is predicted, and at 2,000 meters, 25 hours/year is expected. This effect drops off significantly until only 7 hours/year are predicted at 5,000 meters. The shadowing plumes were fairly evenly distributed with distance and direction.

The longer plume lengths and plume shadowing effects tend to occur when the ambient air is relatively saturated with moisture and cool in temperature. These conditions usually occur during



GPU Nuclear Corporation EBASCO An ENSERCH Engineering and Construction Company	ANNUAL WINDROSE-1988 OYSTER CREEK NUCLEAR GENERATING STATION	EXHIBIT 2-1

cloudy, overcast conditions and precipitation events. During these episodes, the plume would tend to be less noticeable but its origin would still be clearly discernible. Denser, longer plumes can also occur during stagnant, hazy and very humid conditions in the summer when the air cannot hold additional moisture. Again, during these periods, visibility is already compromised by natural conditions and any plume effects would be reduced.

Fogging and icing are more critical potential effects from the round mechanical draft cooling towers. The model predicted hours of fogging to be identical to hours of rime icing for this system. Therefore, all fogging effects occur when the temperature was below 32°F. Fogging/icing occurs for 1.7 hours/year at 100 meters and drops off to only 0.5 hours/year at 1,000 meters. These effects are considered minimal.

Salt Deposition

The cooling towers would utilize brackish water from the Oyster Creek NGS intake canal as a cooling medium which will be recycled two times through the tower system. The high salts content of the brackish makeup water and two cycles of concentration yields a relatively high salt deposition impact from the cooling tower. The highest average deposition by distance would occur at 700 meters (187 mg/m^2-month). The highest deposition by direction would be to the east at 700 meters (652 mg/m^2-month). The average annual deposition by distance is given below:

Distance (m)	Average Deposition (mg/m^2-year)
100	0.0
200	394
300	746
500	1654
700	2246
1000	1982
1500	648
2000	156

Appendix B provides the output data tables as calculated by the SACTI model for the round mechanical draft cooling towers.

2.3.2 Natural Draft Cooling Tower

Fogging and Icing

The predicted plume length characteristics associated with the natural draft cooling tower would be configured differently from that of the round mechanical draft cooling tower. With the natural draft cooling tower, the plume length would exceed 300 meters 99 percent of the year as opposed to 42 percent for the round mechanical draft cooling towers. Approximately 20 percent of the time the plume would exceed 1,500 meters in length and can be longer, especially in the easterly directions based upon prevailing westerly winds. At 10,000 meters, plumes would still be visible more than 10 percent of the time.

Plume shadowing would occur for 36 hours/year at 1,000 meters, and at distances out to over 5,000 meters, approximately 10 hours/year of shadowing was predicted. SACTI does not have an algorithm to predict fogging and icing impacts from a natural draft cooling tower, assuming such cooling towers do not cause any fogging or icing episodes.

Salt Deposition

The height of the natural draft cooling tower (600 feet) and the high velocity of the exhaust prevents salt deposition from occurring at distances less than 700 meters downwind. Therefore, no deposition was predicted for distances closer than 700 meters. The maximum average deposition occurs at 1,300 meters (53 mg/m^2-month). The highest deposition rate, occurs in the east direction at 1,300 meters downwind distance 181 mg/m^2-month. The average annual deposition by distance is given below:

Distance (m)	Average Deposition (mg/m^2-year)
700	168
1000	218
1300	633
1700	467
2300	192
5300	99

- The salt deposition from the natural draft cooling tower is much more widely distributed than that of the round mechanical draft cooling tower due to the higher plume release height and volume flow for the natural draft tower.

Appendix C provides the output data tables as calculated by the SACTI model for the natural draft cooling tower.

2.4 CONCLUSIONS

The cooling tower modeling study performed for the Oyster Creek Nuclear Generating Station predicted the effects of round mechanical draft cooling towers and a natural draft cooling tower configurations. Based upon these studies the following conclusions can be drawn:

- The round mechanical draft and natural draft cooling towers are predicted to yield visible plumes to over 10,000 meters for 13.5 and 10 percent of the year, respectively. The large heat rejection load and water flow through these systems cause such long plumes.

- No fogging or icing effects are expected to occur with the natural draft cooling tower. The round mechanical draft cooling towers are expected to create minimal fogging and icing effects (1.7 hours/year maximum).

- Plume shadowing is expected to significantly occur within 400 meters of the facility for both the natural draft and round mechanical draft cooling towers (129 and 116 hours/year, respectively). The natural draft tower shadowing episodes occur at closer distances to the facility whereas the round mechanical draft tower plume shadowing occurs at slightly longer distances.

- The round mechanical draft cooling towers would cause much higher salt deposition rates close to the facility (maximum deposition at 700 meters) relative to the natural draft cooling tower (maximum deposition at 1300 meters). Also, the relative magnitude of the deposition rates would be higher for the round mechanical draft cooling towers due primarily to their lower exhaust release height; the natural draft cooling tower would tend to disperse its salt load over a larger area. [The impact of salt deposition on vegetation is discussed in Chapter 5.]

Generally, visible plumes and shadowing can be considered significant visual effects of both cooling tower alternatives. These effects can be especially significant near the beach and recreational areas to the east. Fogging and icing effects are negligible for both systems.

The effects of salt deposition from cooling towers on the physical integrity and operation of the plant should be considered for all projects. This is especially true for systems utilizing sea water or brackish water as a cooling medium. While it is difficult to quantify these effects some general observations can be made in regard to salt deposition. Excessive salt deposition can affect the operation of electrical components including switchyard transformers and capacitors. Salt buildup can cause arcing, corona discharge and reduced efficiency of these components. However, these effects can be minimized by an adequate preventative maintenance program that includes removal of salt buildup on a routine basis. Since the mechanical draft towers were predicted to have the higher salt deposition rate that the natural draft towers, the effects to electrical components will be more pronounced with that system.

3.0 NOISE EFFECTS

The potential noise impacts of each of the two alternative cooling tower systems were evaluated by comparing the expected noise levels at the nearest noise-sensitive receptors (residential) with New Jersey state standards, Lacey Township standards and existing ambient noise levels.

The NOISECALC computer model, developed by the New York State Department of Public Service (Driscoll, 1985), was used to determine the expected noise levels from the two alternatives at the receptor locations. Source level data were provided by a cooling tower manufacturer (Dwyer, 1992).

Existing ambient noise levels were determined through a monitoring program conducted June 16-17, 1992, at the site and at the nearest sensitive receptors. The nearest receptors are about 2,250 feet (685 meters) northeast of the cooling tower site. Other residential receptors are located to the southeast about 3,500 feet (1,065 meters) from the site.

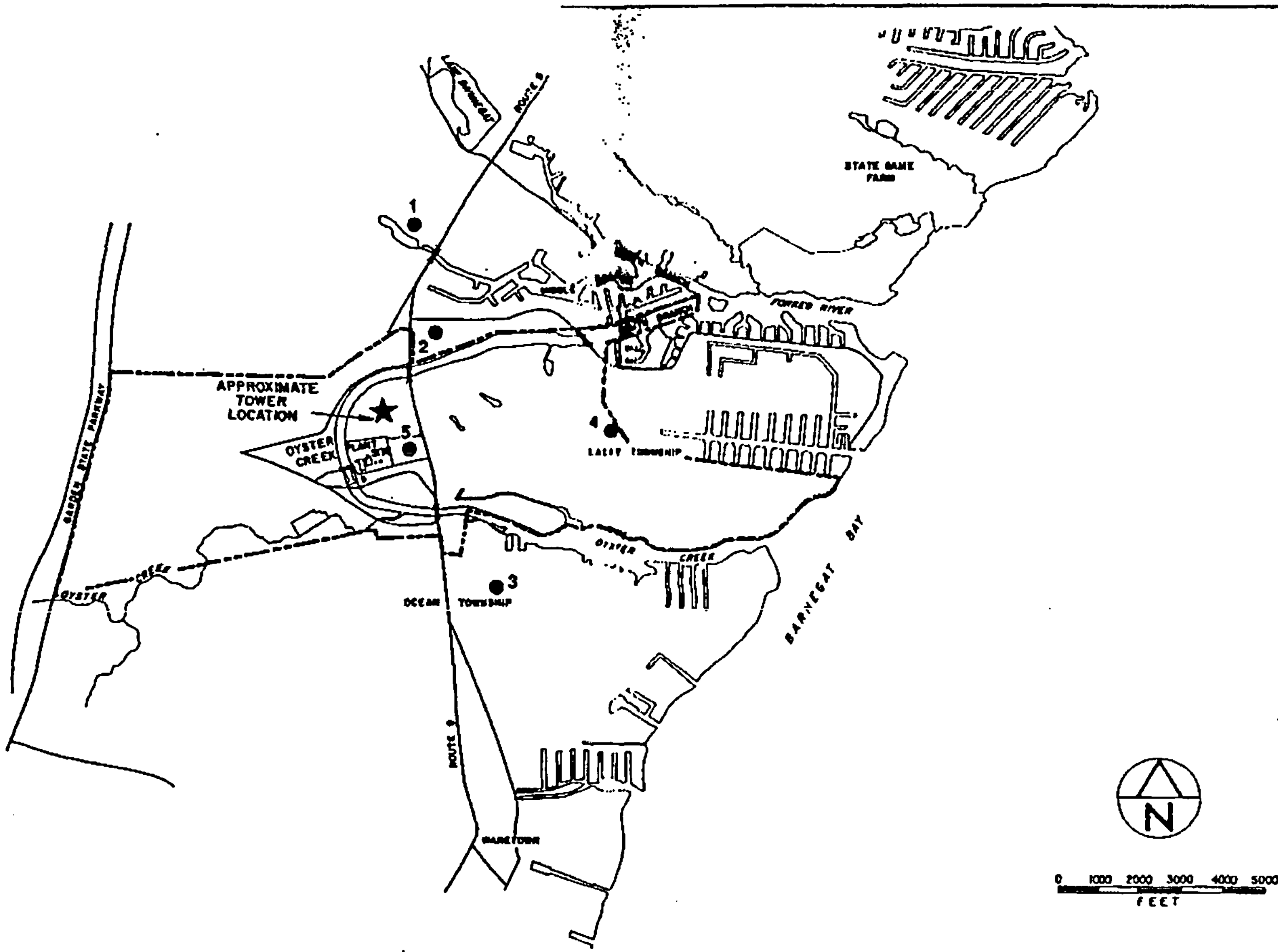
3.1 EXISTING CONDITIONS

3.1.1 Noise Monitoring Locations

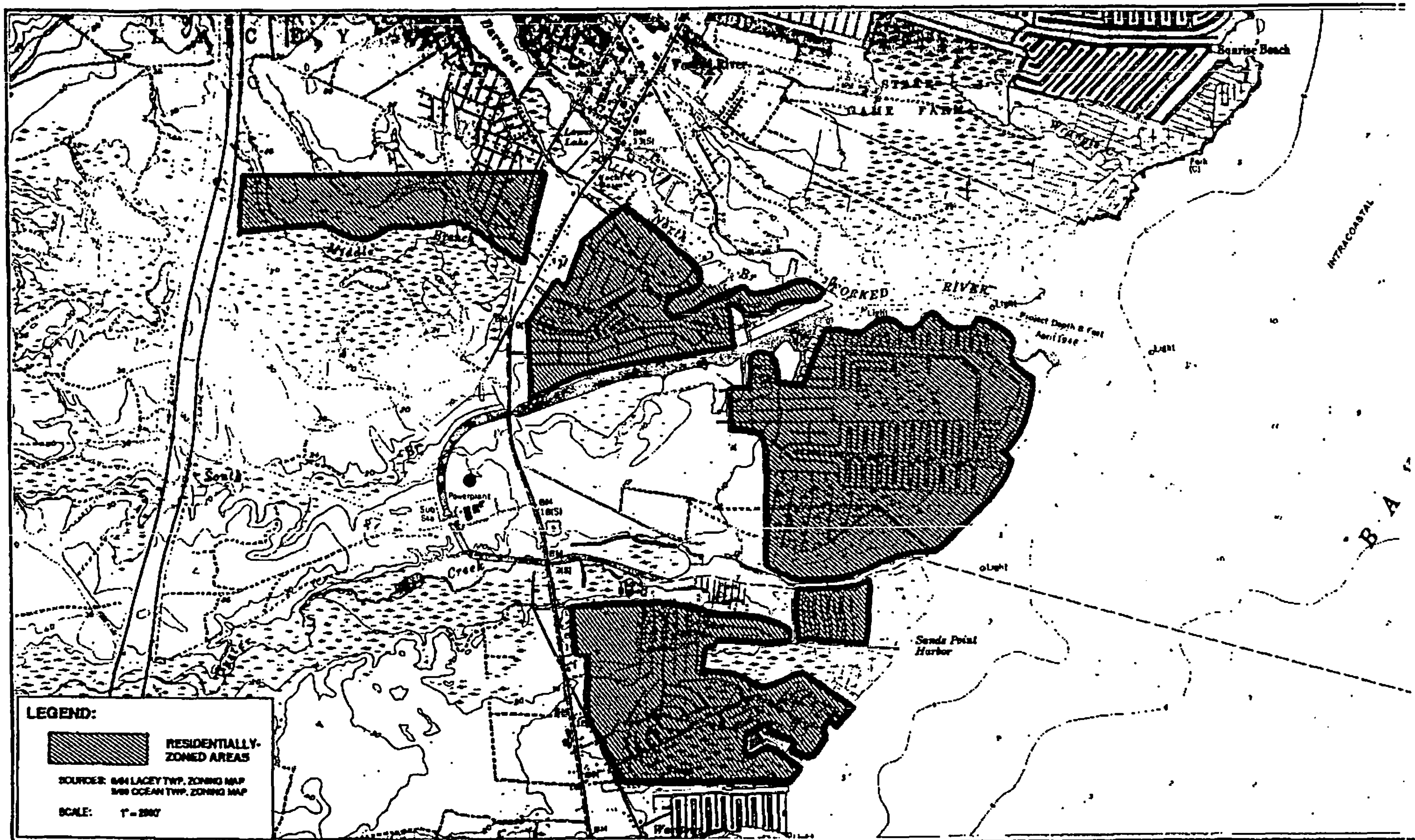
Existing levels of ambient noise were measured at four off-site locations representative of residential areas and at one location on site to determine the contribution of the Oyster Creek Nuclear Generating Station to the noise environment. The noise monitoring locations are shown on the map in Exhibit 3-1 and are described below. Residentially-zoned areas in the site vicinity are shown on Exhibit 3-2.

Location 1 - The first location was at Taylor Avenue and Kennebec Road about one mile north of the plant site. The monitoring location was representative of the adjacent residential community. Monitoring was performed approximately 20 feet from the edge of the road.

Location 2 - Nantucket Avenue is in the closest residential area to the plant. The nearest house in the neighborhood is about 2250 feet northeast of the cooling tower site. The monitor was set up about 150 feet east of Biscayne Drive on the edge of Nantucket Avenue.



GPU Nuclear Corporation EBASCO	**MAP OF NOISE MONITORING LOCATIONS**	EXHIBIT 3-1



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RESIDENTIALLY-ZONED AREAS IN THE SITE VICINITY

EXHIBIT 3-2

Location 3 - The Holly Drive location was chosen to represent the nearest residential area to the southeast. The closest of these houses is about 3500 feet from the cooling tower site. Monitoring was performed at the end of the dead end street.

Location 4 - The Sandy Hook Drive location was slightly outside the one-mile study area. It is representative of the residences due east of the plant site. The monitor was set up at the south end of the street near a ball field.

Location 5 - This location was at the gate to the nuclear generating station. Noise levels measured are representative of far-field noise levels produced by the plant.

3.1.2 Monitoring Methodology

Both A-weighted and octave band sound levels were obtained at four of the five monitoring locations (1-4) and only octave band levels were obtained at Location 5. The A-weighted scale was designed to account for the manner in which the human auditory system responds to sounds of different frequencies. Very low and very high frequency sounds are attenuated electronically by the meter to produce an instrument response proportional to the subjective response of an average person. Octave band sound level measurements are taken at different frequencies to show the tonal characteristics of the overall sound.

The A-weighted sound level was measured continuously and simultaneously at the four locations over a complete 24-hour period using four Larson-Davis Laboratories Model LDL 700 precision sound level analyzers (LDL 700) with integral data loggers. These analyzers were equipped with optional circuitry and microphones to permit them to meet the more stringent requirements of ANSI S1.4-1983 Standard for Type I Precision Sound Level Meters. The microphones were Bruel & Kjaer Type 4176 prepolarized condenser precision measurement microphones. The microphones were equipped with 3.5 inch diameter foam windscreens to reduce wind effects and they were mounted at a height of 5 feet above the ground.

The octave band analyzer was not operated continuously but rather was used like a camera to take snapshots of the audio spectrum. Moments were selected by the operator when intrusive sounds, such as from traffic, were at a minimum so that only the residual sounds were characterized. This is important since the proposed cooling towers would operate continuously, at a relatively constant level of noise, and this would impact the residual level the most. Intrusive sound levels from traffic and other intermittent sources will not be altered by cooling

tower operations. Two spectra were obtained at Locations 1 through 4. One was obtained during the very early morning hours (0200 to 0300) when human activity is generally at a minimum. The other was obtained during the mid afternoon hours (1500 to 1600) during the time when a normal workday level of activity was expected.

3.1.3 Data Analysis

The LDL 700 continuous analyzers were programmed to start automatically at 1400 on June 16, 1992 and to stop 24 hours later at 1400 on June 17. The analyzers were further programmed to compute and store the equivalent sound level (L_{eq}) occurring during each minute and each hour of the 24-hour period. The equivalent sound level is the energy averaged sound level occurring during the specified averaging period. Other hourly parameters computed and stored were the statistical sound levels exceeded 10, 50 and 90 percent of each 1-hour sample period (L_{10}, L_{50} and L_{90}, respectively). These statistical data are useful for determining the variability of sound levels which is a major part of the characterization of a sound environment.

At the end of the sample period, the analyzers were connected to a laptop computer to which the data were downloaded and stored on a diskette. The data were then imported into a spreadsheet program which was used to produce graphs of the data. One graph was produced of the 1-minute L_{eq} levels to show the often rapid variation in sound levels experienced in outdoor environments. Another graph was produced of the hourly statistical sound levels showing all three curves in the same plot.

Octave band data were manually transcribed from the analyzer to preprinted data sheets. The values were then graphed. The day and night octave band levels from each site are plotted on the same graph to permit easy comparison of the day and night levels.

3.1.4 Noise Survey Results

The noise environment in the vicinity of the plant was dominated by traffic noise on Route 9 and other main roads, natural sounds of birds, insects and rustling leaves, and occasional aircraft overflights during the day. During the night, traffic noise diminished considerably and natural sounds became dominant. The power plant could be heard faintly at all locations at night.

Graphs of the 1-minute L_{eq} levels, the hourly L_{10}, L_{50} and L_{90} levels, the octave band levels, and a data sheet summarizing the meteorological conditions present during the monitoring period are

presented in Appendix D. These graphs show the variation in sound levels throughout the day and night. Levels were always higher during the day and minimum levels were recorded at night between 1 a.m. and 4 a.m. The high levels of 60 to 70 dBA measured at Location 4 on Sandy Hook Drive were caused by a ball game in progress on the adjacent ball field. The lowest levels of about 30 dBA were also measured at this location in the middle of the night.

The hourly L_{90} levels, which provide the basis for comparison with predicted cooling tower levels, are presented in Table 3-1. These data are a summary of the L_{90} levels presented graphically in Appendix D. For impact assessment purposes, the average of the four quietest consecutive hours at night (1 a.m to 4 a.m.) will be used for comparison with the predicted noise levels from the cooling tower alternatives. These averages, rounded to the nearest decibel, are 38 dBA, 40 dBA, 43 dBA and 30 dBA at Locations 1 through 4, respectively.

3.2 NOISE MODELING

3.2.1 Methodology

Three tower operating configurations were modeled for the two alternative types of towers. The first is two round mechanical draft towers with all fans operating at full speed; the second is the same two mechanical draft towers with all the fans operating at half speed; and the third is with the single hyperbolic natural draft tower operating at full water flow.

Attenuation factors employed in the NOISECALC computer model included geometric spreading of the sound waves and atmospheric absorption. Sound levels were modeled at three distances from the cooling tower site. The first at 2,250 feet represents the nearest points of the residential area located to the northeast, the second at 3,500 feet to represent the residential area to the southeast, and the third at 2640 feet (1/2 mile) determined to be the distance required to meet the noise standards. Source level data provided by the cooling tower manufacturer is presented in Table 3-2. The 50-foot measurement distance, for the sound levels presented, was added to the radius of each tower to determine the distance from the acoustic center.

