UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

In the Matter of	)	
	)	
CONSOLIDATED EDISON COMPANY OF	)	
NEW YORK, INC., and the	)	Docket No. 50-286
POWER AUTHORITY OF THE STATE OF	)	
NEW YORK	)	
(Indian Point Station Unit No. 3)	)	

ECONOMIC AND ENVIRONMENTAL IMPACTS OF ALTERNATIVE CLOSED-CYCLE COOLING SYSTEMS

FOR

INDIAN POINT UNIT NO. 3

JANUARY 1976

ECONOMIC AND ENVIRONMENTAL IMPACTS OF ALTERNATIVE CLOSED-CYCLE COOLING SYSTEMS FOR INDIAN POINT UNIT NO. 3

VOLUME NO. 1

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SUMMARY AND CONCLUSIONS

(1) On the basis of the economic and environmental evaluation presented in this report, a natural draft wet cooling tower system is selected as the preferred closed-cycle cooling system which could be backfitted on Indian Point Unit No. 3, if an alternative to the present once-through cooling system is required.

(2) The alternatives of natural cooling ponds, spray canals, dry cooling towers, natural draft wet cooling towers, linear and round mechanical draft wet cooling towers, mechanical draft wet/dry cooling towers, and fan-assisted natural draft wet cooling towers were investigated as alternative closed-cycle cooling backfits for Indian Point Unit No. 3.

(3) The substantial land requirements for natural cooling ponds or spray canals make these systems impractical for Indian Point Unit No. 3.

(4) Dry cooling towers are not practical or feasible cooling alternatives for Indian Point Unit No. 3 because the high turbine backpressures associated with operation of dry cooling towers are not compatible with the design of the Indian Point No. 3 turbine.

(5) Fan-assisted natural draft wet cooling towers are not considered viable alternatives for Indian Point Unit No. 3 because such systems are neither in operation nor under construction in the United States.

(6) Round mechanical draft wet cooling towers system is not yet considered a feasible alternative for Indian Point Unit No. 3 because the only prototype operating in this country is shown having serious design deficiency.

(7) Linear mechanical draft wet cooling tower systems and mechanical draft wet/dry cooling tower systems could be physically backfitted, although the costs would be substantially higher than the preferred alternative (Item(1) above).

(8) The evaluations presented in this report are based upon the schedule for retrofitting a closed-cycle cooling system established by the Stipulation (See Section 1.1). That schedule shows the cessation of operation of the once-through cooling system by September 15, 1981, and assumes a closed-cycle cooling system service date of April 15, 1982.

(9) The cost estimates for the natural, linear and round mechanical draft wet cooling tower systems, a mechanical

draft wet/dry cooling system and a fan-assisted natural draft wet cooling tower system are:

Type of System	Total Capital Costs $1,000,000	Incremental Generating Costs (Annual Levelized Revenue Requirements $1,000,000)
Natural Draft(Wet)	107	47.4
Linear Mechanical Draft(Wet)	155	61.3
Mechanical Draft(Wet/Dry)	178	66.3
Round Mechanical Draft (Wet)	103	51.2
Fan-Assisted Natural Draft (Wet)	108	48.7

(10) The results of the comparative environmental impact study for alternative closed-cycle cooling systems are:

(a) Operation of either natural draft wet or mechanical draft wet/dry cooling towers would cause negligible fogging and