The two round mechanical draft towers would each be 210 feet in diameter and each would contain twelve 200 horsepower fans with the capability for half speed or full speed operation. Half speed operation conserves power and reduces the noise level when maximum cooling is not required,

TABLE 3-1

EXISTING HOURLY L_{90} SOUND LEVELS (dBA)
June 16-17, 1992

HOUR OF DAY	LOCATION 1 TAYLOR AVENUE	LOCATION 2 NANTUCKET ROAD	LOCATION 3 HOLLY ROAD	LOCATION 4 SANDY HOOK DRIVE
2 p.m.	45.5	43.0	49.5	43.5
3 p.m.	46.5	44.5	49.5	44.0
4 p.m.	47.5	45.5	50.5	41.5
5 p.m.	47.0	46.0	50.5	47.0
6 p.m.	45.0	46.0	50.0	50.5
7 p.m.	44.0	44.5	48.5	48.5
8 p.m.	43.5	44.0	48.5	36.5
9 p.m.	43.5	43.5	47.0	35.5
10 p.m.	42.0	43.0	45.5	34.0
11 p.m.	40.5	41.5	44.5	31.5
12 midnight	39.0	41.5	44.5	30.5
1 a.m.	37.5	40.0	43.5	30.0
2 a.m.	38.0	39.5	43.0	30.0
3 a.m.	37.5	39.5	43.0	29.0
4 a.m.	38.0	41.5	42.5	30.5
5 a.m.	42.0	43.5	49.5	35.0
6 a.m.	45.0	45.0	49.5	36.5
7 a.m.	44.0	45.0	51.5	37.0
8 a.m.	41.0	44.0	51.5	33.5
9 a.m.	40.0	42.5	49.5	33.5
10 a.m.	40.0	43.0	47.5	32.5
11 a.m.	41.5	42.5	49.0	40.5
12 noon	47.0	45.5	50.5	48.0
1 p.m.	47.0	46.5	55.0	48.0

such as at night. The single hyperbolic natural draft tower would be 409 feet in diameter and would contain no fans. The primary source of noise in this type of tower is waterfall noise and the noise level is proportional to the amount of water flowing through the tower.

TABLE 3-2

SOURCE SOUND LEVEL DATA

OCTAVE BAND CENTER FREQUENCY (Hertz)	Sound Level 50 Feet from Edge of Tower (dBA)		
	Round Mechanical Draft (full speed)	Round Mechanical Draft (half speed)	Natural Draft (no fans)
31.5	81	73	54
63	82	74	56
125	78	66	56
250	72	70	57
500	70	68	66
1k	70	63	67
2k	68	65	67
4k	70	72	70
8k	70	72	69

Source: Dwyer, 1992

3.2.2 Modeling Results

The results of the modeling are presented in Table 3-3 for the A-weighted sound levels. The results indicate that the mechanical draft towers, with the fans operating at full speed, are the loudest alternative with sound levels of up to 51 dBA at the nearest residences. The percentage of time full speed operation of the cooling towers would be required depends on ambient temperature and heat dissipation requirements. The quietest alternative is also the mechanical draft towers, but with the fans operating at half speed. The fan speed reduction reduces the sound level by about 4 dBA. Noise levels for the single natural draft tower are mid-way between the levels produced by the mechanical draft towers at the two fan speeds.

TABLE 3-3

PREDICTED A-WEIGHTED SOUND LEVELS (dBA)

LOCATION	Round Mechanical Draft (full speed)	Round Mechanical Draft (half speed)	Natural Draft (no fans)
Northeast Residences (2250 Feet)	51*	47	49
One-Half Mile (2640 Feet)	49	45	47
Southeast Residences (3500 Feet)	46	42	43

* = Exceeds New Jersey noise standard (50 dBA)

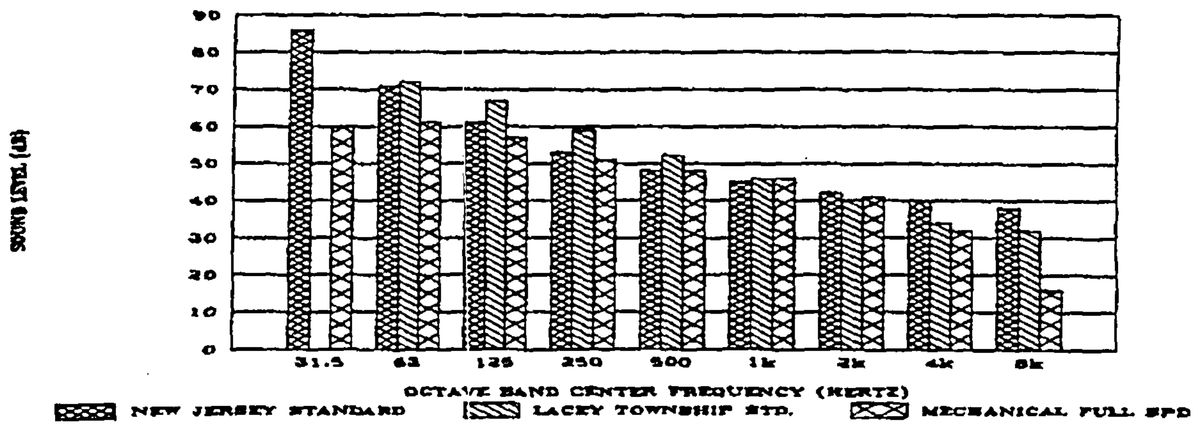
Expected octave band levels obtained from the modeling are presented graphically in Exhibits 3-3 and 3-4 along with the New Jersey nighttime octave band limits for residential areas and the Lacey Township octave band limits for residential areas. The predicted levels for the three alternative configurations show significant differences in the low frequency levels and almost no differences in the higher frequencies. This is due to the fans in the mechanical draft towers which are responsible for producing the low frequency noise. Waterfall noise, in all configurations, primarily produces sound in the mid and high frequencies.

Although the human auditory system is much less sensitive to low frequency sounds than to mid frequency sounds, the higher levels of low frequency noise from the fans would adversely affect the quality of the sound. The probability is high that the fans will produce pure tone noises at the blade passage frequencies of 1096 Hertz and 548 Hertz for full and half speed operation, respectively. These tones would significantly increase the audibility, and hence the noise impact, of the mechanical draft cooling towers.

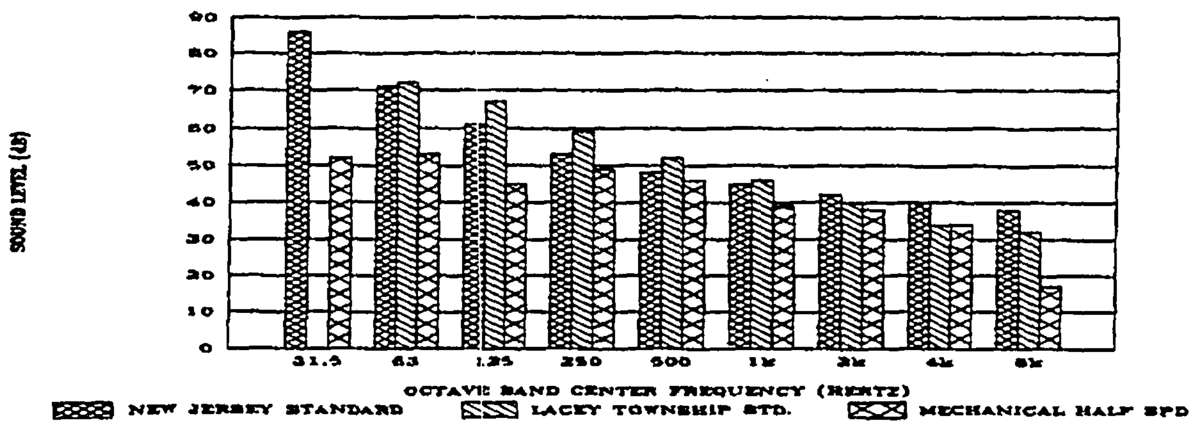
3.3 NOISE IMPACT ASSESSMENT

Comparisons are made of both the A-weighted and octave band levels with the most stringent state and local standards for residential receptors at night. Daytime limits are significantly higher and will easily be met for any type of land use, even if the nighttime limits are exceeded by a

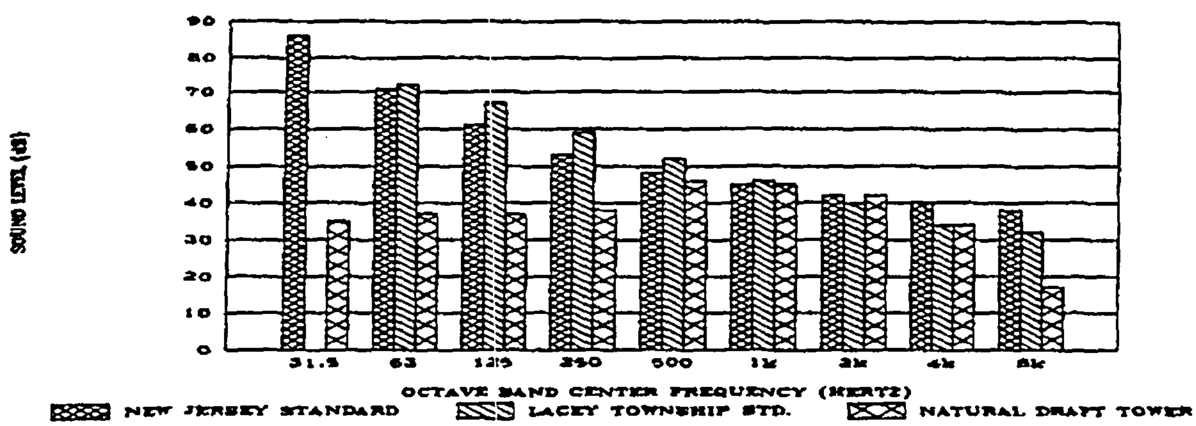
MECHANICAL DRAFT TOWER — FULL SPEED



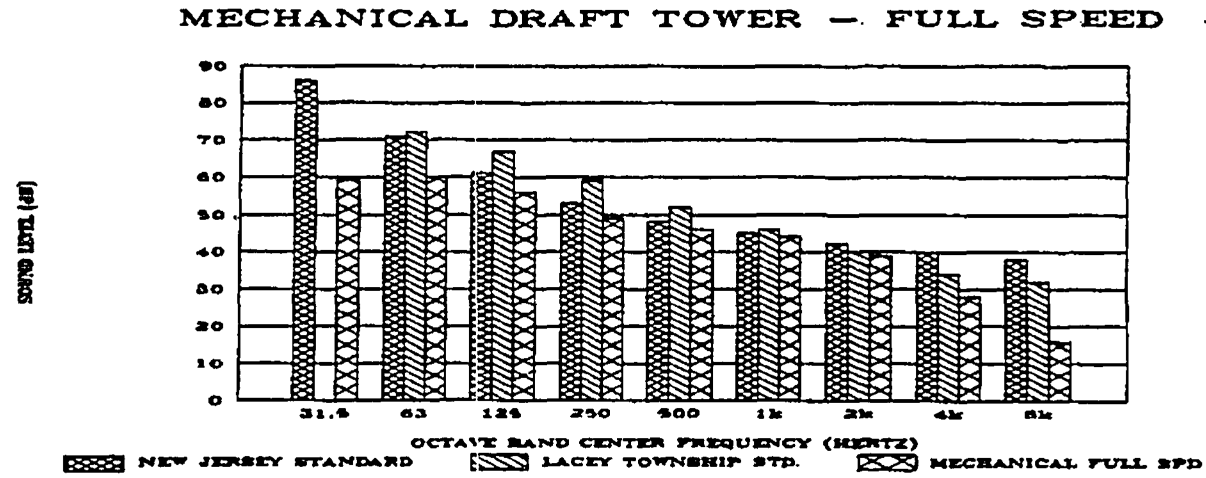
MECHANICAL DRAFT TOWER — HALF SPEED

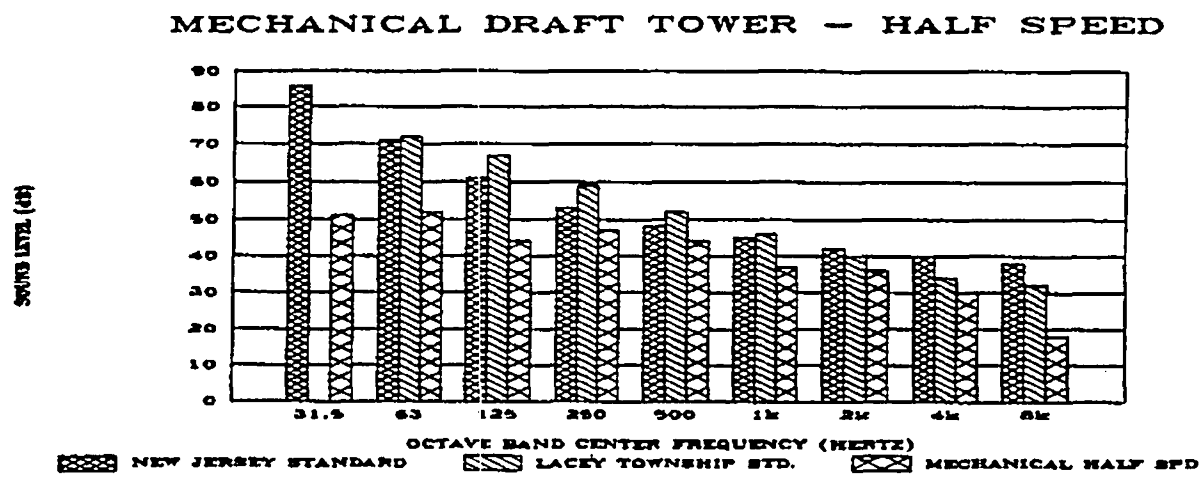


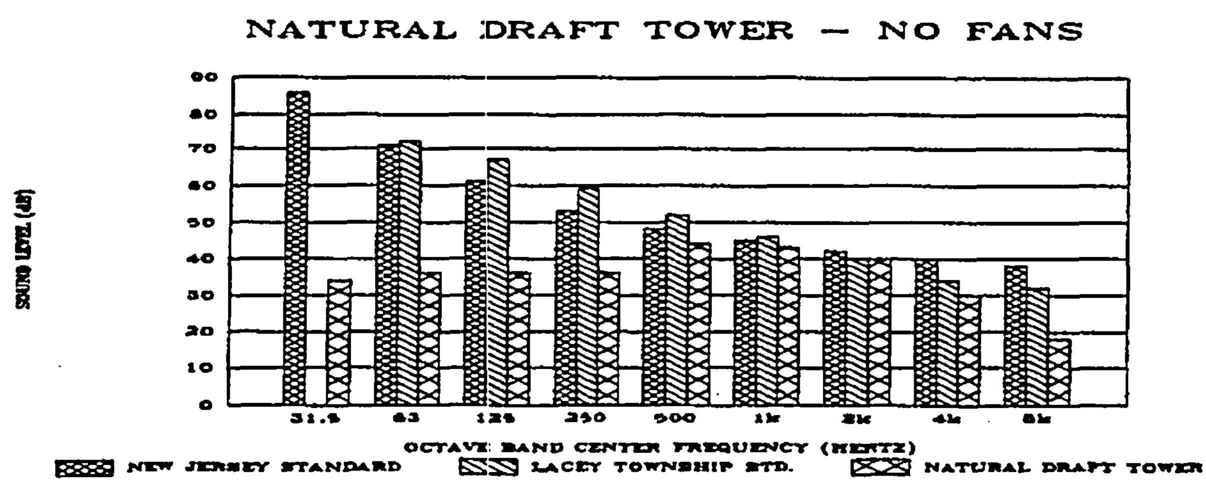
NATURAL DRAFT TOWER — NO FANS



GPU Nuclear Corporation / EBASCO — An ENSERCH Engineering and Construction Company	PREDICTED OCTAVE BAND LIMITS AT NEAREST RESIDENCE	EXHIBIT 3-3







GPU Nuclear Corporation

EBASCO

PREDICTED OCTAVE BAND LIMITS AT ONE-HALF MILE

EXHIBIT 3-4

moderate amount. Comparisons are also made of the predicted A-weighted levels with existing L_{90} background or residual noise levels.

3.3.1 Comparison with State Standards

The State of New Jersey has noise standards for both A-weighted and octave band levels (NJAC, Title 7, Chapter 29, 1985 revision). The levels are more stringent for the nighttime hours since people are generally more sensitive to noise at night during normal sleep hours. Any industrial facility that is intended to be operated 24 hours a day must be designed to meet the lower nighttime limits. The A-weighted limit is 50 dBA and the octave band limits range from 86 dB at 31.5 Hz to 38 dB at 8 kHz. The values for all octave bands are plotted in Exhibits 3-3 and 3-4. If a continuously operating plant is designed to meet the nighttime limits, the daytime limits will be automatically met.

The predicted A-weighted levels shown in Table 3-3 are below the nighttime limit of 50 dBA at all locations for all tower configurations except one. When the mechanical draft tower fans are operated at full speed, the resulting noise level at the nearest residential receptor will be 51 dBA, which is one decibel above the standard.

The predicted octave band levels at the nearest residences are shown in Exhibit 3-3 for all tower configurations. The predicted levels are below the standard curve at all points except at 1 kiloHertz where the curve is exceeded by one decibel during full speed operation of the mechanical draft tower fans. At the slightly greater distance of one-half mile, the state standards are met for all tower configurations at all frequencies (Exhibit 3-4). At the residences to the southeast (3500 feet), all of the predicted levels are below the standard curve for all configurations.

3.3.2 Comparison with Local Standards

Lacey Township has noise standards for the different octave bands at residential boundaries, but it does not have a single A-weighted limit (Chapter 108-52, 1991 revision). The octave band limits vary from those of the State, being higher in some bands and lower in others. These are also plotted in Exhibits 3-3 and 3-4.

At the nearest residence (Exhibit 3-3), the Lacey Township limits would be exceeded by 1 dB at 2 kHz during full speed operation of the mechanical draft tower fans and by 2 dB, also at 2 kHz, during full flow operation of the natural draft cooling tower.

At a distance of one-half mile (Exhibit 3-4), the natural draft tower sound level at 2 kHz equals the township standard of 40 dB, but none of the limits are exceeded. The mechanical draft tower also meets all of the township limits at this distance.

3.3.3 Comparison with Existing Ambient Levels

There are no legal limits related to increases in noise levels due to new facilities, but it is commonly recognized that the degree of noise impact is related to the amount of increase. Generally, increases of 3 dBA or less are considered insignificant and increases above 3 dBA are significant (EPA, 1976). The existing ambient level is commonly taken to be the residual or L_{90} levels measured late at night when the proposed facility noise is likely to be most noticeable. The late night L_{90} levels at the nearest residences (northeast) and second nearest residences (southeast) were determined to be 40 dBA and 43 dBA, respectively (see Section 3.1.4).

The predicted A-weighted levels for these two locations are 51 dBA and 46 dBA (Table 3-3), respectively, with the mechanical draft fans operating at full speed. This represents increases of 11 and 3 dBA, respectively. Thus, the increase would be significant at the nearest residences but not significant at the second nearest group of residences. Half speed operation of the mechanical draft tower fans and operation of the natural draft tower would produce significant increases of 7 and 9 dBA, respectively, at the nearest residences.

At a distance of one-half mile, the increases over existing levels would be only 2 dBA less than the increases described above for the nearest residences at 2,250 feet. These increases would range from 5 dBA for the natural draft tower to 9 dBA for the mechanical draft tower operating at full fan speed.

3.4 CONCLUSIONS

At the nearest residences, the round mechanical draft cooling towers operating at full fan speed would exceed the New Jersey state noise standard of 50 dBA for residential boundaries at night by 1 dBA and the state octave band limit of 45 dB at 1 kHz by 1 dB. The Lacey Township standard of 40 dB at 2 kHz would also be exceeded by 1 dB. The natural draft cooling tower would also cause the Lacey Township 2 kHz octave band limit of 40 dB to be exceeded by 2 dB. The mechanical draft towers operating at half speed would be acceptable at the location based on all the standards.

A distance of one-half mile was determined to be the minimum distance at which all state and local noise standards for A-weighted and octave band noise limits would be met for the mechanical draft cooling towers and the natural draft cooling tower. However, commonly used impact assessment criteria still indicate that, even though the legal limits would be met, significant noise impacts would still occur due to the low background levels that currently exist.

Although the minor exceedances of octave band limits were noted in the mid and high frequency bands, the higher levels of low frequency noise produced by the mechanical draft tower fans would adversely affect the quality of sound produced. The sound of falling water produced by the natural draft tower would be preferred over the fan noise produced by the mechanical draft cooling tower alternative.

4.0 VISUAL EFFECTS

4.1 EXISTING CONDITIONS

The Oyster Creek NGS is located at the eastern edge of the Pine Barrens area of New Jersey approximately 9.5 miles south of Toms River in Ocean County. Jersey Central Power and Light (JCP&L) owns 1,416 acres in Lacey and Ocean Townships, of which 755 acres are west of US Route 9 and 661 acres east of US Route 9. The westerly portion of this holding is bounded by the Garden State Parkway on the west, US Route 9 on the east, and by land zoned for general industrial use in Ocean Township to the south and industrial use in Lacey Township to the north. The easterly portion of the JCP&L owned lands is bounded by US Route 9 on the west, by land zoned for commercial and waterfront development uses on the south, for marine commercial use on the north, and for municipal and quasi public, municipal park and residential use on the east.

The population concentrations nearest the proposed cooling tower locations are 0.6 miles northeast in the Forked River section of Lacey Township and 0.9 miles southeast in the Waretown section of Ocean Township. A sizable retirement community known as Pheasant Run is located 1.5 miles north of the site in Lacey Township. This area is zoned for residential retirement cluster development and consists of single-family homes. Pheasant Run is bordered by older residential areas of Lacey Township on the north and east, by the Garden State Parkway on the west, and by woodland (mainly Pinelands) and wetlands on the south. As of the 1990 census, Forked River had a population of 4,243 and Waretown had a population of 1,283 (US Census Bureau, May 1992).

The present Oyster Creek NGS facility is partially to nearly fully visible from local and state roads in the immediate vicinity and from nearby residences. Existing cooling system elements of the station have low to negligible visual impact. Viewers of the plant site would probably not be very aware of the facility as they travel north or south on Route 9 if it were not for the stack and adjacent turbine and reactor buildings which visually pinpoint the facility. The station is set well back from Route 9 and planting has been installed along this road to soften the view. These plantings will tend to provide additional screening in years to come as they become taller.

Travelling south on Route 9, the existing Oyster Creek NGS facilities can first be seen at a point about one mile away. Approaching the site, plant related structures are seen intermittently between commercial and residential areas along this road where extensive strip and other commercial development has taken place. Principal among this development is the Lacey

Business Park, located at Route 9 and Old Shore Road approximately 0.3 miles north of the proposed tower location.

Travelling north on Route 9, the stack is visible at a point about 1.4 miles south of the plant location. It reappears intermittently through the intervening visual barriers of shops, restaurants, and industries. It is in full, unimpeded view for about 0.7 of a mile and is seen behind a foreground of planting.

As the traveller proceeds south on the Garden State Parkway (GSP), the power plant is not visible at all since it is hidden from view by existing planting in the median strip. One is aware only of transmission lines and towers which are viewed intermittently paralleling the road. The plant is also not visible from the GSP interchange nearest the plant, which is Interchange 69 at County Route 532 (Wells Mills Road) in Ocean Township. Views from the interchange, which is 2.1 miles southwest of the power plant, are obstructed by existing vegetation paralleling the GSP corridor in that area.

Proceeding north on this same highway, however, the traveller is aware of the transmission lines and towers for about 2.2 miles, and the transmission towers are close to the road for about 0.6 of a mile. A lateral view (at right angles to the road) is gained of the transmission line towers and station in an opening of about 500-600 ft.

4.2 IMPACT ASSESSMENT

4.2.1 Methodology

The two alternative cooling systems were assessed on strictly physical and visual characteristics, with the intent of presenting the aesthetics analyses as objectively as possible. No attempt was made to assess viewer reactions to shapes or configurations of various cooling alternatives.

Certain basic premises were established for this analysis and they are listed below:

1) Any above-ground structure constitutes an additional intrusive element into the existing scene. Its intrusiveness varies with its physical dimensions; therefore, the taller or longer or wider a structure is, the more intrusive it is.

2) Since the two tower schemes considered here would each involve structures which are either round or hyperbolic in shape, they would each be approximately equal in possessing shapes which would be more amenable to shapes occurring in nature than, for example, the rigid shapes found in square or rectangular structures. Because of this fact, physical size becomes the dominant aesthetic evaluative element and shape is subordinated.

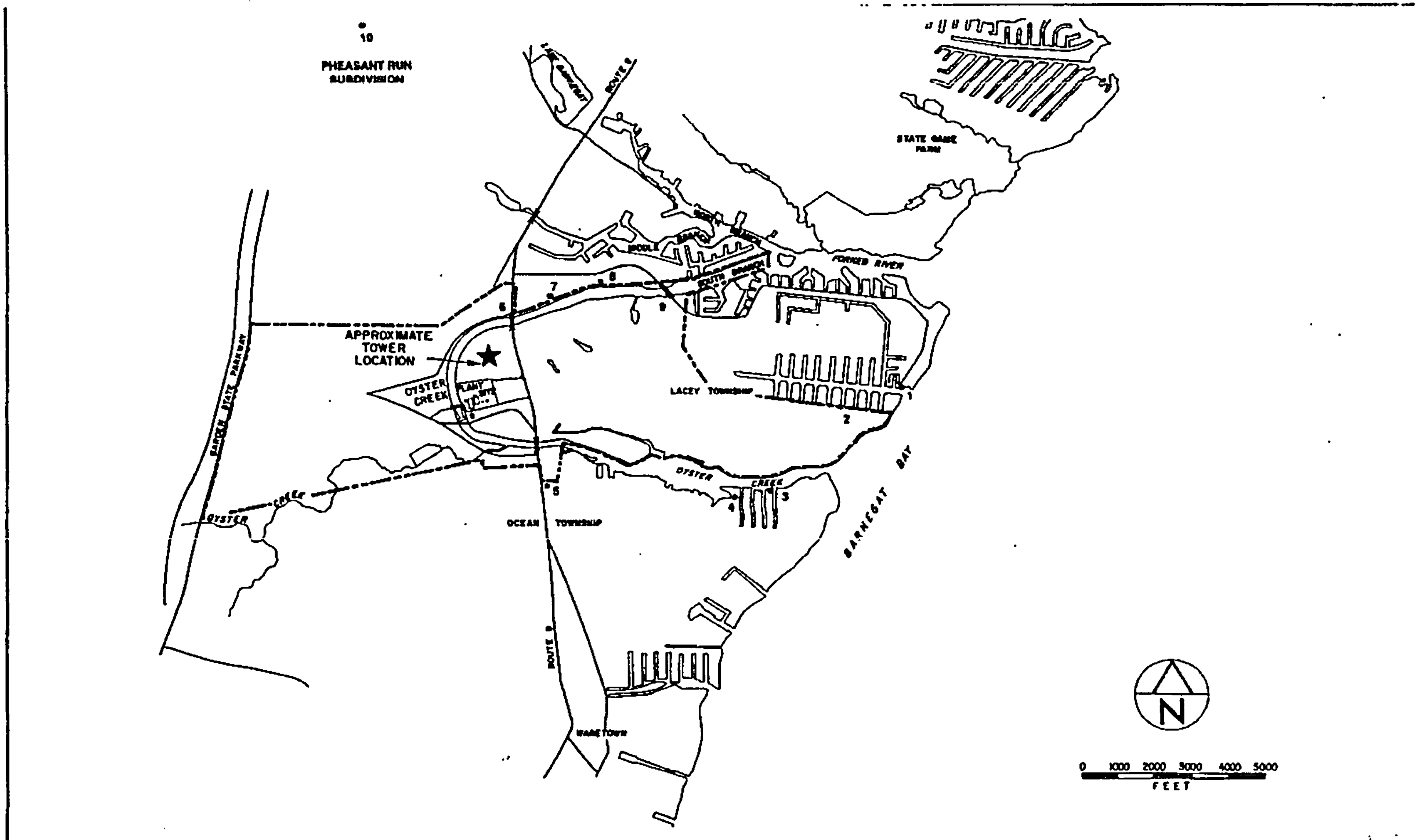
3) It was assumed that visible elevated plumes generated by the cooling towers would have the greatest impact when the plumes were directly overhead of the observer. Therefore, frequency of occurrence of overhead visible plumes was calculated for the summertime, when the local population is at a maximum, and these frequencies were used in assessing the visual impact of elevated plumes.

4.2.2 Photographic Analysis

In addition to considering the physical size and shape of the cooling systems and their interaction with meteorological phenomena, an evaluation was made of the visual impacts which the entire complex -- existing power plant elements together with preferred cooling tower systems -- would have upon the human population in the area. In order to accomplish this, photographs were taken from several representative areas in the affected vicinity (areas such as backyards of residences, local and through roads, and Barnegat Bay shore locations). These photographs were enlarged and the two cooling tower systems were superimposed upon them, as they would appear to the observer if they were constructed.

The locations from which the photographs depicting the cooling tower alternatives were taken are shown in Exhibits 4-1 and 4-3. The natural draft cooling tower photosimulations themselves are shown in Exhibits 4-2a through 4-2e. The round mechanical draft cooling tower photosimulations themselves are shown in Exhibits 4-4a through 4-4c.

Ten viewing locations were visited for photographic analysis as part of the Oyster Creek cooling tower visual assessment originally conducted in 1977. One of these locations, a boater's view of the plant from three-quarters of a mile off-shore in Barnegat Bay, was not replicated for the updated assessment as a map review and field reconnaissance revealed this view to be essentially unchanged. A second boat-borne view evaluated in the earlier assessment, that from Oyster Creek looking west toward the plant, was replicated by photographic analysis of a virtually

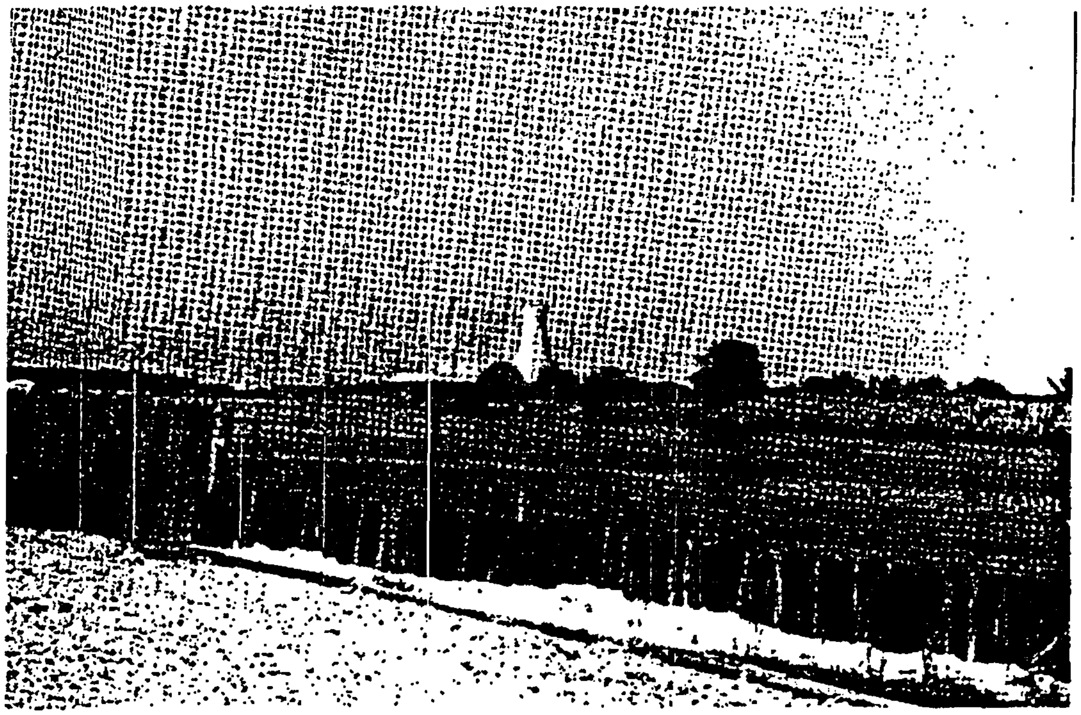


GPU Nuclear Corporation EBASCO	**MAP OF PHOTOGRAPH LOCATIONS FOR VISUAL / ASTHETIC ANALYSIS NATURAL DRAFT HYPERBOLIC COOLING TOWER**	EXHIBIT 4-1

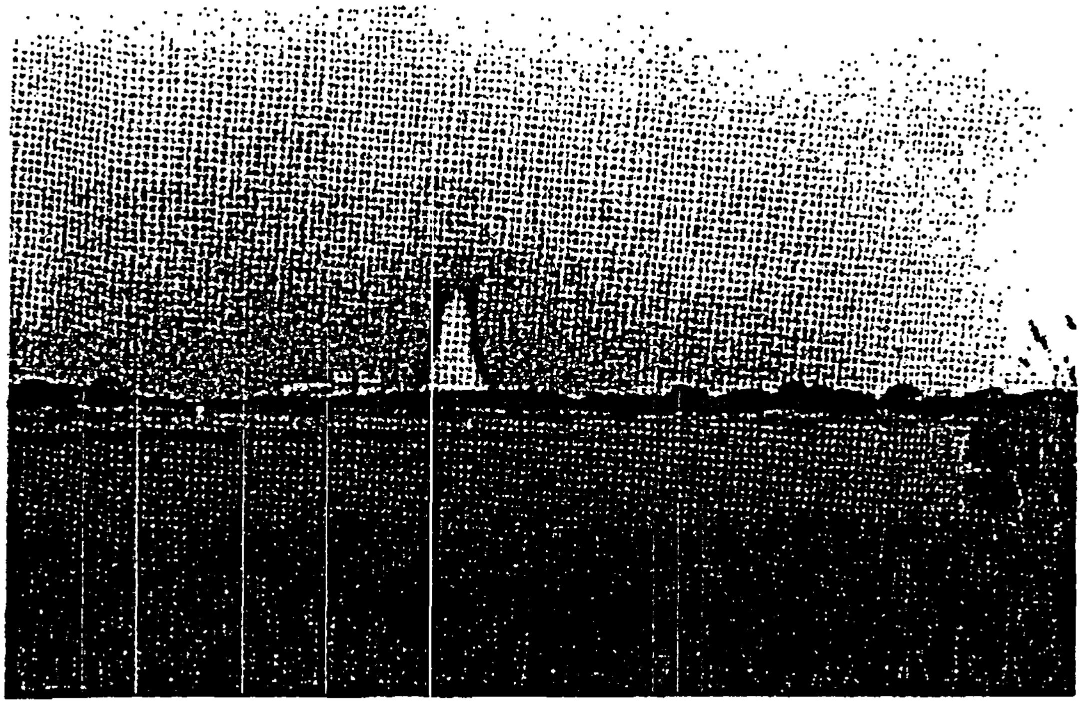
LOCATION No. 1 - VIEW FROM RESIDENCE AT BEACH BLVD. AND BINNACLE PT.

LOCATION No. 2 - VIEW FROM RESIDENCE AT ORLANDO DRIVE AND PENGUIN CT.

GPU Nuclear Corporation	PHOTOGRAPHIC ANALYSIS - NATURAL DRAFT COOLING TOWER VISUAL ASSESSMENT	EXHIBIT 4-2a
EBASCO An ENSERCH Engineering and Construction Company		

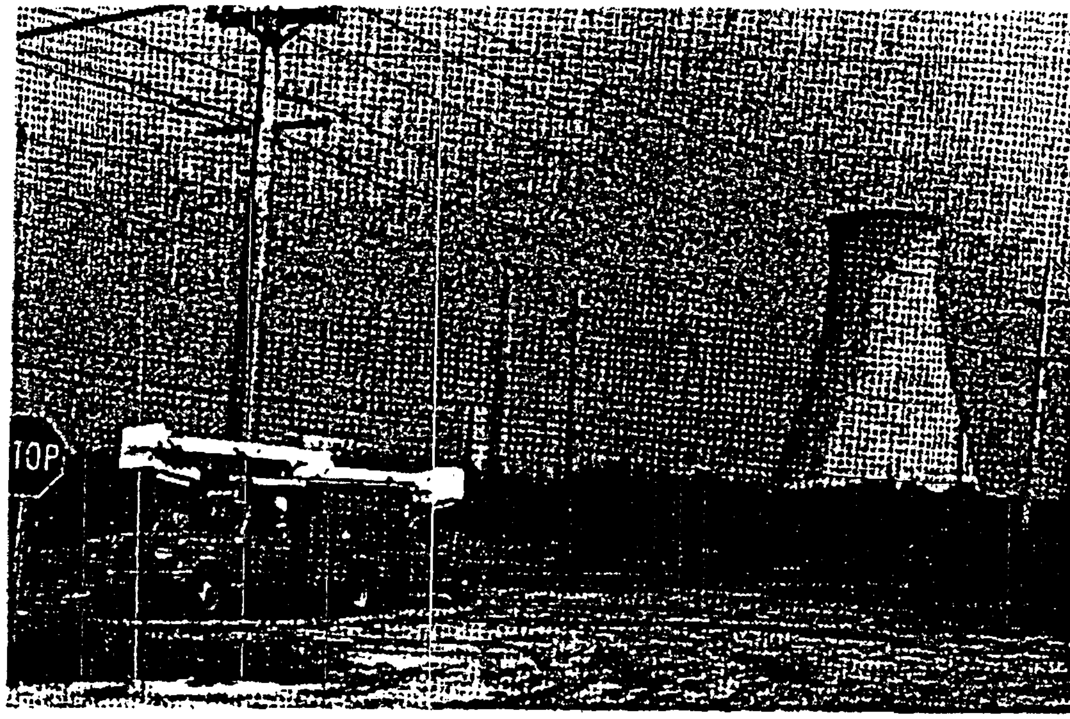


LOCATION No. 3 - VIEW FROM LAST RESIDENCE ON COMPASS RD.
LOOKING ACROSS OYSTER CREEK

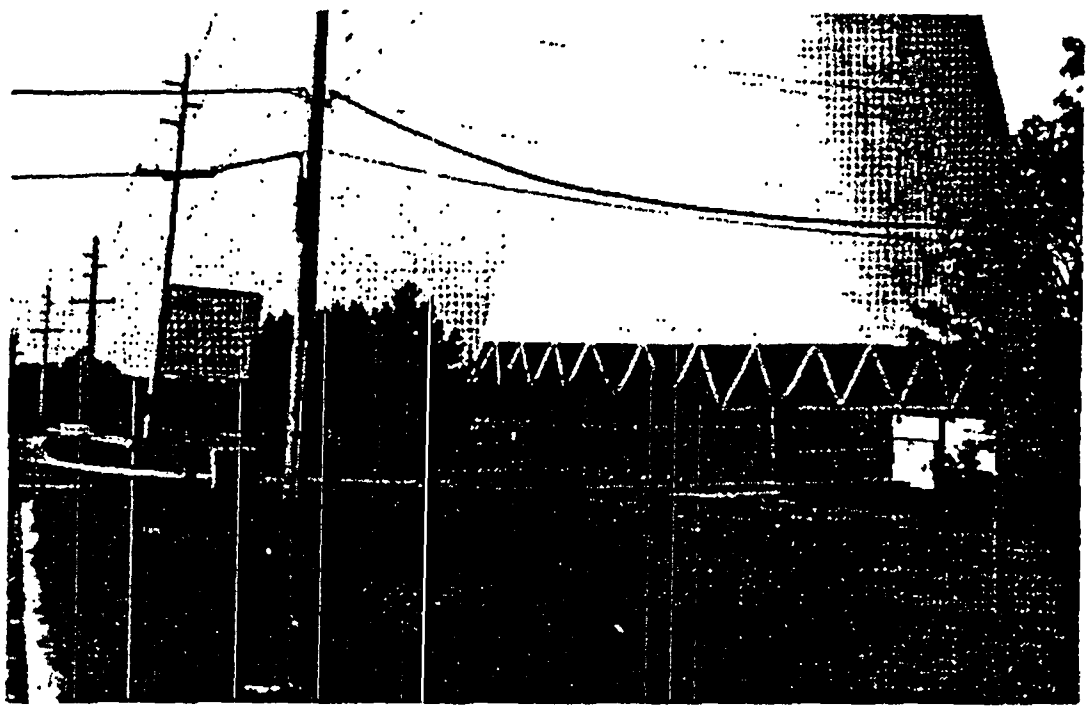


LOCATION No. 4 - VIEW FROM WESTERN SIDE OF CABLE RD.
LOOKING ACROSS OYSTER CREEK

GPU Nuclear Corporation	PHOTOGRAPHIC ANALYSIS - NATURAL DRAFT COOLING TOWER VISUAL ASSESSMENT	EXHIBIT
EBASCO An ENSERCH Engineering and Construction Company		4-2b

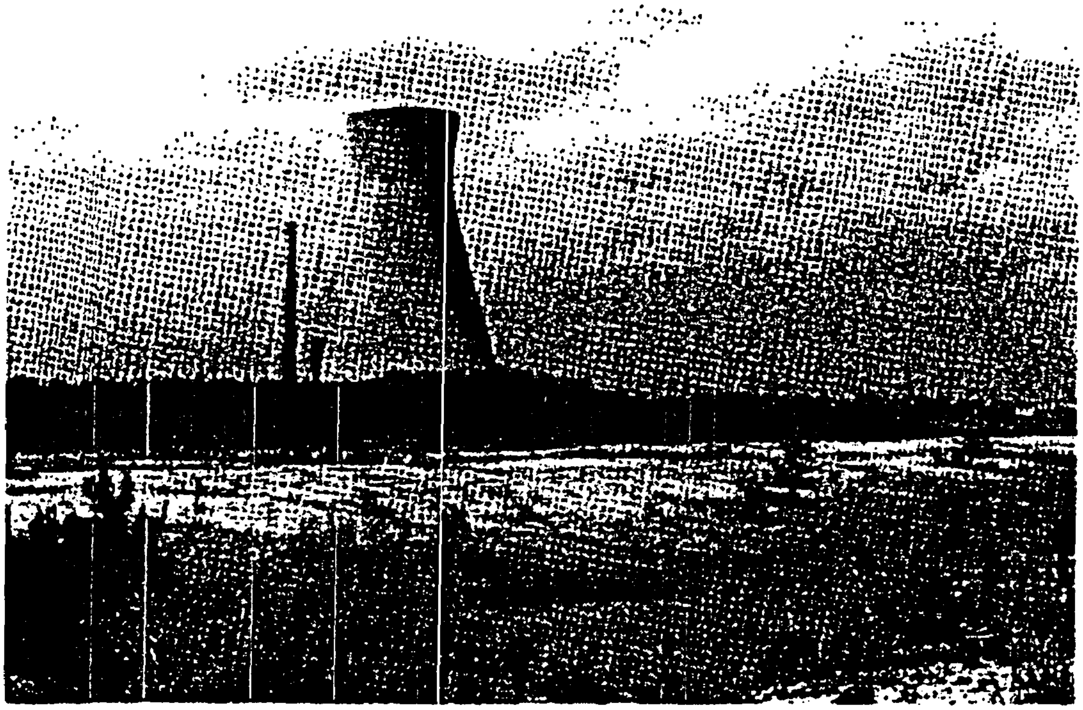


LOCATION No. 5 - VIEW TAKEN FROM NE CORNER OF BAY PARKWAY AND ROUTE 9

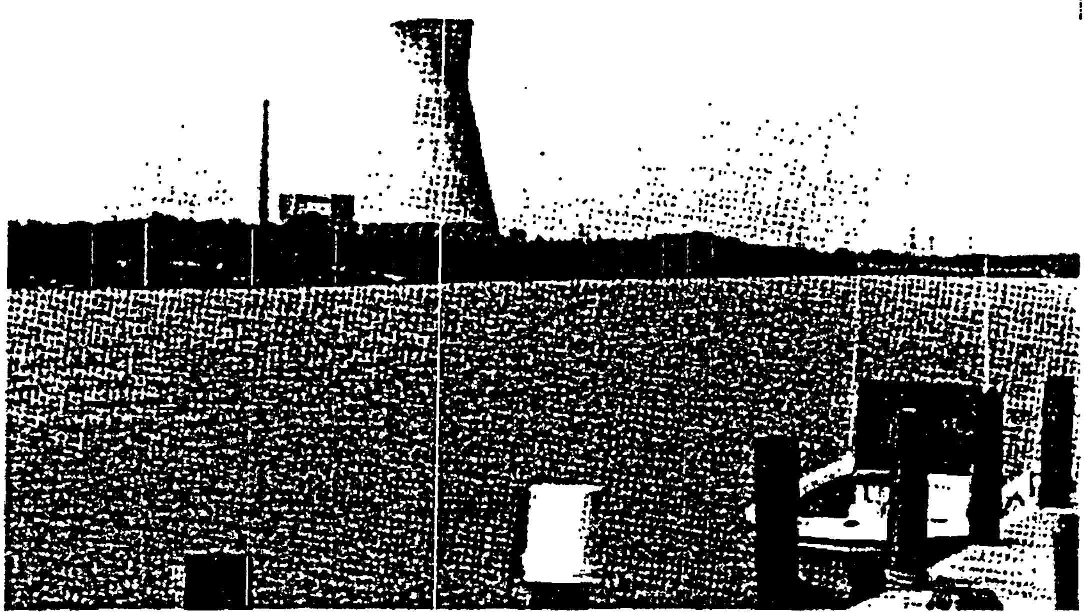


LOCATION No. 6 - VIEW FROM ROUTE 9 AT ABOUT 4/10 THS. MILE NORTH OF EX. PLANT

GPU Nuclear Corporation EBASCO An ENSERCH Engineering and Construction Company	PHOTOGRAPHIC ANALYSIS - NATURAL DRAFT COOLING TOWER VISUAL ASSESSMENT	EXHIBIT 4-2c



LOCATION No. 7 - VIEW FROM CAPE COD DR. SOUTH OF NANTUCKET RD.



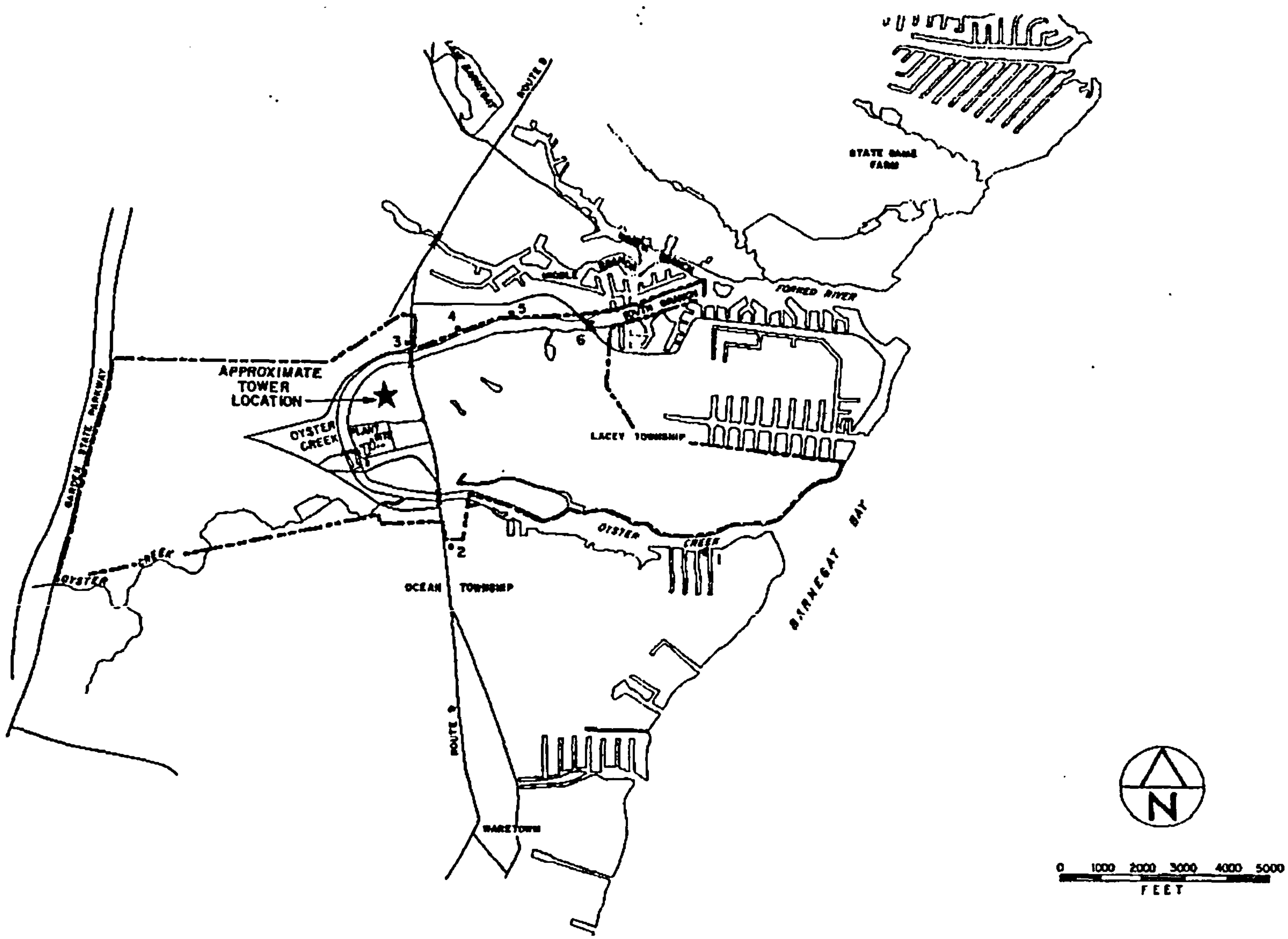
LOCATION No. 8 - VIEW FROM BERMUDA DR. SOUTH OF NANTUCKET RD.

GPU Nuclear Corporation	PHOTOGRAPHIC ANALYSIS - NATURAL DRAFT COOLING TOWER VISUAL ASSESSMENT	EXHIBIT 4-2d
EBASCO An ENSERCH Engineering and Construction Company		

LOCATION No. 9 - VIEW FROM BEACH BLVD. BRIDGE OVER SOUTH BRANCH OF FORKED RIVER

LOCATION No. 10 - VIEW FROM CANTERBURY DR. AND BROOKDALE DR. IN PHEASANT RUN SUBDIVISION

GPU Nuclear Corporation EBASCO An ENSERCH Engineering and Construction Company	PHOTOGRAPHIC ANALYSIS - NATURAL DRAFT COOLING TOWER VISUAL ASSESSMENT	EXHIBIT 4-2e



GPU Nuclear Corporation

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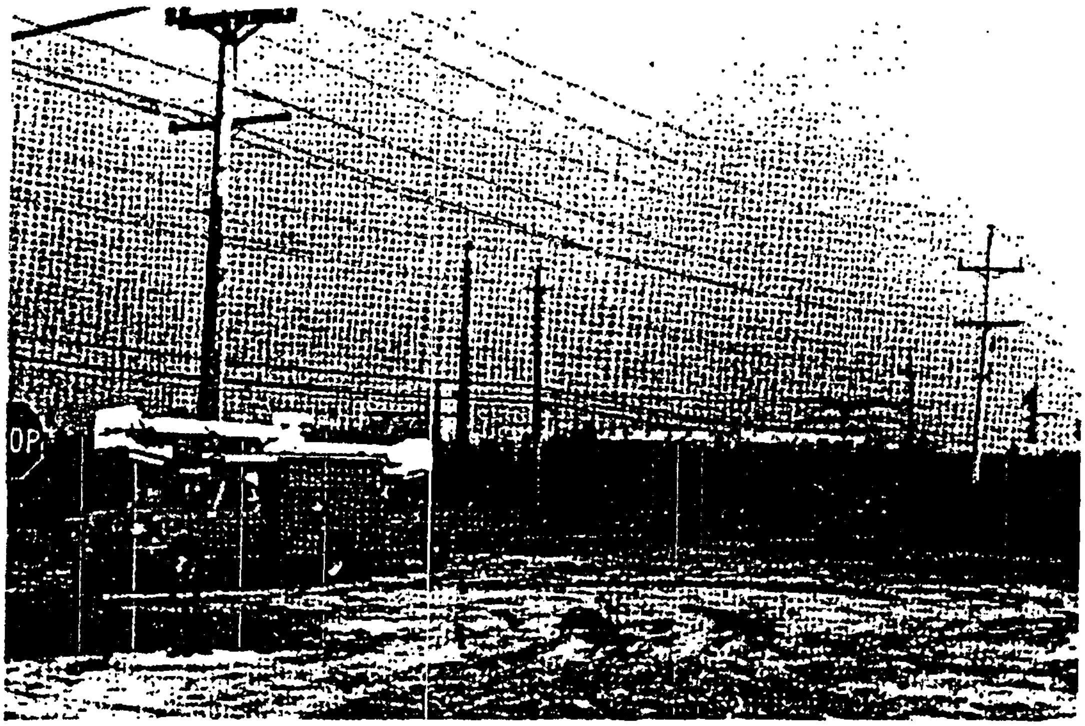
MAP OF PHOTOGRAPH LOCATIONS FOR VISUAL / ASTHETIC ANALYSIS ROUND MECHANICAL DRAFT COOLING TOWERS

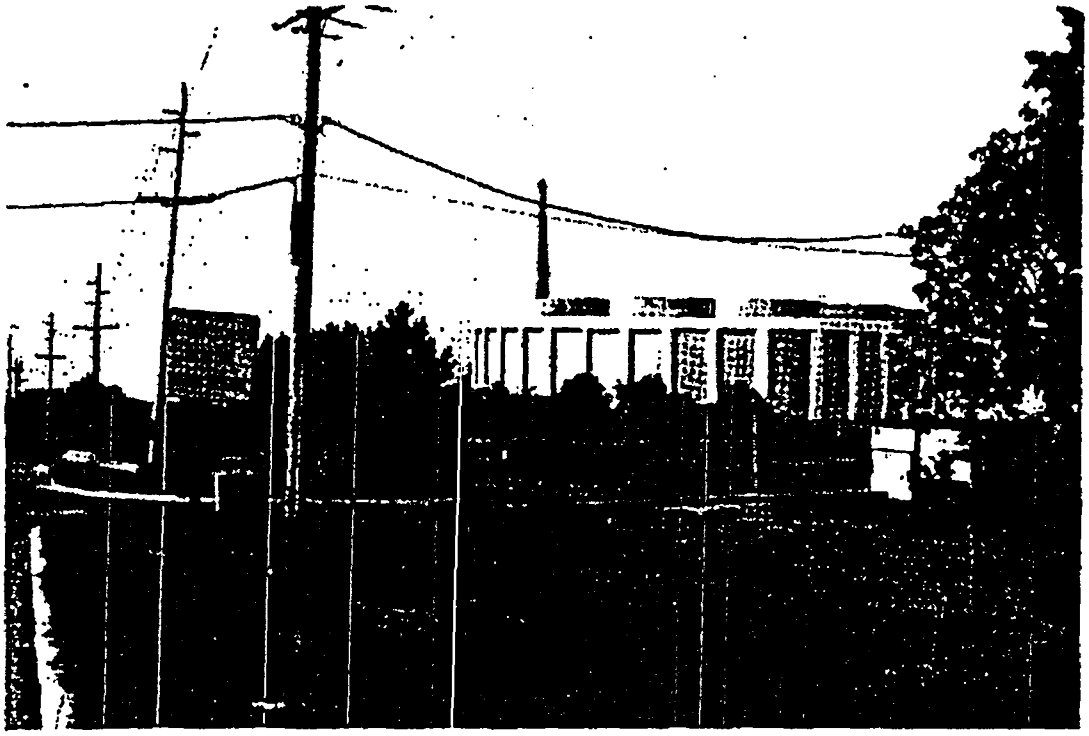
EXHIBIT 4.3

LOCATION No. 1 - VIEW FROM LAST RESIDENCE ON COMPASS RD. LOOKING ACROSS OYSTER CREEK

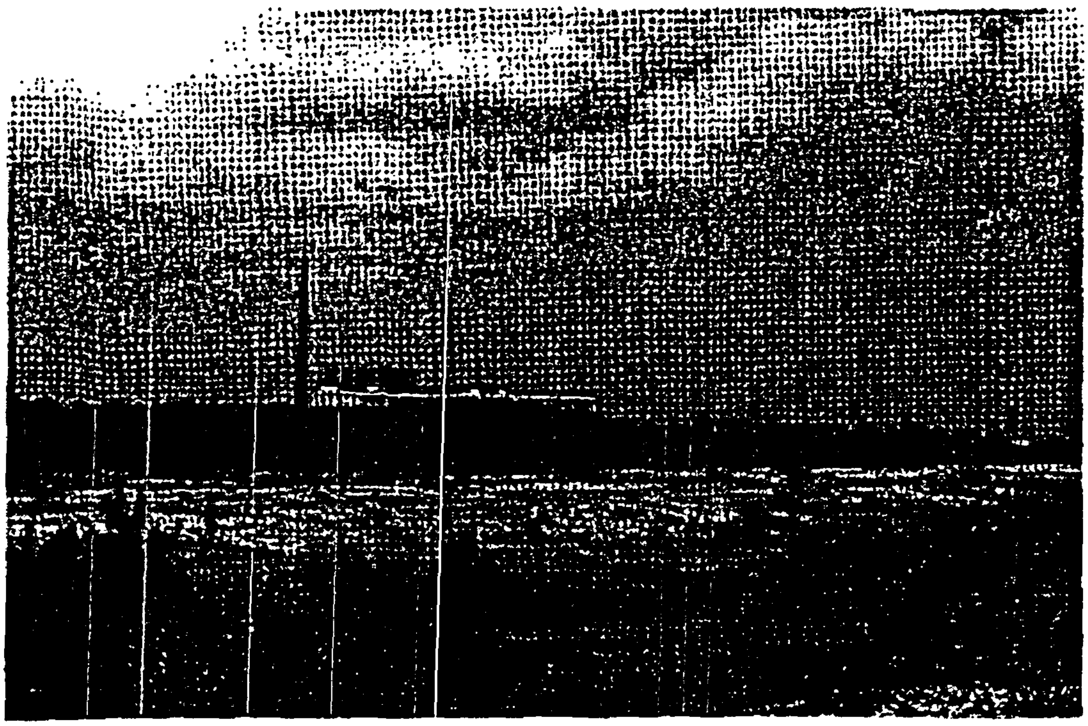


LOCATION No. 2 - VIEW TAKEN FROM NE CORNER OF BAY PARKWAY AND ROUTE 9

GPU Nuclear Corporation EBASCO An ENSERCH Engineering and Construction Company	PHOTOGRAPHIC ANALYSIS - ROUND MECHANICAL COOLING TOWERS VISUAL ASSESSMENT	EXHIBIT 4-4a

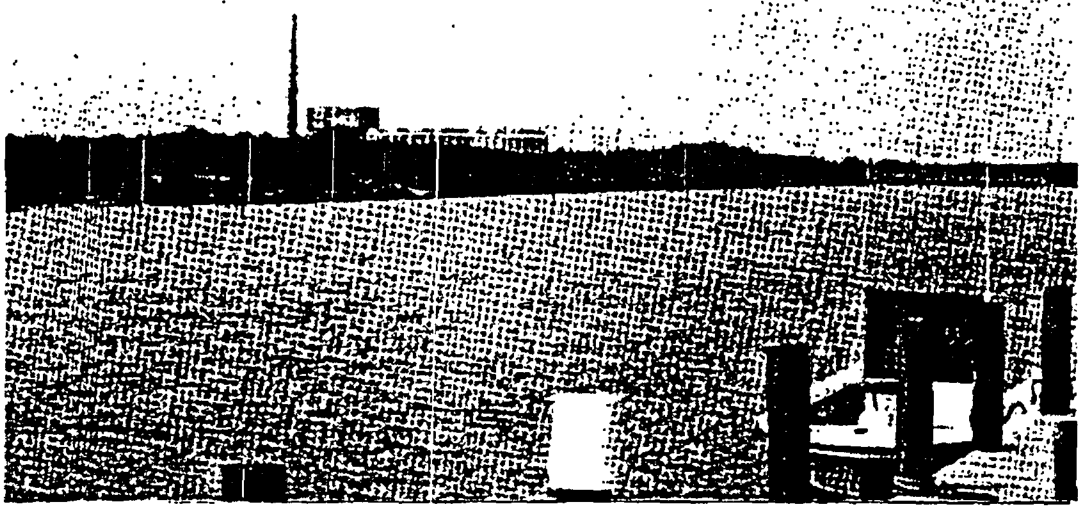


LOCATION No. 3 - VIEW FROM ROUTE 9 AT ABOUT 4/10 THS. MILE NORTH OF EX. PLANT

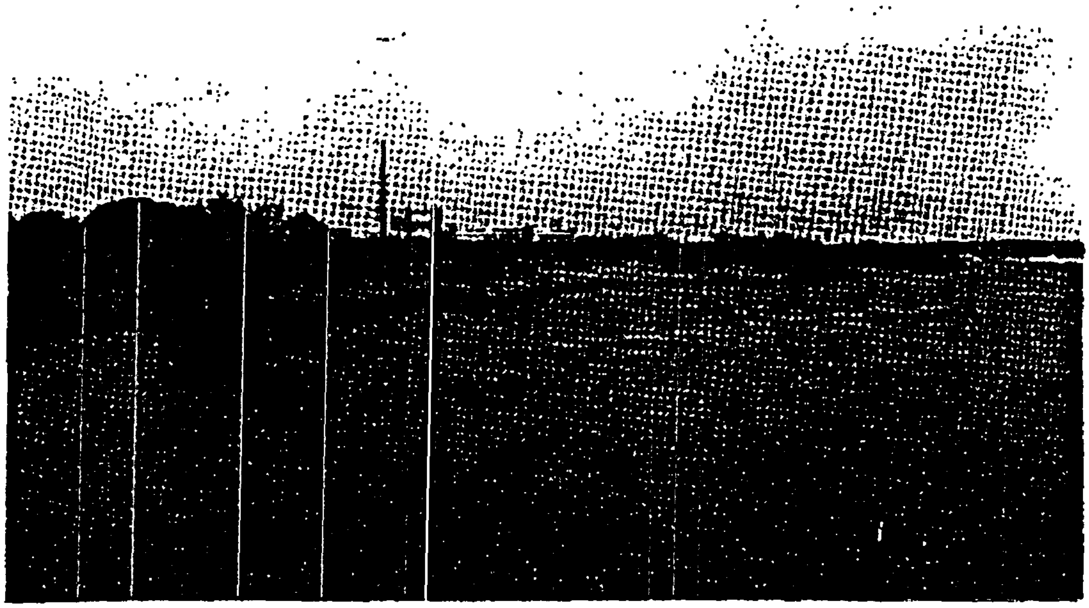


LOCATION No. 4 - VIEW FROM CAPE COD DR. SOUTH OF NANTUCKET RD.

GPU Nuclear Corporation EBASCO An ENSERCH Engineering and Construction Company	PHOTOGRAPHIC ANALYSIS - ROUND MECHANICAL COOLING TOWERS VISUAL ASSESSMENT	EXHIBIT 4-4b



LOCATION No. 5 - VIEW FROM BERMUDA DR. SOUTH OF NANTUCKET RD.



LOCATION No. 6 - VIEW FROM BEACH BLVD. BRIDGE OVER SOUTH BRANCH OF FORKED RIVER

GPU Nuclear Corporation	PHOTOGRAPHIC ANALYSIS - ROUND MECHANICAL COOLING TOWERS VISUAL ASSESSMENT	EXHIBIT
EBASCO An ENSERCH Engineering and Construction Company		4-4c

identical view taken from the shore of Oyster Creek off Cable Road in Ocean Township (see photographic location number 4 on Exhibit 4-2b).

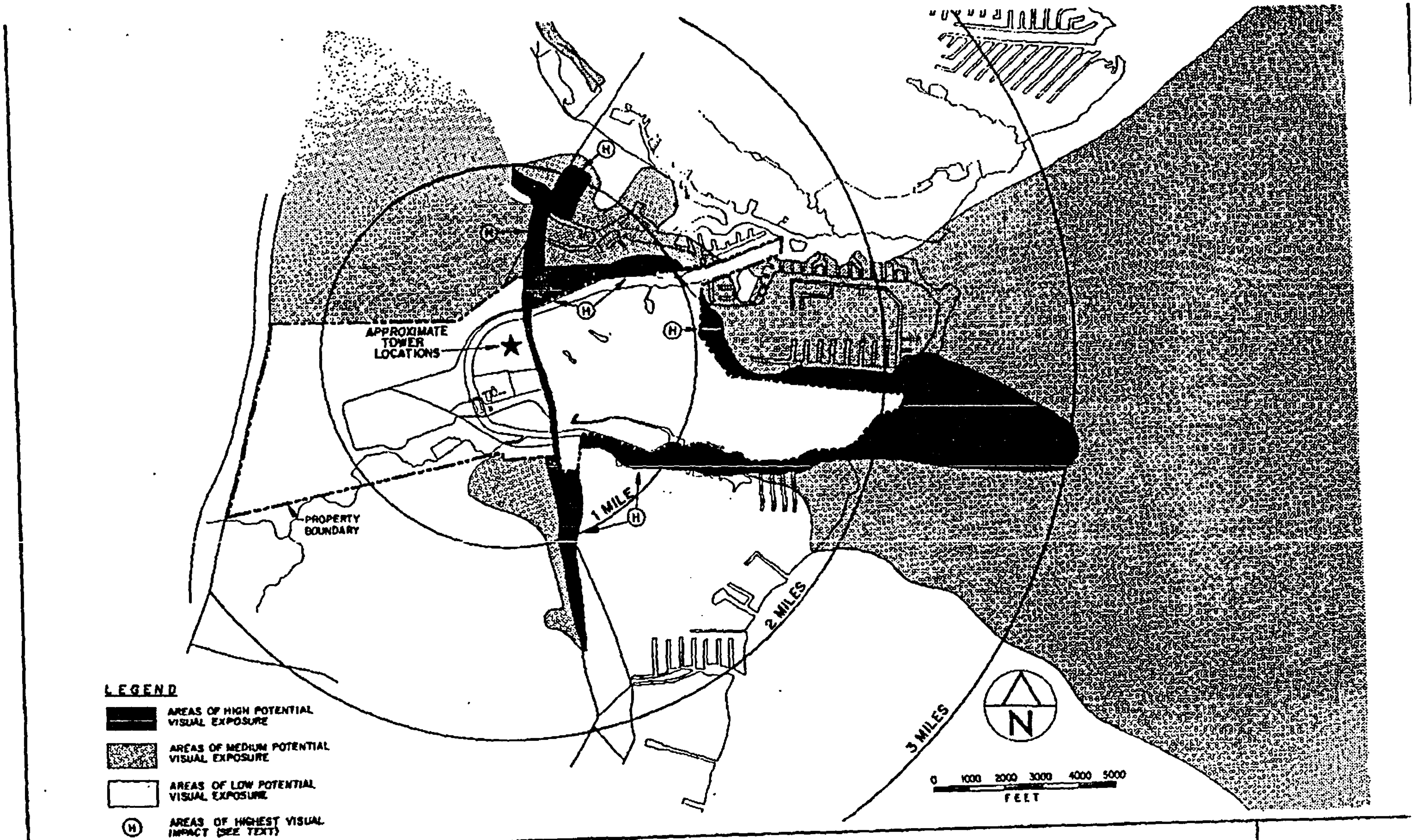
Two other viewing locations from the 1977 assessment were closely approximated for the updated assessment to account for recent development which presently screens views of the plant from these locations. The first of these earlier views, from the backyard of a residence at Nantucket Road and Biscayne Drive in Lacey Township, is now largely screened by the adjacent L&H Plumbing and Heating Supply building on Route 9. The second 1977 view, from a vacant lot on the corner of Nantucket Road and Bermuda Drive, is now virtually eliminated by a home built on the property and much heavier natural vegetation. Approximated views for these locations, identified in Exhibit 4-2d as photographic location numbers 7 and 8, respectively, were selected for their essentially unobstructed views of plant elements and their proximity to the earlier viewing locations they replicate.

One additional viewing location not visited in 1977 was evaluated to assess potential visual impacts of the Oyster Creek cooling towers on major recent development in the site area. This location, within the Pheasant Run residential community in Lacey Township, is shown as number 10 in Exhibit 4-2e. It was selected due to its available view of the project site and the large number of potential viewers residing there. The specific photographic site, near the Pheasant Run Community Center on Canterbury Drive, is the focal point for community activities and includes a swimming pool and other outdoor recreation facilities.

4.2.3 Visual Exposure Analysis

A field survey was conducted on May 14, 1992 to further determine the visibility of the existing station in the surrounding area. This survey, in which the visibility of the existing Oyster Creek Nuclear Generating Station was used as a basis for judgment about the potential visibility of the preferred alternatives, allowed delineation of approximate areas of high, medium, or low visual exposure to high elements at the Oyster Creek NGS plant site. The areas of potential visual exposure and population concentrations are shown in Exhibit 4-5.

Areas of high potential visual exposure were defined as those in which power plant elements (stack, reactor and turbine buildings, and cooling towers) would be dominant in the view available to the observer when he faced in the direction of the plant. In other words, in these areas the observer would be forced to look at the tall elements because of their overriding importance in the scene.



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AREAS OF POTENTIAL VISUAL EXPOSURE TO POWER PLANT ELEMENTS

EXHIBIT 4-5

Areas of medium potential visual exposure were defined as locations where the view of the plant elements would be mitigated by one or more of the following: distance, elevational differences, natural vegetation, or intervening development. In areas of medium exposure, the plant would be viewable but not as obviously dominant for observation as in the "high" category. An example of these areas of medium exposure are roads (with or without trees) which are located in the direction of the facility. Most roads in the area which run approximately north-south would afford some glimpses of the facility. Another example of this type of exposure is the high ground on the north side of the Deer Head Lake - Lake Barnegat complex, where the observer would be looking across the lakes toward the plant site, and the natural vegetation is some distance away.

Areas of low potential visual exposure were defined as areas where the plant is either a great distance away, or there are many intervening structures and/or much vegetation between the observer and the plant facilities. An example of an area of low exposure is the most northerly subdivision in Ocean Township, which is immediately adjacent to the JCP&L property line. Because of stands of existing trees, the plant cannot be readily seen from this residential area despite the fact that it is very close to the plant. The only areas where observers in this subdivision would normally see the plant are those along Oyster Creek, where there are no trees. The interior of the subdivision is very well protected by intervening homes and existing intervening vegetation.

It should be noted that the single most important visual modifier in this region is the presence or absence of existing vegetation. In situations where vegetation is close to the viewer, it will have a maximum screening and blocking effect. Where it is some distance from the viewer, it will have a lessened screening effect but will still serve as a partial screen and softening element. Vegetation also gives scale to scenes because the observer has some intuitive "feel" for the height of a tree. No such comparison is possible with tall plant structures since they lack similar references to scale.

4.3 CONCLUSIONS

4.3.1 General

In general, shapes of both round towers and hyperbolic towers are considered more aesthetically pleasing than that of other configurations since curvilinear surfaces are more eye-appealing and tend to soften the outlines of the form. While the shape of the natural draft cooling tower is

thought to be pleasing, the structure would be 600 feet tall, constituting a dominant visual feature in any vista. In comparison, the round mechanical draft cooling towers would be only 62 feet tall, allowing for visual integration with other facility elements.

In assessing visual and aesthetic impacts of cooling tower systems, consideration must be given not only to the dimensions, shape and location of the towers, but also to those effects resulting from their operation such as elevated plumes and ground level fogging. Section 2.0 - Atmospheric Effects provides further discussion of elevated plumes and ground level fogging.

One advantage to be gained in the location of any cooling towers at the Oyster Creek Nuclear Generating Station, despite their large dimensions, is that they could be placed upon lands already owned by JCP&L and within close proximity to established plant elements. The benefits of this arrangement are two-fold: they would be viewed as part of the overall power plant complex, and not as separate intrusive elements in the regional scene; and they would not require further removal of visually important forested lands for their installation. For this reason, impacts would not be as great as they would be if towers were placed in an area disassociated from the other plant facilities.

Qualitative assessments for the visual and aesthetic impacts of the alternative cooling water systems are provided in Table 4-1. In general, over-all high impact ratings were given to high or extensive structures which would create ground fog and/or visible plumes. Low impact ratings were given to systems of low profile which would create lower amounts of fog and entail small amounts of existing vegetative removal. Finally, the capability of the system to accommodate restorative plantings was also factored into these results. As indicated in Table 4-1, both the natural draft and round mechanical draft cooling tower alternatives are rated as having high potential for visual impact.

Of the cooling tower systems under consideration, the one which would be most acceptable from an aesthetic standpoint is the round mechanical tower. This conclusion is based on the tower shape and ability to blend with other low profile elements. Two towers would be required, each about 62 feet high and 210 feet in diameter. Positioned close to the existing plant, they would tend to combine with other facilities of the site complex, and, therefore, not present a significant visual intrusion.

The natural draft cooling tower would present a pleasing hyperbolic profile and curved surfaces which can intrigue the eye of the observer. Its principal drawbacks would be its large size (409

TABLE 4-1

SUMMARY OF VISUAL/AESTHETIC IMPACTS

Cooling System	Permanent Loss of Vegetative Cover	Profile Impact	Visible Plume	Ground Fog	Combined Impacts
Natural Draft Towers	None	High	High	None	High
Round Mechanical Towers	None	High	High	None	High

feet in diameter at the base and 600 feet in height) and the high level plume which would be observable during the colder months and/or when the relative humidity is high.

4.3.2 Natural Draft Cooling Towers

Visual Exposure

The natural draft cooling tower would be approximately 600 feet in height and would have a base diameter of 409 feet. At the closest point, this tower would be between 350 and 400 feet from the right-of-way of Route 9. For comparison with existing plant elements, the existing turbine building is about 265 feet by 180 feet by 88 feet in height, and the existing reactor building is 145 feet by 140 feet by 146 feet in height. The existing stack is 368 feet tall, and has an exit diameter of about 18 feet.

Exhibit 4-5 shows the area surrounding the Oyster Creek station in terms of relative potential exposure to prominent power plant structures. The areas which would be most heavily impacted are those with high exposure and a high population density.

Photographic Analysis

A structure 600 ft high with an average diameter of 323 ft would have a large impact on the visual aspects of the region, and this is demonstrated by photographs in Exhibits 4-2a through 4-2e. The locations from which these photographs were taken are shown in Exhibit 4-1. As might be expected, the natural draft tower would have a large visual impact upon the viewer who is travelling on Route 9, as shown in Exhibit 4-2c, locations 5 and 6. This tower and other high plant elements would also be seen from Island Beach State Park, some six miles from the facility, where it would be apparent on the bay side, from the Sedge Island area, and from the top of the dunes on the ocean side of this island. However, since most of the visitors to Island Beach Park pursue recreational activities at the ocean shore and in its waters, the visual impacts from the plant structures would be minimal for recreational visitors.

Visible Plumes

An analysis of atmospheric effects (Section 2.0) provided a projection of the length and duration of visible plumes associated with a natural draft cooling tower. This analysis indicated that plumes exceeding 300 meters would be visible essentially all year long. Plumes exceeding

10,000 meters in length would be visible approximtely 10 percent of the time. While plume shadowing, fogging and icing episodes are not predicted to be significant, the virtually constant visible plume would significantly increase the visibility of the natural draft cooling tower system.

Ground Level Fogging

Ground fogging effects from the natural draft cooling towers will be negligible.

4.3.3 Round Mechanical Draft Cooling Towers

Visual Exposure

The two round mechanical draft cooling towers would be 62 feet in height and would have a base diameter of 210 feet. The tower closest to Route 9 would be approximately 650 to 700 feet from the pavement of this thoroughfare. Because of their relatively low profiles, these towers would have low to medium impact upon the viewer, even in a close view such as that presented in Exhibit 4-4b, location 3.

Photographic Analysis

Exhibit 4-3 indicates the locations from which the photographs were taken. There would be vistas from which the towers could be viewed as a single massive unit of approximately 415 feet in diameter, but the effect would be minimized by the low profile of the units. Exhibit 4-4a, location 1, and Exhibit 4-4c, location 5, show the cooling towers as seen from two other locations. These Exhibits show that the round mechanical towers would have the ability to blend in with other elements at the Oyster Creek NGS.

Visible Plumes

The analysis of atmospheric effects (Section 2.0) provided a projection of the length and duration of visible plumes associated with the round mechanical draft cooling towers. This analysis indicated plumes exceeding 400 meters would be visible approximately 99 days of the year. Plumes exceeding 10,000 meters in length would be visible approximately 13.5 percent of the time. While plume shadowing, fogging and icing episodes are not predicted to be significant, the relatively frequent occurrence of visible plumes would significantly increase the visibility of the round mechanical draft cooling towers.

Ground Level Fogging

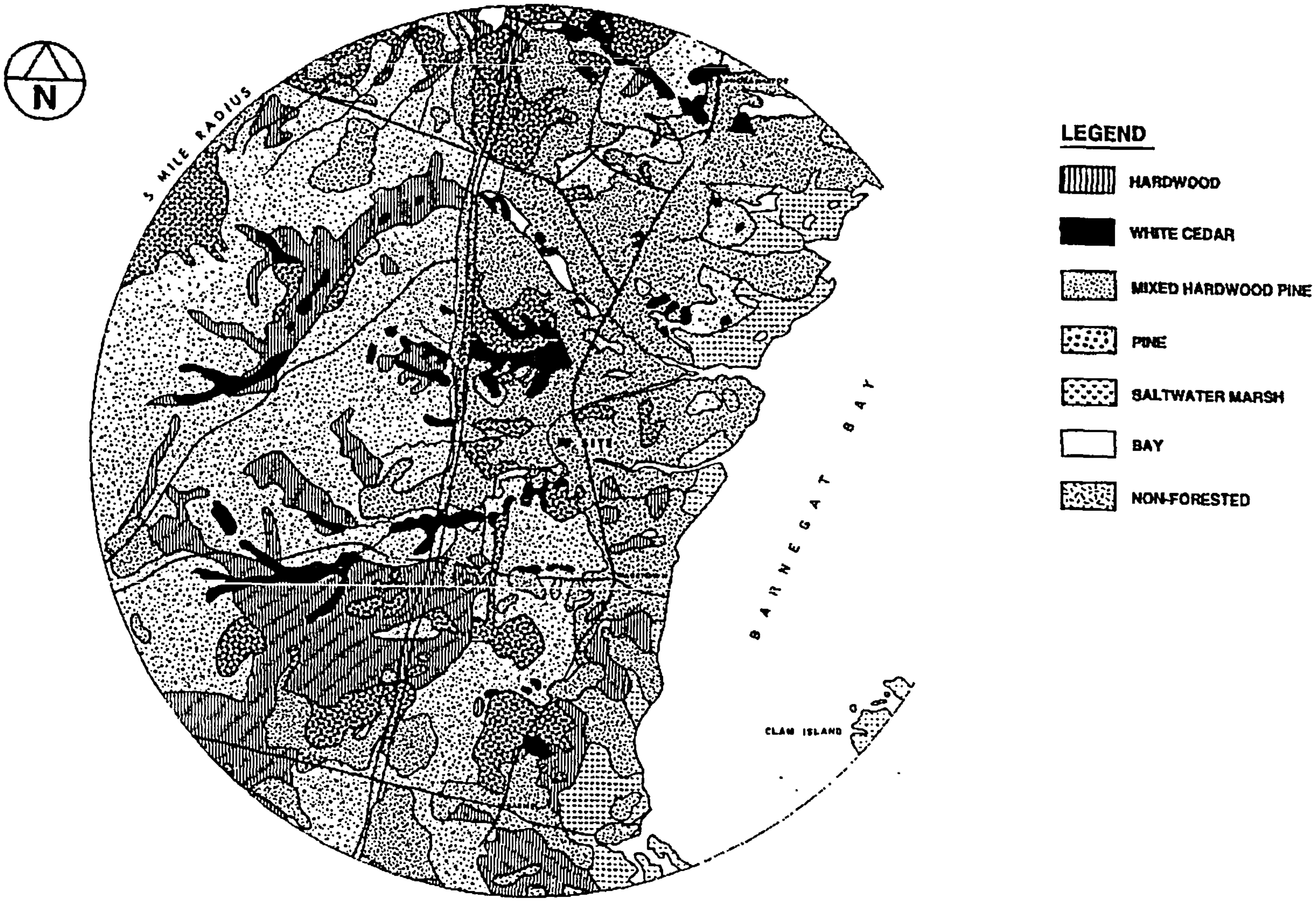
The plume emitted from the round mechanical cooling tower would be expected to reach ground level only about two hours per year at a distance of 100 meters. Thus, the impact due to ground fogging would be negligible.

5.0 TERRESTRIAL EFFECTS

5.1 EXISTING SITE CONDITIONS

The five mile radius study area for the Oyster Creek site encompasses a number of diverse habitat types. The most extensive, approximately 32 percent of the study area, is the mixed pine/hardwood forest community, commonly known as Pinelands habitat. The dominant species within this community includes the pitch pine (*Pinus rigida*) and several oak species, including blackjack, red, and scarlet oak (Exhibit 5-1). Shrub species common to this area are sheep laurel (*Kalmia latifolia*), flowering dogwood (*Cornus florida*), bayberry (*Myrica pennsylvanica*) and bracken fern (*Pteridium latiusculum*). The occurrence and location of vegetation communities is influenced by the topographic relief of the area. The study area is generally flat to slightly sloping. The major soil types in the area, as mapped by the Soil Conservation Service in the Ocean County Soil Survey (1977), coincide with the topography of the area. Lakehurst and Lakewood soils occur in slightly higher areas and generally support pitch pine-oak, or upland shrub communities. Atsion soil generally supports lowland pitch pine forests. Manahawkin muck soils are generally found in low lying areas, such as stream corridors, and support cedar swamps, pitch pine lowland forests or lowland shrub communities.

Overall soil types in the study area are acidic, coarse, sandy soils. The dominant vegetation in the pineland community have adapted to this soil substrate. The coarse, sandy infertile soils of the region produce vegetation that is highly susceptible to fire. The vegetation of the Pinelands has essentially evolved into a "fire environment" (Robichaud and Buell 1973). Species of the upland vegetation are not usually killed by fires. The vegetation, instead, burns to the ground and resprouts readily from its underground systems. Some species grow vigorously following the fires, especially lowbush blueberry (Robichaud and Buell,1973). The May 3, and June 13 1992 wildfires did severe damage to the Pineland and White cedar wetlands communities on the Oyster Creek study site. However, it can be assumed that the upland Pineland areas disturbed by these fires will grow back to their previous stage. The May and June wildfires destroyed approximately 10,450 acres within Lacey Township (Barriesi 1992). Approximately 20 percent of the study area vegetation was destroyed in these fires. The area burned has been approximated, since aerial photography of the destroyed area was not available.



GPU Nuclear Corporation EBASCO	KEY TO VEGETATION IN A 5 MILE RADIUS	EXHIBIT 5-1

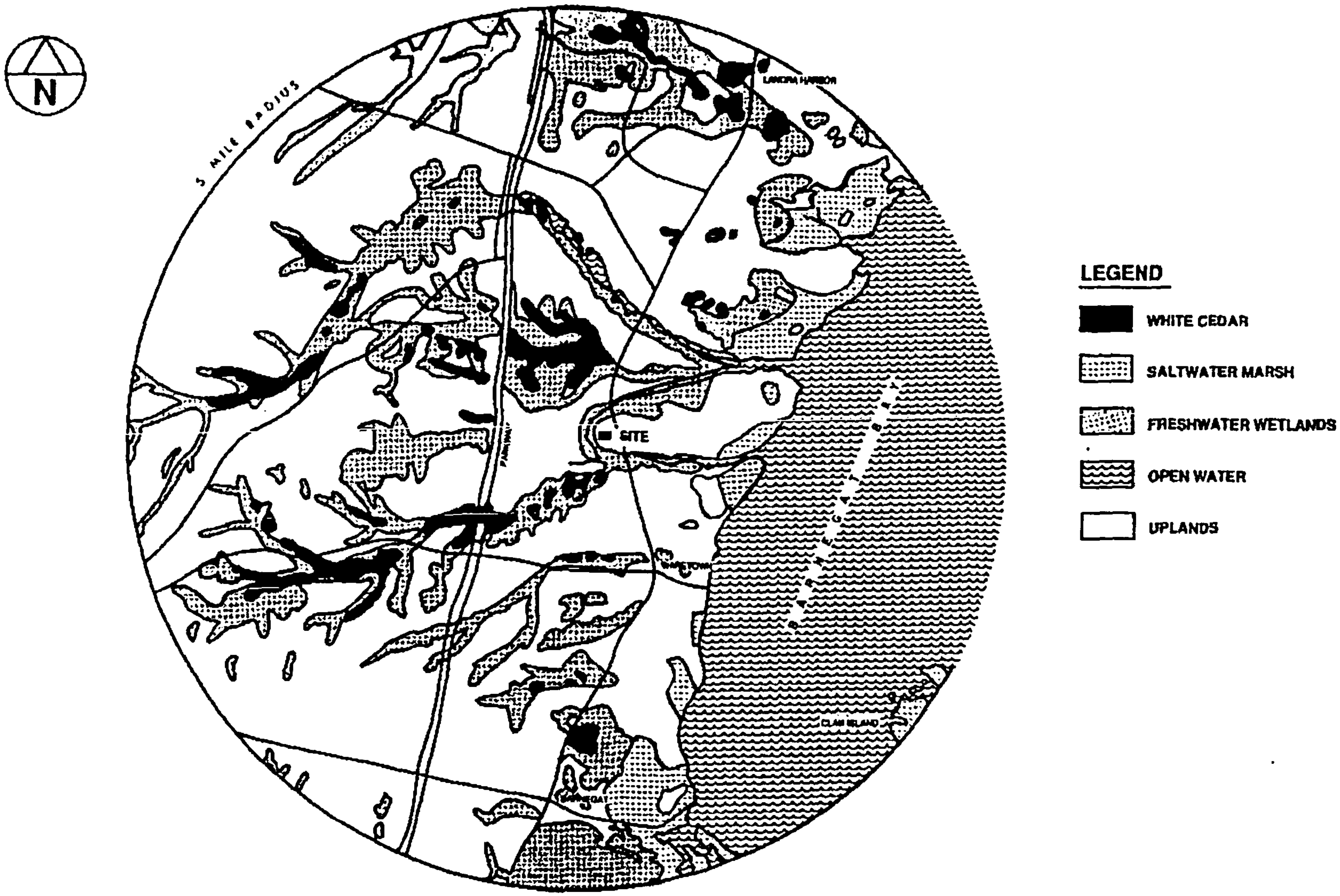
5.1.1 Wetlands

Wetlands are considered sensitive terrestrial ecological areas. Impacts to these areas should be avoided to the maximum extent possible. Wetlands comprise approximately 14.0 percent of the study area (Exhibit 5-2). Atlantic white cedar swamps, and tidal salt marshes are distinguished from the remaining freshwater wetlands because they represent relatively rare and sensitive wetland systems. They are of particular importance due to their scarcity, uniqueness, and habitat values for migratory and resident fish and wildlife. White cedar swamps encompass approximately 1.3 percent of the study area, while saltwater tidal marshes are approximately 3.5 percent of the study area. The remaining freshwater wetlands consist of hardwood deciduous, scrub/shrub and emergent wetlands and encompass approximately 9.8 percent of the study area. The Atlantic white cedar bogs occur in New Jersey on the Outer Coastal Plain in the Pinelands and on the Cape May peninsula. Due to their area specific nature, the Atlantic white cedar bogs are valued for their scarcity and uniqueness. Since 1700 the white cedar swamps of the New Jersey Pinelands have been depleted and destroyed by man's activities and fire. Only a fraction of the once vast white cedar swamps are remaining in the Pinelands (Robichaud and Buell 1973).

The tidal salt marshes which occur along the New Jersey coast are valued for their migratory and resident habitat values for fish and wildlife, as well as their scarcity and uniqueness. The Brigantine/Barnegat salt marsh wetlands within the study area have been designated by the U.S. Fish and Wildlife Service as a "Priority Wetlands Site" under the Emergency Wetlands Resource Act of 1986 (16 U.S.C. 3901). This Act directs the Department of the Interior to identify specific wetland sites that should receive priority attention for land acquisition by federal and State agencies through the Land and Water Conservation Fund. Exhibit 5-3 shows the areas being given priority attention for land acquisition. These areas are under consideration by the U.S. Fish and Wildlife Service for inclusion in the E. B. Forsythe National Wildlife Refuge. These tidal salt marshes are also considered part of a "focus area" in the Joint Venture of the North American Waterfowl Management Plan (NAWMP). The marshes have been identified as high priority wintering and breeding habitat for waterfowl (Day 1992).

5.1.2 Threatened and Endangered Flora and Fauna

Within the 5 mile radius study area, various plant and animal species listed on the State and Federal Threatened and Endangered Species Lists and the Pineland Protection list were identified. Due to the scarcity of these species within New Jersey and the nation as a whole, protection of their habitat is crucial.

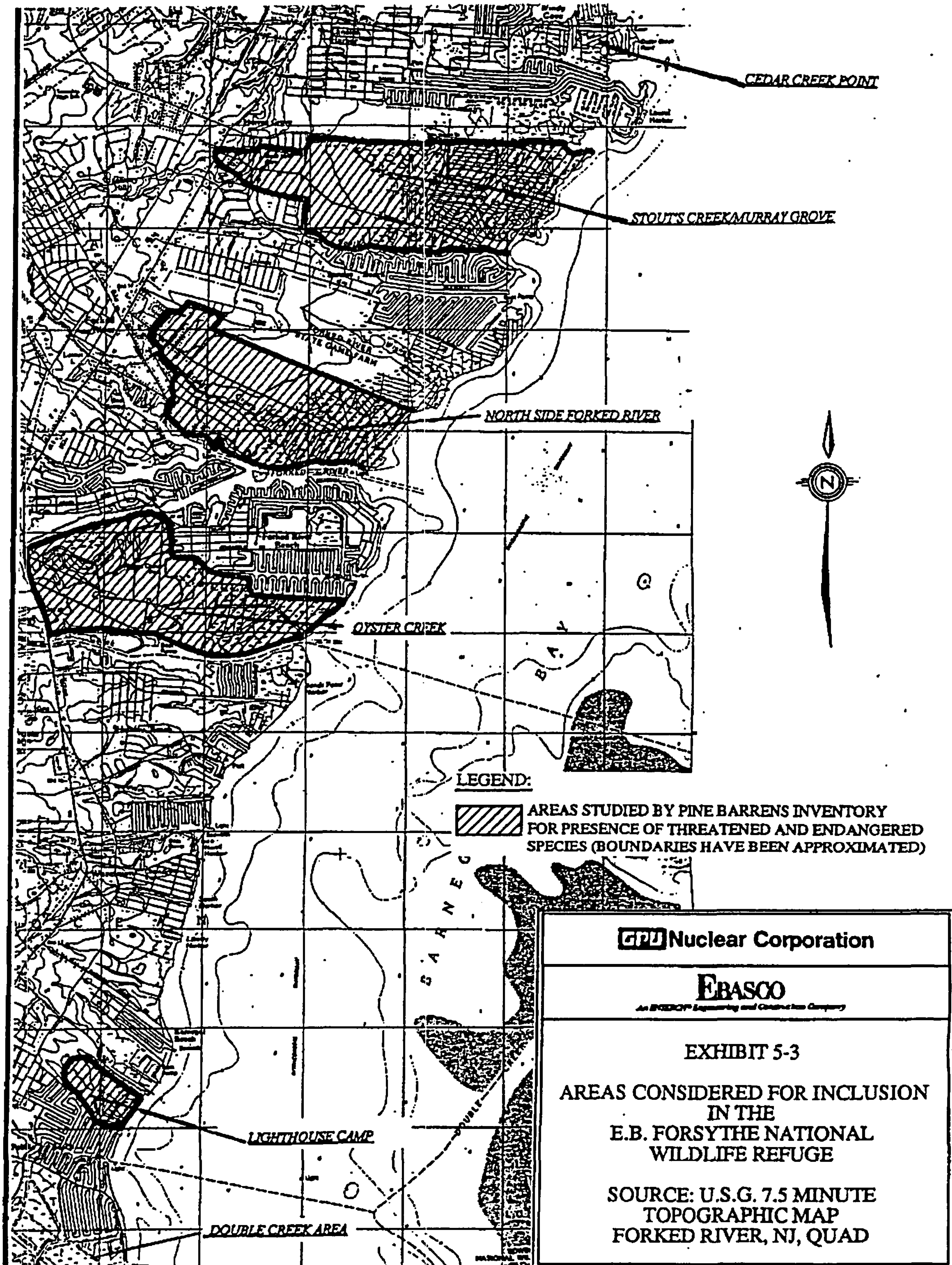


GPU Nuclear Corporation

EBASCO

KEY TO WETLANDS IN A 5 MILE RADIUS

EXHIBIT 5-2



GPU Nuclear Corporation

EBASCO

EXHIBIT 5-3

AREAS CONSIDERED FOR INCLUSION IN THE E.B. FORSYTHE NATIONAL WILDLIFE REFUGE

SOURCE: U.S.G. 7.5 MINUTE TOPOGRAPHIC MAP FORKED RIVER, NJ, QUAD

Because of the diverse habitats present, an abundance of plant and wildlife species exist within the study area. Being located within a migratory pathway also increases the number and diversity of bird species using the study area. Passerine, shorebirds, waterfowl, wading and tropical birds use the Atlantic Coast flyway during their migration (Beall 1992).

The habitat requirements of the rare, threatened and endangered wildlife within the Oyster Creek study area are diverse, ranging from dense woodlands for the Barred Owl (*Strix varia*) to open grasslands for the Grasshopper Sparrow (*Ammodramus savannarum*) (Table 5-1). Based on a wildlife study for nine sites proposed for inclusion into the E.B. Forsythe National Wildlife Refuge, birds were found to be the dominant wildlife species within the Oyster Creek study area. The highest number of species (127 with 53 breeding locally) was recorded at the Forked River site (Exhibit 5-3). The lowest number was recorded at the Sloop Creek site (82 with 43 locally breeding). The site proposed for acquisition located closest to the Oyster Creek NGS is designated as the Oyster Creek site. This area is a large tract of farmland owned by Jersey Central Power and Light, located to the east of the Oyster Creek NGS. The parcel extends from U.S. Route 9 to Barnegat Bay. It is currently in the stages of early succession. The area is an old-field environment with deciduous trees starting to establish themselves. An abundance of choke-cherry (*Prunus virginiana*) was also observed. This area was not disturbed by the May or June 1992 wildfires. A large diversity of bird species was observed in this area (99 species, 57 locally breeding) Five grasshopper sparrows (*Ammodramus savannarum*), listed as a threatened species in New Jersey, were heard singing at the site. Several additional species whose nesting habitat is listed as threatened or endangered in New Jersey were also found within this area. The American Bittern (*Botaurus lentiginosus*), Little Blue Heron (*Florida caerulea*), Great Blue Heron (*Ardea herodias*), Northern Harrier (*Circus cyaneus*) and Osprey (*Pandion haliaetu*) were observed resting and hunting on the property, although these species are not thought to be locally breeding on-site.

Habitats of plant species that are listed as rare, threatened or endangered, and occur within the study area are indicated in Table 5-2.

5.2 IMPACT ASSESSMENT

The proposed impacts of the alternative cooling systems on the site's terrestrial ecosystems would primarily be related to land requirements, effluent characteristics, and structural designs of the proposed systems.

TABLE 5-1
LIST OF RARE, THREATENED AND ENDANGERED ANINMALS WITHIN THE OYSTER CREEK STUDY AREA

Common Name	Scientific Name	Status	Habitat
Wood Turtle	Clemmys muhlenbergii	S-T	Vicinity of streams and rivers. In streams and wooded areas and fields adjacent to stream
Little Blue Heron*	Egretta caerulea	S-T(B)	Marshes, swamps, ricefields, ponds and shores
Corn Snake	Elaphe guttata	S-E	Rocky hillsides, meadows, along stream corridors and river bottoms
Peregrine Falcon	Falco peregrius	S-E, F-E	Variety of open habitats including seacoasts were suitable nesting cliffs, open forested regions
Pine Barrens Treefrog*	Hyla andersonii	S-E, F-P	Streams, ponds, cranberry bogs and other wetlands. Post-breeding habitat surrounding woods
Osprey*	Pandion haliaetus	S-T	Primarily along rivers, lakes and seacoasts
Pine Snake*	Pituophis melanoleucus	S-T	Lowlands to mountains, brushland, woodland, open coniferous forests, farmland and marshes
Black Skimmer	Rynchops niger	S-E	Coastal waters including bays, estuaries (lagoons and mudfalts in winter and migration)
Roseate Tern	Sterna dougallii	S-T, F-P	Seacoast, bays and estuaries
Common Tern	Sterna hirundo	S-D	Lakes, ocean, bays, beaches, nests in colonies on sandy beaches and small islands
Barred Owl	Strix varia	S-T	Dense woodlands(conifer and hardwood), esp. bordering streams, marshes and meadows
Coastal Heron Rookeries	Coastal Heron Rookeries	S-T(B)	Marshes, swamps, ricefields, ponds and shores

Grasshopper Sparrow*	Ammodramus savannarum	S-T	Old fields, open grasslands, cultivated field, savannas
Great Blue Heron*	Ardea herodias	S-T(B)	Freshwater and brackish marshes, along water bodies, ocean beaches
Northern Harrier*	Circus cyaneus	S-E	Marshes, meadows, grasslands and fields
American Bittern*	Botaurus lentiginosus	S-T	Freshwater bogs, swamps, wetfields, brackish and saltwater marshes
Savanna Sparrow*	Passerculus sandwichensis	S-T	Open fields, meadows, salt marshes, pariares, dunes and shores

* Documented siting within the study area
S State
F Federal
E Endangered
T Threatened
B Breeding Population
P Proposed for listing to the Federal Endangered and Threatened species list
D Species exhibiting a continual decline in population

TABLE 5-2

LIST OF RARE, THREATENED OR ENDANGERED PLANTS WITHIN THE OYSTER CREEK STUDY AREA

Common Name	Scientific Name	Status	Habitat
Pine Barren Reedgrass	Calamovilfa brevipilis	F-A, LP	Swamps & bogs in the pinelands of N.J.
Barratt's Sedge	Carex Barratii	F-A, LP	Wet ground especially in pine barren swamps near the coast
Pink Tickseed	Coreopsis rosea	LP	Wet, often sandy or acid soils, or in shallow waters
Twisted Spikerush	Eleocharis tortilis	S-E	Pine barren ponds
Rough Cottongrass	Eriophorum tenellum	S-E	Bogs & swamps
Pine Barren Boneset	Eupatorium resinosum	S-E, F-NP, LP	Wet places especially in pine barrens
Pine Barren Gentain	Gentiana autumnalis	F-A, LP	Moist pine barrens on the coastal plain
Swamp-Pink	Helonias bullata	F-LT, S-E, LP	Swamps & bogs, on the coastal plain
New Jersey Rush	Juncus caesariensis	F-NP, S-E, LP	Sphagnum bogs in the pine barrens
Southern Twayblade Orchid	Listera austrailis	LP	Wet deciduous woods
Whorled Water-Milfoil	Myriophyllum verticillatum	S-E	Submersed in quiet water or rooting on muddy shores
Pine Barren Smoke Grass	Muhlenbergia torreyana	F-A, LP	Moist pine-barrens

TABLE 5-2 (CONTINUED)

LIST OF RARE, THREATENED AND ENDANGERED PLANTS WITHIN THE OYSTER CREEK STUDY AREA

Common Name	Scientific Name	Status	Habitat
Bog Asphodel	Narthecium americanum	F-EX, S-E, LP	Pine barren bogs
Knieskern's Beaked Rush	Rhynchospora knieskernii	F-T, S-E, LP	Pine barren bogs
Short-beaked Baldrush	Rhynchospora nitens	F-V, S-I	Pine barren bogs
Pale Beak Rush	Rhynchospora pallida	F-V, S-R	Acid bogs along the coast
Curly Grass Fern	Schizea pusilla	F-A, LP	On hummocks in bogs or in wet grassy places in acid soils
Long's Bulrush	Scirpus iongii	F-NP, S-E, LP	Wet or damp sandy, clayey or peaty soils
Fragrant Ladies'-Tresses	Spiranthes odorata	S-I	Bogs & wet places especially pine barrens
Pine Barren Bellwort	Uvularia Puberula Var nitida	S-E	Moist woods, also on the coastal plain
Two-Flowered Bladderwort	Utricularia Biflora	S-E	Shallow water on the coastal plain

S State
F Federal
E Endangered
T Threatened
LP Taxa listed by Pinelands Commission as endangered or threatened within their legal jurisdiction
NP Preparing to propose taxa for endangered or threatened species, but currently no substantial data
V Species vulnerable to extinction throughout range
A Species more abundant than previously believed
EX Species may possibly be extinct
I Imperiled in New Jersey because of rarity (6 to 20 occurrences)
R Rare in New Jersey (21 to 50 occurrences)

Impacts resulting from land requirements would depend on acreage required for the construction of the proposed cooling systems and the ecological sensitivity of the affected areas. The presence of wetlands within these areas would be considered an ecological sensitivity factor. Depending on the type of cooling system, effluent effects may be caused by the atmospheric emission of salts and their ultimate deposition on the surrounding environs, or the possible fogging or freezing effects which may occur on vegetation within the vicinity of the cooling systems. Structural design-related impacts could be associated with the proposed cooling systems encroachment into bird flyways.

The alternative cooling water systems were evaluated to consider their physical and chemical characteristics in relation to the terrestrial ecological characteristics of the site environs. Relevant research findings reported in site-related reports and scientific literature were used to rate the type and severity of impacts on a qualitative basis as high, medium, and low or not applicable. The several (e.g., land, flora, fauna) impact "ratings" for each cooling system alternative were then used to derive a summary rating which represented an estimate of the total system's impact on the site's terrestrial ecosystems, relative to the other alternative cooling systems.

5.2.1 Land Requirements

The alternative cooling systems vary in their permanent acreage disturbance, from approximately 10 acres for the proposed cooling towers, to no disturbance for the existing once-through cooling system. The impacts due to the land requirements of the alternative cooling water system would essentially be related to construction of the systems. The clearing of vegetation would eliminate or displace fauna which may utilize the area, and emigrating organisms may be subject to stresses as a result of displacement from their home ranges. Mammals dispersed into unfamiliar surroundings are considered more vulnerable to predators and other causes of death (Boyce Thompson Institute 1974). There are, however, no State or Federally listed rare, threatened or endangered species within the location of the proposed cooling tower construction. Construction of the natural draft cooling tower and the mechanical draft cooling tower systems would disturb approximately 10 acres of land. Most of the land area would be disturbed during construction of the cooling towers. The proposed location for the towers is to the north of the existing power plant. The area is an open meadow with two existing knolls. The soil in this area has been listed as a Psamments, sulfidic substratum by the Soil Conservation Service. This soil unit is classified as a previously filled area consisting of excessively drained to well drained soils. The area was probably filled during the excavation for the plant construction (Browne 1992). A watermound surrounds a portion of the existing intake canal to the north and west of the cooling

tower site. The watermound is a man-made freshwater pond designed to deter salt-water intrusion from occurring during or subsequent to creation of the intake/discharge canal (Browne 1992). It appears that neither tower configuration will disturb the watermound. A drainage swale which collects stormwater drainage from an existing parking lot and discharges into the watermound bisects the proposed location of the cooling towers. The swale is lined with rip-rap, and ponded with water along its downstream end. It is predominantly vegetated with hydrophilic plants. The swale meets the Federal Manual three parameter definition of wetlands. Approximately two acre of wetlands will be disturbed with the construction. To the south the meadow is surrounded by the plant parking area and to the east by the meadow and several pitch pines (*Pinus rigida*) which act as a barrier between the meadow and U.S. Route 9.

Although the original construction of the existing once-through cooling system disturbed approximately 100 acres of land for construction, no further impacts or disturbances are expected for the continued use of this system. The intake canal channels water from Barnegat Bay to cool the plant and then the discharge canal returns the water back to the Bay.

The existing wetland swale, considered an ecologically sensitive area, will be disturbed by the proposed construction of the cooling towers. Therefore, the rating for impacts for both the mechanical draft cooling towers and natural cooling draft tower was given a medium impact rating from the consideration of the wetlands disturbed and the land requirements. The once-through cooling system was rated not applicable, since no additional land will be disturbed for the continued operation of the system.

5.2.2 Atmospheric Effects

Atmospheric effects can be separated into two areas of concern: vapor emissions and salt emissions. Vapor emissions are a concern due to the potential for ground level fogging and ice deposition. Salt emission is a concern because of it potential harmful effects on vegetation.

Vapor Emissions

Ground level fog produced by any of the alternative cooling systems is not expected to impact off-site terrestrial ecosystems.

Ice deposition from freezing steam fog from any cooling system source, including cooling ponds and towers, would be light and friable, similar to that deposited by natural freezing fog (Carson

1976). It is believed that this type of ice, called rime, does not damage woody vegetation, as would dense glaze ice formed from freezing rain and drizzle. The potential for ice damage occurring to woody vegetation, however, is possible under severe weather conditions.

At the Palisade nuclear power plant in Michigan, ice accumulation on woody vegetation from the plume and drift during the severe winter of 1976-77 damaged vegetation by physically breaking branches and entire trees. The ice caused the most extensive damage to woody vegetation that had previously been affected by high levels of sulfates and calcium from the tower's plume and drift. The Michigan plant has two mechanical draft cooling towers which are approximately 66 feet high and designed to cool 757,000 L $min.^{-1}$ of condenser cooling water (Rochow 1978). The major vegetation damage occurred within 166 feet of the towers, with limited additional disturbance continuing beyond that area.

The possibility exists that mechanical draft towers at Oyster Creek NGS could destroy woody vegetation within the vicinity of a tower under severe weather conditions. However, no woody vegetation exists within the area 400 feet to 700 feet from the proposed location of the mechanical draft towers. Only herbaceous vegetation is found within this location, and herbaceous vegetation is not usually injured by ice, because of its dormant winter state. Little published data exists for ice damage to woody plants resulting from vapor emissions of natural draft towers. Because of the height of the proposed natural draft tower at Oyster Creek, frost damage would not be expected to occur. Salt and water particles are more evenly deposited over a greater distance from the towers. Therefore, large accumulations of rime would not be expected to accumulate and cause vegetation to freeze (DeVine 1974).

The existing once-through canal has shown no sign of vegetation damage due to ice (Browne 1992). The area within 2,000 feet of the canal is primarily unforested, see Exhibit 5-1. Any impact due to icing from the canal would be minor in terms of area affected. The only area which has shown any vegetation damage is a small area of white cedars located southeast of Route 9 along the intake canal. It is believed that these trees were killed during two severe storms which occurred in October and November of 1991. During these storms, the elevation of the canal rose due to unusually high tidal activity, and saturated the trees with saline water (Browne 1992).

The ratings of the existing once-through cooling system as well as the natural draft cooling towers for vapor emissions would be a low (minimal) impact rating. No vegetation damage from ice deposition has been recorded along the existing canal and no vegetation damage is anticipated

from the natural draft cooling tower. The mechanical draft cooling towers was also assigned a low (minimal) impact because they are not anticipated to cause extensive damage to herbaceous vegetation, should ice deposition occur.

Salt Emissions

Cooling tower drifts deposit dissolved solids on vegetation and soil in the vicinity of the towers. Plant injury can result if soil salinity increases to levels that inhibit plant water intake, or if specific ions, such as sodium or chlorine accumulate in the plant tissues at toxic concentrations (Bernstein 1975). There are major differences in the injurious effects to plants caused by soil contamination and direct foliar contact. Soil contamination can produce a chronically deteriorating biota over the life of the facility, while foliar contamination can result in a series of damaging episodes independent of one another. Salt particles that are deposited on leaf blades usually wash off during periods of rain. Accumulation of salt on leaf surfaces, however, can occur between rainfalls and may be absorbed by foliar tissue when relative humidity is sufficient to maintain salts in a dissolved state. Morphological studies of salt-stressed plants have indicated reductions in total chlorophyll, chloroplast density, intercellular free space, as well as general leaf thickening as signs of salt contamination within a plant (Hindawi 1976).

The proposed cooling towers are not expected to cause soil contamination. The largest salt deposit expected from the mechanical draft cooling towers is 625.46 kg/km^2/month at 700 meters from the tower. The natural draft cooling tower has a maximum salt deposition of 180.68 kg/km^2/month at 1200 meters. These numbers can be considered inconsequential when compared to a single application of common fertilizer which can add another 10,000 kg of salt/km^2 (Davis and Freeman 1980).

Foliar absorption of salt is more rapid than root uptake and is the principle mechanism of specific ion injury resulting from salt deposition (Bernstein 1975). Relative humidity plays an important role in the absorption of salt by foliar tissues. Depending on the site conditions, a change in relative humidity from 50 percent to 85 percent can double the toxicity of the saline mist (McCune et. al. 1977). The salt particle size also plays an important role in absorption by the leaf blade. In laboratory studies, plants were more injured from chloride ions when 95 percent of the particles were between 50 and 150 micrometers in diameter. Injury to plants was decreased approximately 50 percent when 40 percent of the particles were larger than 150 micrometers (McCune et. al. 1977). In laboratory studies done by McCune and Silberman (1991) the total of exposure duration and range of total salt deposition affected the reaction response of

the plant. Canada Hemlock had the lowest intolerance to salt contamination. A six hour duration of 4.15 micrograms CL^{-}/cm^{2} would cause damage to the tree, while pinto beans could tolerate a salt deposit of 122.7 micrograms Cl^{-}/cm^{2} before damage would occur.

According to Talbot (1979), when assessing the potential impact of cooling tower drift on the biota within the study area, the following should be included:

(1) A comparison of ambient salt levels (natural atmospheric salt loading) and tower salt contribution to the atmosphere;

(2) An objective determination that the cumulative salt load (ambient plus tower-induced levels) will or will not harm the flora or fauna of the region;

(3) Comparison of pre-and post-operational salt levels in native vegetation, and

(4) An investigation of the salt tolerances of plants and animals found in the area influenced by the tower.

The current ambient salt levels within the location of the proposed cooling towers is approximately 1.9 micrograms/meter (DeVine 1974). The proposed natural draft cooling tower is not expected to increase the ambient salt levels by more than 10 percent of the existing level. In the Northeastern U.S., field symptoms of acute injury to plants are not usually observed on indigenous coastal vegetation at ambient salt concentrations below 40 micrograms/meter (DeVine 1974).

At the Chalk Point, Maryland natural draft cooling tower, which circulates 260,000 gpm of brackish water, no evidence of vegetation damage was reported during the partial operating of the tower from May 1975 to April 1976. Although the pre-operational studies done using simulated salt deposition models for the vegetation surrounding the plant predicted plant effects at specific salt deposition levels, the proposed salt levels were not achieved by the cooling tower. Corn, soybeans and flowering dogwood (*Cornus florida*) were all expected to show signs of salt contamination, such as reduced crop yield and leaf damage (Davis 1979).

A study of the effects of salt deposition on indigenous plant species at the Turkey Point, Florida power plant was performed during the pre and post-operation of the plant. The cooling tower is a mechanical draft tower, which circulates saltwater at a rate of 20,000 gpm. The cooling

tower was operating at approximately 40 percent at the time of the study. A power spray module running at the same circulation operated for an additional 6 percent during the study time. The results of the study revealed that indigenous vegetation was not affected by the salt deposition. However, the introduced species including bush bean and corn were affected within 215 meters of the towers. Bush bean was the only plant exhibiting salt toxicity symptoms. Marginal leaf chlorosis and blade discoloration occurred during the three week test period. The bean plants were five weeks old at the initial exposure time (Hindawi 1976).

These two examples of salt deposition effects are normal examples of the majority of post-operative cooling towers reviewed. Short-term exposure was more common than long term chronic exposure. Introduced species such as corn, bush bean and pinto beans were studied because of their sensitivity to salt. Foliar injury that did occur to these plants, although it affected their appearance, did not reduce crop yields. Most of the towers reviewed, however, had lower saltwater circulation rates than the proposed cooling towers at Oyster Creek site.

Therefore, it can be expected that larger quantities of salt deposition will occur at the Oyster Creek study area. If the McCune and Silberman (1991) studies are used to predict the future effects on vegetation at the Oyster Creek site, plant injury would be expected to occur. Field spray application studies by Francis (1977) produced injury to flowering dogwood (Cornus florida) at salt deposition levels between 220 and 1,330 kg Cl^-/km^2/month. Davis and Freeman (1980) used regressors of field data collected by John Hopkins University to estimate that 110 kg Cl^-/km^2/month would cause a 1 percent reduction in corn yields; while 660 kg Cl^-/km^2/month would similarly affect soybean.

Although the vegetation types studied at other sites, such as corn and soybeans, are not located within the Oyster Creek study area, the proposed mechanical draft cooling towers are expected to reach a maximum salt deposition rate of 652.46 kg/km^2/month at 1600 meters east of the proposed towers; the natural draft tower are expected to reach a maximum of 180.68 kg/km^2/month at 1300 meters from the proposed tower.

The existing alternative, the once-through canal, has previously caused no disturbance to the existing vegetation. Therefore, the existing cooling water system of the Oyster Creek NGS is expected to cause no future disturbances to the vegetation surrounding the canal due to salt deposition.

The mechanical draft towers, with their higher predicted concentration of salt deposition, would be expected to have more harmful effects on the vegetation within the study area than the natural draft towers. The mechanical draft cooling tower is therefore given a high (poor) impact rating because of the potential for vegetation disturbance. The natural draft cooling tower was given a medium impact rating, because the salt concentration from the tower, although it is lower than the mechanical draft towers, is high enough to potentially cause vegetation damage. The existing once-through canal was given a low impact rating, since salt deposition has yet to affect the existing vegetation on the Oyster Creek study area.

5.2.3 Structural Design-Associated Impacts

The proposed location of the alternative cooling towers is within the limits of the Atlantic Coast Corridor Flyway. The flyway is the migratory path along the Atlantic Coast that is used by passerine, wading, tropical shorebirds and waterfowl. As was previously discussed, this area is an important location for waterfowl and passerine migration. Passerines would be most affected by construction of the cooling towers. In the majority of mass bird kills associated with airport ceilometers, light houses and other man-made structures, passerines are the species most commonly killed (Avery et al. 1976). This is attributable to the nocturnal migratory habits of passerines. Inclement weather during night migration is the major cause of bird collisions with man-made structures. Inclement weather conditions cause birds to fly at lower altitudes and also appears to attract birds to the light of man-made objects (Gauthruix 1978, Avery 1976).

Migrating birds are affected by weather patterns, such as high winds, cold fronts, storms and low cloud cover. These conditions are responsible for most bird collisions with man-made structures (Avery 1976, McKlusky 1992). Researchers have observed that birds are drawn to the light of the towers or other man-made structures, although disagreement exists on why birds are drawn to the lights. Several researchers believe the birds are guided by the moon and stars, even the constellations, during normal migration. Therefore, on stormy, cloudy or low visibility nights, when the moon and stars are obscured, birds may be attracted to lights believing them to be the moon or stars. (Avery 1976). Birds were attracted to both the white lights of towers and the red warning lights.

Foul weather is also a hazard for daytime migrants. When daytime migrants encounter a cold front or headwinds before making landfall, they will often fly within a few meters of the ground. On these occasions, when flights are delayed and arrival is at night, tremendous numbers of birds may strike wires, towers, etc. (Gauthreaux 1978).

Bird collisions with the 495 foot natural draft cooling tower at the Davis-Besse plant in Port Clinton, Ohio on Lake Erie were monitored during spring and fall migration for approximately six years. Between 75 and 350 birds a season were found dead within the vicinity of the cooling tower. Losses in both seasons were primarily related to cold fronts and high pressure systems (McKlusky 1992). Lighting on the tower consists of four strips of clear halogen lighting and six red warning lights.

At Three Mile Island power plant, located in Pennsylvania on the Susquehanna River, a shorter bird collision study was done during the period of July 1973 to May 1975. A total of 64 birds were discovered at the plant's four 370 foot natural draft cooling towers (Mudge 1975). Many factors could play a role in the reason why only 64 birds were found dead during the study. Scavengers could have removed a number of carcasses from the area, the plant may not be in a major flight pathway for bird migration, or the height of the towers may have aided in keeping the number of bird collisions low.

Height of towers is a major factor in bird collisions. Cooling towers typically range between 10 and 150 meters. Studies conducted during normal migration, using radar to count the number of migrating birds, revealed that most birds normally migrate below an altitude of 500 meters. Studies using direct visual means to detect migratory birds as they passed through a narrow vertical beam of light suggest that a considerable number of birds fly at an altitude of 100 meters or less at night, particularly within the first hour of nocturnal flight and when the birds land during their flights. Daytime migrants normally fly at altitudes below 300 meters and quite often just above tree levels (Gauthruis 1978).

Height and lighting condition appear to be the major causes of bird collisions with towers and man-made structures. The Federal Aviation Administration requires the use of high frequency white and red lights on structures over 200 feet tall. The effects of lighting on migratory birds were previously discussed. Since FAA-mandated lighting would be required on the natural draft cooling tower, the potential of such a tower to attract birds in inclement weather would be higher.

The existing once-through canal will have no associated impacts due to structural design. The canal has had no harmful effects on the birds in the study area, or those migrating through the area. Concerns had been previously been raised that waterfowl flying along the Atlantic Coast may be attracted to the warmer waters of the Oyster Creek NGS discharge canal. The lack of food available in the canal, due to the hypersaline water conditions and the "rip-rap" rock lining the canal, have resulted in the canal being used as only a temporary stopover. Cormorants, loons,

egrets, ospreys, herons and mergansers have all been seen visiting the canal; however, none have become permanent residents (Browne 1992).

The natural draft cooling tower was given a high (poor) impact rating because of the potential for bird collision at the tower. Since the Atlantic Coast Flyway is such an important migratory pathway, building a 600 foot tall obstruction within the flyway would be considered a high risk impact. The mechanical draft cooling tower would be considered a medium impact rating, because bird collisions with this tower are not anticipated to be as extensive as those associated with the natural draft tower. The existing once-through canal is considered to be have a low impact rating. The canal neither causes bird collisions nor hinders migration.

5.3 CONCLUSIONS

The three proposed alternatives, the natural draft cooling tower, the mechanical draft cooling towers and the existing once-through canal, were all considered for their possible impacts due to land requirements, atmospheric effects and structure design.

Land requirements for the two different cooling tower designs were given medium impact ratings, because of the 10 acres required to construct either the natural draft tower or the mechanical draft towers. The cooling towers will also impact 2.0 acres of the wetland areas bordering the existing drainage swale in the cooling tower site. The existing once-through canal received a not applicable impact rating because no additional land requirements are required for the continued use of the canal.

The potential for damage to surrounding vegetation due to fogging or icing effects is considered to be a minimal impact for all three proposed cooling systems.

Vegetation damage (through foliar contact or soil contamination due to accumulation of salt drift) would be a potential problem with the mechanical cooling tower systems. The mechanical draft cooling tower was given a high (poor) impact rating for its potential damaging effects on the vegetation surrounding the site; the natural draft cooling tower was given a medium impact rating for potential vegetation effects. The existing once-through cooling system has proved to have no effect on the vegetation surrounding the canal. Therefore, it was given a low impact rating.

Bird collision would be a potential problem concerning the natural draft cooling tower, resulting in a high impact rating. The mechanical draft cooling tower would present a less extensive

collision obstacle for migratory birds during inclement weather conditions. Therefore, it received a medium impact rating. The existing once-through canal possesses no hazards for migratory birds, and in some instances, may provide a temporary "stopoff" for migratory waterfowl. The existing once-through canal received a low impact rating.

The summary of impact ratings gives the existing once-through canal a low (favorable) rating. The mechanical draft cooling tower alternative has been given a moderate rating. Although the mechanical draft tower may deposit salt at sufficient levels to damage some of the surrounding vegetation, the majority of the vegetation that would be affected is herbaceous vegetation restricted to the Oyster Creek NGS site. The natural draft cooling tower has been given a high (worst) rating, due to the potential bird collisions with the tower.

6.0 REGULATORY REQUIREMENTS

This section briefly discusses the major Federal, New Jersey and local non-air quality/meteorology regulatory requirements expected to affect construction and operation of the proposed cooling towers at the Oyster Creek NGS. It is important to note that this discussion takes a conservative approach to identification of permits due to the conceptual stage of project development. The objective of this approach is to reduce the possibility that changes in design specification and facility layout could result in additional licensing requirements beyond those identified in this document.

6.1 FEDERAL REQUIREMENTS

6.1.1 Clean Water Act, Section 404/Rivers and Harbors Act, Section 10

Authorization is required from the U.S. Army Corps of Engineers (ACOE) Philadelphia District to discharge dredge or fill material into waters of the United States (Clean Water Act, Section 404) or to place a structure or conduct dredging activities in a navigable water of the United States (Rivers and Harbors Act, Section 10). A "discharge" includes the placement of fill material into waters of the United States and associated tidal and freshwater wetlands. "Placement of a structure" in a navigable waterway includes the construction of an intake or discharge structure below the mean high water mark of a navigable waterway. The need for ACOE authorization may be triggered by the construction of cooling towers and associated structures at the Oyster Creek NGS if these activities impact wetlands or if proposed structures are located within navigable waterways.

There are two ways to obtain ACOE approval for these activities: 1) through an individual permit; or 2) under the nationwide permit (NWP) program found within 33 CFR 330.5. An individual permit application requires the proponent to justify why navigable waterways and wetlands should be disturbed (a presumption exists that wetland disturbances should not be approved for non-water dependent activities) and submit to the ACOE decision-making process, including the possibility of a public hearing. In contrast to the individual permit, the nationwide permit program is based on the good faith of the permittee. Although most applicants send a letter of notification, the nationwide permit program allows activities which meet certain conditions to be authorized without communication with the ACOE or the Section 401 water quality certification program as administered by the State of New Jersey. Examples of available nationwide permits include those for the construction of selected outfall structures (Permit No.

7); and the discharge of fill material into less than one acre of wetlands (Permit No. 26). Each of these nationwide permits contain restrictions and/or conditions which must be complied with prior to authorization.

Another important distinction between a nationwide permit and individual permit is that, under the individual permit, the National Environmental Policy Act (NEPA) requires that the ACOE scrutinize with a greater degree of care the environmental impact(s) of the activity. With enough public interest, an activity that requires an individual permit could require an Environmental Impact Statement (EIS). Typically, the scope of the EIS would be limited to the scope of the activity triggering the individual permit.

Because the proposed project could be constructed on or near wetlands, a wetlands delineation is recommended for this site for subsequent submittal to the ACOE, Philadelphia District as part of any nationwide permit application. This delineation will better pinpoint total wetland coverage, wetland quality, and the total area of land suitable for development.

Assuming that construction related activities for the proposed project would qualify for nationwide permitting, approximate ACOE review time is typically 45 days.

6.1.2 Federal Aviation Act

Pursuant to Section 1101 of the Federal Aviation Act, the Federal Aviation Administration (FAA) requires that notice be given to the FAA before a construction permit is filed for any proposed construction or alteration to navigable airspace which would be over 200 feet above ground level at the site or in which the construction will be proximate to an airport or heliport. Construction of a natural draft cooling tower will require notice to the FAA.

A "Notice of Construction Form" must be prepared and submitted to the FAA at least 30 days before the earlier of either:

- The date of the commencement of construction; or

- The date an application for a construction permit is to be filed.

Upon receipt of the application, the FAA will study the effects of the proposal on navigable airspace and make a determination as to whether the project would be an obstruction to navigable

airspace. To determine this, the FAA uses standards under Subpart C of 14 CFR 77 which are based on the height of the construction or alteration and its proximity to surface levels and imaginary surface levels of airports and heliports. Review time is generally 90 days.

FAA will acknowledge the receipt of the notice in writing. The acknowledgement will also contain any marking and lighting requirements and a statement that the aeronautical study has resulted in a determination that the construction or alteration:

(1) Would not exceed the standards and will not be a hazard to air navigation;

(2) Would exceed the standards but would not be a hazard to air navigation; or

(3) Would exceed the standards and further aeronautical study is necessary to determine whether it would be a hazard to air navigation. This study may be requested by the applicant within 30 days. Pending completion of the study, the construction or alteration is presumed to be a hazard to air navigation.

6.2 NEW JERSEY REQUIREMENTS

6.2.1 Coastal Area Facility Review Act (CAFRA) - Coastal Permit Program

CAFRA was enacted into law in 1973. CAFRA implementing regulations provide a process in which certain facilities in the "CAFRA zone" require preconstruction review and approval. The Oyster Creek NGS site is in the CAFRA area and electric generating stations are one of the facilities defined as requiring CAFRA approval. The construction of cooling towers associated with the Oyster Creek NGS will likely require CAFRA approval.

CAFRA application procedures are set forth in the Coastal Permit Program rules (NJAC 7:7). These procedures represent a consolidation of rules for CAFRA, the Waterfront Development Law, and the Wetlands Act programs. The major permit procedures required for CAFRA include an optional pre-application conference, an application and an EIS. All applications for CAFRA permits are evaluated against location, use and resource policies as specified in the state's applicable Coastal Resource and Development Policies (NJAC 7:7E). Specific criteria for electric generating facilities are contained in 7:7E-7.4(b)(9).

The New Jersey Department of Environmental Protection and Energy (NJDEPE) will require an EIS for CAFRA regulated activities and all major wetlands and waterfront development permit applications. The purpose of the EIS is for the applicant to present to the NJDEPE and the public sufficient level of detail and information on the proposed project effects and its potential to impact natural resources and human activities at the project site and surrounding region. An EIS must conform to the format set forth in the waterfront development regulations which requires in-depth information on all water-related and land use and construction practices. The requirement for an EIS will vary depending upon the nature and complexity of the project and surrounding area. A pre-application meeting with the NJDEPE Land Use Regulation Element staff will confirm the issues and content of any EIS to be prepared for this project.

Note that, in the CAFRA area, CAFRA governs construction of certain facilities, the Waterfront Development Act applies to the actual waterfront and land under tidal and navigable waters, and the Wetlands Act controls certain actions in coastal wetlands. The same substantive standards apply to all three programs, e.g., the Coastal Resource and Development Policies.

6.2.2 Waterfront Development Act - Coastal Permit Program

The Waterfront Development Act (NJSA 12:5-3) requires approval of a waterfront development permit prior to work on any waterfront or in any tidal or navigable waterway. The actions covered include dredging, filling, and the erection of structures such as docks, bulkheads, piping and intake or discharge structures. The procedural and substantive requirements are found in the Coastal Permit Program and the Coastal Resource and Development Policies discussed above under CAFRA. The installation of the intake/discharge structures in the existing Oyster Creek canals may require a Waterfront Development permit assuming the structures will be located below the mean high water mark. Projects subject to the provisions of the Waterfront Development Act are exempt from Stream Encroachment Permit requirements (NJAC 7:8 et. seq.).

It can be anticipated that NJDEPE review of any CAFRA application for the proposed project, including related waterfront development and coastal wetlands approvals, would likely take six to nine months to complete.

6.2.3 Wetlands Act - Costal Permit Program

The Wetlands Act (NJSA 13:9A-1 et seq.) imposes a permit requirement for construction or filling of coastal wetlands. Wetlands maps have been prepared which delineate areas governed by the Act. The procedural and substantive requirements for the Act are governed by the Coastal Permit Program and the Coastal Resource and Development Policies, discussed under CAFRA.

Given the locations of the proposed cooling towers, it is possible that mapped wetlands could be impacted and therefore, a coastal wetlands permit may be required.

6.2.4 Water Quality Management Plan Consistency Determination

Pursuant to the State Water Quality Act, discharges to surface water from projects subject to CAFRA require a determination that the project does not conflict with the Statewide or Areawide Water Quality Management Plans.

The application for Consistency Determination must include a narrative description of the project, which presents the geographic location, type of development, and anticipated wastewater flow; a USGS Quadrangle map showing the project site boundaries and discharge location; and sealed drawings or plans which illustrate all proposed structures and infrastructure.

Upon review of the initial application submittal, the NJDEPE may request additional supporting documentation. To avoid such delays, any supporting documentation which may be required should be discussed and determined at the CAFRA permit pre-application meeting. Consistency Determination applications would be reviewed by the Wastewater Facilities Management Division of the NJDEPE.

6.2.5 Riparian Lands

In New Jersey, submerged lands washed by the ocean tides are called riparian lands. Defined by statute, these are lands which are now or were previously covered by mean high tide to which the state has a claim. These lands also may include filled areas formerly subject to tidal action. The State owns the land as a trustee for the public and exercises its control either through its proprietary role as owner, or through its regulatory rule under the Waterfront Development Law (see N.J.S.A. 12:5-3). The existence of unsatisfied riparian claims at the proposed cooling tower site is not known to Ebasco, and should be investigated during further project efforts.

The State's ownership role is exercised by the Tidelands Resource Council which may grant, lease, or license the State-owned tidelands. A large portion of the State's riparian lands were sold in the nineteenth and early twentieth centuries. However, the present practice of the Council is to license the use of the land, unless exceptional circumstances warrant a grant.

The Council itself is composed of twelve citizens appointed by the Governor with the advice and consent of the State Senate. The Council is independent of either the executive or legislative branches, although it does rely for staff support on the Land Use Regulation Element of the NJDEPE. The NJDEPE Commissioner and the Assistant Commissioner for Environmental Regulations may veto the minutes of the Council and return the affected applications to them for reconsideration. If the Council reaffirms its decision, administrative and judicial appeal options are available to the aggrieved party.

6.2.6 Pinelands Protection Act

The Pinelands Protection Act (NJSA 13:18A-1 et. seq.) established the Pinelands Commission and gave the Commission review authority over all new development within the state Pinelands area. The Pinelands area is defined by the Act and encompasses all or portions of 52 municipalities in 7 counties, including portions of Lacey Township. The Pinelands area is basically divided into an outer "Protection Area" and an inner "Preservation Area". Information provided to Ebasco indicates that the proposed cooling towers will not be located in either a Protection or Preservation Area, and as such, it is anticipated that construction of the proposed towers will not be subject to Pinelands Commission review or the provisions of the Lacey Township ordinancies regarding activities in the Pinelands Area. Coordination provisions exist by which the Commission may participate in permitting actions of other agencies (NJAC 7:50-4.71-4.75).

The decision criteria in the Act are that an application is disapproved if the development would not conform to the Plan or its minimum standards, or would result in "substantial impairment of the resources of the Pinelands area." (NJSA 13:18A-15).

6.2.7 Modification to Existing New Jersey Pollutant Discharge Elimination System Permit (NJPDES)

NJDEPE exercises the Federal NPDES permitting power under the NJPDES regulations (NJAC 7:14A-1 et seq.) and the New Jersey Water Pollution Control Act (NJSA 58:10A-1 et seq.). NJPDES regulations govern the issuance of permits for point source discharges to surface waters. Based upon Ebasco Environmental's understanding of the proposed project, cooling tower blowdown will be discharged to the existing Oyster Creek NGS discharge canal. This discharge of cooling tower blowdown to surface waters will require a modification to the existing Oyster Creek Nuclear Generating Station NJPDES permit.

NJPDES regulations (NJAC 7:14A-3.17) incorporate EPA's technology-based treatment criteria for alternative thermal effluent limitations and for criteria applicable to cooling water intake structures included in Sections 316(a) and 316(b) of the Federal Clean Water Act. A NJPDES permit application could require the performance of impact studies in accordance with Sections 316(a) and 316(b). A 316(a) study evaluates the thermal impacts of the outfall plume on a receiving surface water body while a 316(b) study evaluates the biological impacts of an intake structure on fish and other organisms in a water body.

Discharge characteristic descriptions would require significant detail on water treatment additives such as biocides used to treat cooling water. Monitoring of these chemicals will be required and stringent water quality regulations could preclude the use of some chemicals. Wastewater quality must comply with both state pollutant discharge limits which can be project specific as well as with New Source Performance Standards established by the federal Clean Water Act (40 CFR 423). Approximate review time frames for NJPDES Discharge to Surface Water permits is six months depending upon the scope of the proposed discharge.

6.2.8 Treatment Works Approval

In addition to a NJPDES Permit for the discharge of wastewater, the facility may also be required to obtain a Treatment Works Approval from NJDEPE for the construction and operation of process equipment associated with wastewater treatment activities. An application for Treatment Works Approval consists of calculations, construction drawings of the equipment, and other similar engineering information. This application must be submitted and approved by the NJDEPE before the equipment is installed. Approximate NJDEPE review time for Treatment Works Approvals is 90 days.

6.2.9 Water Allocation Permit

This permit requires any facility diverting more than 100,000 gallons of water per day from surface or groundwater for non-agricultural purposes to establish its privilege to divert the water, and to obtain a water supply allocation permit. The necessity to obtain this permit for withdrawals in excess of 100,000 gallons from the Oyster Creek NGS intake canal is dependent upon the water quality classification of the intake canal at the point of withdrawal. If the water is classified as saline, no permit is necessary. If classified as brackish, the NJDEPE retains the authority to review the classification and use in order to determine whether a permit will be necessary. Fresh water withdrawals will require a permit.

6.2.10 Water Quality Certification

NJDEPE conducts Section 401 water quality certifications for dredging projects to regulate the method of dredging, turbidity, sedimentation controls, dewatering and disposal and any other activity triggering an individual ACOE permit. Also, quantity and sites of dredging, dewatering and disposal are regulated. The purpose of the certification is to assure that New Jersey water quality standards are not violated by the proposed dredging activity.

It is anticipated that any water quality certification would be processed in concert with the NJPDES permit modification required for this project.

6.2.11 Dewatering Permit

This construction-related permit must be obtained from NJDEPE, Bureau of Water Supply Allocation for any water rerouting which may occur during the construction of subsurface facilities (e.g., foundation).

6.2.12 Discharge Prevention, Containment and Countermeasure (DPCC) Plan/Discharge Cleanup and Removal Plan (DCR)

A major facility, i.e. a facility with total hazardous materials storage capacity in excess of 20,000 gallons, is responsible for implementing a DPCC/DCR Plan that has been approved by the NJDEPE and details types and volume of hazardous waste/substance storage capacity, spill containment and control measures (e.g., curbs, dikes, berms) and measures/actions to be taken to contain and clean-up discharges of hazardous substances. Plans must also include drainage

and land use maps detailing land areas within 1,000 feet of the facility boundary, including all arterial and collection sewers, storm drains, catchment or containment systems, diversion systems and water courses into which surface water run-off from the facility would drain. Topographic maps, showing environmentally sensitive areas extending to the maximum area of potential impact of any hazardous substance discharge must also be included in the Plan. In addition to the DPCC/DCR plans, major facilities are subject to extensive requirements regarding the design standards for equipment, the type and frequency of maintenance and inspections, personnel training, operating procedures and recordkeeping.

The storage of additional water treatment chemicals at the Oyster Creek NGS facility to support cooling tower operations may trigger either development of a new DPCC/DCR Plan or modification of an existing plan.

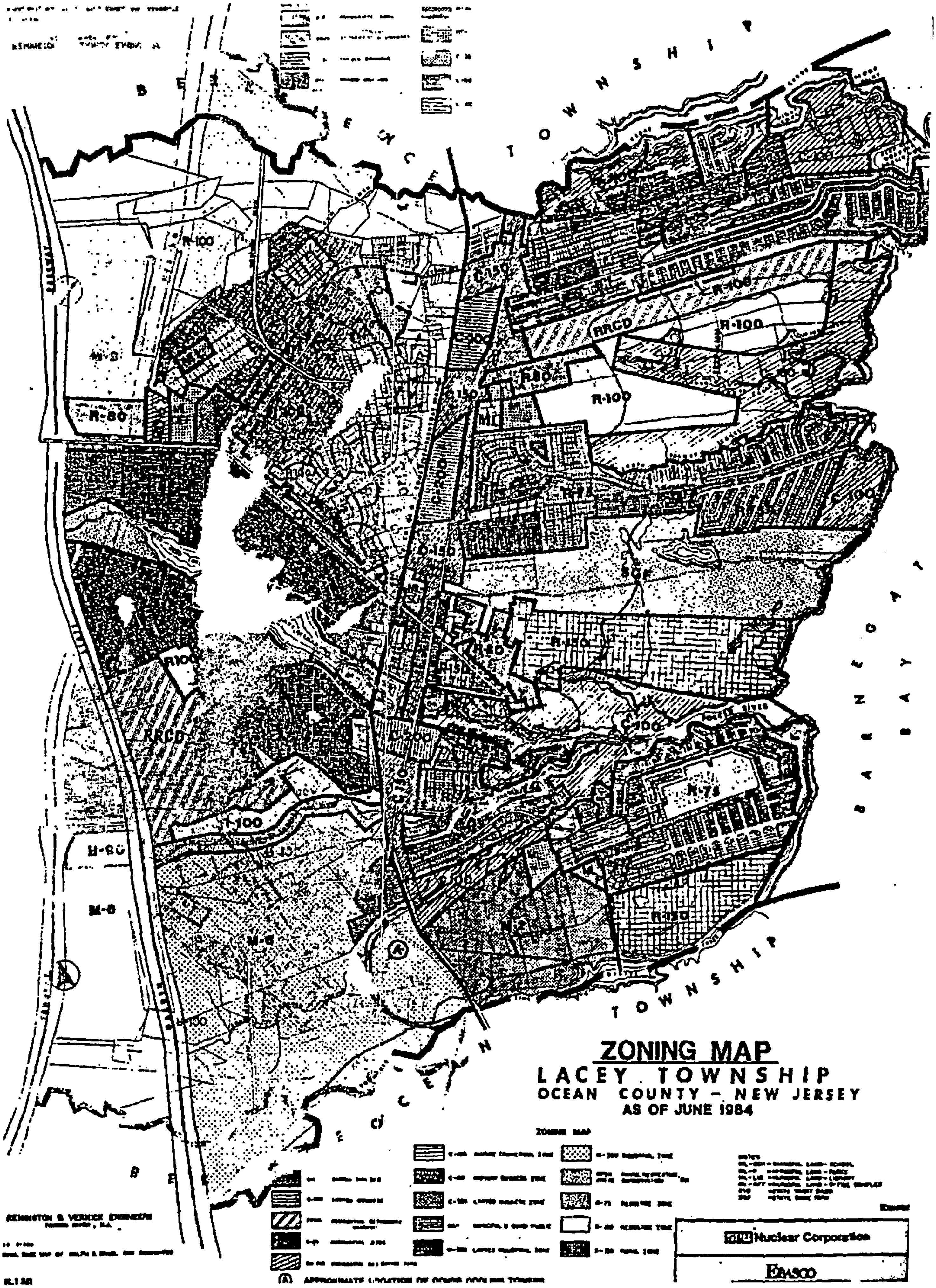
6.3 OCEAN COUNTY

6.3.1 Site Plan Review

Ocean County, through the Ocean County Planning Board, retains a limited amount of site plan review authority over projects within the county. This review authority extends to any application for development approvals which may affect county roads with regard to access, expansion, setbacks, drainage, etc. The county also retains site plan review authority over projects which involve one acre or more of impervious area due to the county's jurisdiction over certain drainage structures which may be impacted by a project.

6.3.2 Soil Erosion and Sedimentation Control Plan Certification

Certification from the Ocean Soil Conservation District (SCD) is required for projects that disturb more than 5,000 square feet of surface area of land. An application for plan certification must include a development plan. This plan should specify the schedule and duration of all the construction activities (e.g., clearing, excavation, storing, grading, filling, transporting of soil, etc.) which will disturb surfaces and cause soil to be exposed to potential erosion. The area and quantity of soil to be disturbed as attributable to each of these construction activities should also be provided. Additionally, the plan should include a site drawing showing existing topography and the location and type of sedimentation and erosion control measures (e.g., hay bales, sediment fences, etc.) to be utilized on the project.


ZONING MAP
LACEY TOWNSHIP
OCEAN COUNTY - NEW JERSEY
AS OF JUNE 1984
BERKELEY TOWNSHIP
OCEAN TOWNSHIP
BARNEGAT BAY
R-100
R-80
M-5
RRCD
C-100
C-200
C-150
R-75
R-90
I-100
Nuclear Corporation
EBASCO

6.4 LACEY TOWNSHIP

6.4.1 Zoning Ordinance (Chapter 108)

Information received to date by Ebasco Environmental indicates that the proposed site of the cooling towers is to be located in a M-6, or Industrial, zone (see Exhibit 6-1, Lacey Township Zoning Map). According to Section 108-51 of the Ordinance, "public utility activity constituting the manufacture of electricity" is considered a prohibited use. Although considered prohibited, the Oyster Creek Nuclear Generating Station, as a function of being a non-conforming use (use does not conform to the regulations of the Ordinance for the zone in which it is located), is permitted continued existence in the M-6 zone. However, according to Section 108-22 of Article IV (Nonconforming Uses and Structures), nonconforming uses shall not be:

- Enlarged, extended, or increased;
- Expanded; or
- Further reduced in size.

As a non-conforming (and prohibited) use, Lacey Township would likely take the position that the installation of cooling towers at the existing facility can only be permitted if a variance is granted. If so required, requests for variances are heard by the Township Board of Adjustment during one of its regularly scheduled meetings. Site plan review can be conducted simultaneously with any variance request by the Board of Adjustment, subject to the same conditions and restrictions as would be imposed by the Township Planning Board during site plan review.

6.4.2 Site Plan Review (Chapter 90)

In addition to zoning provisions, the Ordinances of Lacey Township address site plan review procedures as administered by the Planning Board. Site plan applications need to be prepared at a scale of one inch equals 50 feet and must be at least 15" x 20", but no larger than 30" x 40" and should be drawn and certified by a New Jersey licensed professional engineer.

Applications should be submitted to the Planning Board which must notify the applicant of a complete application within 45 days of submission. The Planning Board may grant preliminary approval to site plan applications upon determination that the site plan application is complete and complies with all applicable statutes, laws, regulations and ordinances of the state, county

and township. Preliminary approval must be granted or denied no later than 45 days after submission of a completed application for development of 10 acres or less of land and 95 days for development of over 10 acres of land. Final approval must be granted or denied within 45 days after submission of a complete application for final site plan approval.

The Ocean County Planning Board may have review authority over site plan applications pursuant to NJSA 40:27-6.6. When the county has review jurisdiction, the Township Planning Board may condition its site plan approval on the County Planning Board's determination.

In cases where the Zoning Board of Adjustment has review authority pursuant to NJSA 40:55D-74, the review time shall comply with the Township Zoning Ordinance.

In reviewing any site plan, the Planning Board shall consider a number of design criteria. Some of the design criteria are:

- buffering
- landscaping
- lighting
- storm drainage, sanitary waste disposal, water supply and garbage disposal
- soil erosion, preservation of trees, noise, protection of watercourses
- traffic analysis, on-site parking and off-street parking and fire safety and protection

Site plan applications will not be considered complete for filing until an Environment Impact Statement has been submitted to the Township Environmental Commission if the land use will have a substantial impact on the environment. Applications must include a detailed project description from the construction phase to operation, an inventory of existing environmental conditions, potential adverse environmental impacts of the project and measures which will be taken to avoid them.

6.4.3 Flood Hazard Area (Chapter 68)

This chapter applies to all streams and areas of special flood hazards within the jurisidiction of the Township as detailed in adopted reports and maps.

The placement of structures or fill materials into the flood hazard area within the Township requires a Development Permit from the Township Zoning Office. Flood hazard areas are

defined to include areas delineated according to the Flood Insurance Rate Map for Lacey Township (Federal Flood Insurance Administration). Applications to the Zoning Office should include project plans showing nature, location, dimension and elevation of all existing and proposed structures, fill, storage of materials and drainage facilities and the plans must be certified by a New Jersey P.E.

The Township Zoning Officer will review applications and notify the NJDEPE and Federal Flood Insurance Administration. Applications will be considered with the site plan application and are therefore likely to be subject to the review time frames as set forth in the Township site plan review regulations. If the development permit application is denied, the applicant can apply to the Township Board of Adjustment for a variance.

7.0 ECONOMIC ANALYSIS OF CONSTRUCTION ALTERNATIVES

The economic review and analysis presented in this document is based on parameters and findings set forth in a report issued by National Economic Research Associates, Inc. (NERA) on November 28, 1977.

This review study investigates the economic costs incurred from the installation and operation of one of two alternative cooling systems being considered for the Oyster Creek Nuclear Generating Station. The thrust of the analysis is to examine the impact of increased capital, operating and maintenance costs to JCP&L and the public at large, as well as perform a largely qualitative assessment of environmental costs to assess the total viability of each alternative from a public policy perspective.

Assessment of financial costs of the two alternative systems are examined for both the installation and operation phases and are presented in the Technical and Economic Evaluation report (Volume I). These include investment capital costs as well as maintenance costs, water costs, etc. associated with the operation of the circulating water system.

Operation of the of the cooling tower(s) may result in a number of adverse environmental effects. These effects are: (1) the production of ground level fogging and, in sub-freezing weather, surface icing conditions which may create hazards for local road traffic; (2) the emission of salt into the atmosphere from cooling which may adversely effect local sustainability of vegetation, aquatic life and physical infrastructure and; (3) increases in background noise levels which may potentially result in loss of residential land use which will in turn affect the local property tax base as well as result in acquisition and transfer costs incurred by JCP&L which are likely to be transferred to its customers. Projected capital and economic costs to the public associated with the two alternatives are as follows:

7.1 CAPITAL COSTS

Capital and operating costs to be incurred as a result of the implementation of either alternative are presented as part of the engineering analysis. It is important to note that capital costs incurred as well as increased operating costs may result in the utility's need to increase prices to pay for these added expenditures. Thus, environmental/economic benefits to the public at large from implementation of either alternative may be counterweighed by increased electricity costs (i.e., mitigation of current problems may prove cheaper).

7.2 ECONOMIC COSTS

Economic costs as discussed in the context of this proposed action are largely reviewed at a qualitative level. These projected costs are attributable to the degradation of the physical environment and quality of life in the vicinity of the plant resulting from implementation of one of the alternative cooling systems. These costs or impacts, are expected to be manifested in three primary ways.

7.2.1 Ground Level Fogging and Icing

Operation of the two round mechanical draft cooling towers is expected to produce incremental increases in hours of ground-level fogging and icing. The natural draft cooling tower is not expected to have measurable impact on natural atmospheric conditions. Increased incidents of fogging and icing impose costs on society primarily through their effects on ground conditions. These potential impacts were examined in the case of vehicular traffic on Route 9 in the NERA evaluation (1977). Assumptions were made as to the potential effects of incremental hours of fogging and icing on expected numbers of accidents, fatalities, injuries and property damage. It was determined that any lost production, hospital and medical costs, administrative costs, vehicle damages and values of lost time due to accident-induced traffic delays, will be regionally negligible and likely to affect only those residents in the vicinity of the plant.

7.2.2 Atmospheric Salt Deposition Impacts

Emissions of sea salt from the towers may lead to corrosive effects on metal systems, residential home siding, landscaping, boats and automobiles. Increased rates of salt deposition may also result in impacts on local vegetation and aquatic life due to settling of salt into wetland and vegetative areas.

Any economic impacts from atmospheric salt emissions on economic activity generated by recreational fishing within the vicinity of the plant will be at best negligible. It is anticipated, however, based on the NERA (1977) study, as well as an examination of residential development and a projection of directional and quantitative distribution of the salt plume, that some impact (primarily on residential development) will take place. Increase in damage to physical infrastructure may result in long term increases in maintenance and rehabilitation expenditures which would be incurred by local residents.

7.2.3 Noise Impacts

Operation of either of the cooling tower alternatives will result in increased noise levels which exceed both New Jersey as well as local nighttime residential noise standards. In order to overcome this problem, JCP&L/GPUN would have to extend its property lines sufficiently to encompass all areas, not commercially or industrially zoned, where the noise standards would be exceeded. This buffer would extend as far as 0.5 miles from the cooling tower.

Estimates of the costs to be incurred by JCP&L/GPUN in meeting the noise regulations were based, therefore, on the costs of acquiring all properties in the area, not currently designated as either commercial or industrial, where noise levels exceed the standards, and on the costs of relocating all households now residing in these areas. Acquisition costs were based on estimated market values in the area, and relocation costs were based on estimates of moving expenses and the number of residential homes purchases. Estimates of these costs are as follows:

<u>Lacey Township</u>

Assessed Value of vacant lots and residential homes within noise impact areas..$3,501,200

Projected property taxes collected from vacant lots and residential homes within noise impact areas..$46,566

Estimated Market Value of vacant lots and residential homes within noise impact areas (approximated price to be paid by JCP&L/GPUN if all impacted properties are purchased)..$3,647,463

Projected relocation costs to be incurred by JCP&L/GPUN..$30,000

<u>Ocean Township</u>

Assessed Value of vacant lots and residential homes within noise impact areas..$826,000

Projected property taxes collected from vacant lots and residential homes within noise impact areas..$14,066

Estimated Market Value of vacant lots and residential homes within noise impact areas (approximated price to be paid by JCP&L/GPUN if all impacted properties are purchased)..$790,279

Projected relocation costs to be incurred by JCP&L/GPUN..$0

As is the case with capital and increased operations costs to be incurred by JCP&L/GPUN, it is conceivable that costs incurred from the acquisition of additional property, additional property tax liability and relocation costs will be transferred to the local or regional consumer base.

7.3 CONCLUSIONS

The implementation of either of the cooling tower alternatives involves large capital and operating costs, as well as the economic costs attributable to the degradation of the physical environment and quality of life in the vicinity of the plant as described above. Many of these costs may eventually be transferred to the public at large. The only reason for considering alternative cooling systems was to mitigate the impact of the Oyster Creek Station on the aquatic environment. The impacts of the heated discharge as well as impingement and entrainment associated with the existing once-through cooling system have been evaluated by JCP&L (1978) in the form of 316(a) and 316(b) Demonstrations. Those Demonstrations were evaluated by the New Jersey Department Environmental Protection and Energy (NJDEPE). The NJDEPE evaluation (Summers et al., 1989) concluded that "Continued operation of the Oyster Creek NGS at the estimated levels of losses to RIS (Representative Important Species) populations, without modification to intake structures and/or operating practices, does not threaten the protection and propagation of balanced, indigenous populations." With respect to mitigating the impact of the existing once-through cooling system, the NJDEPE evaluation concluded that "The only technology that appears to have costs not wholly disproportionate to anticipated benefits is modifying the operation schedule of the dilution pumps."

Given these findings the increased costs associated with either cooling tower alternative are not justifiable from either an economic or an environmental standpoint.

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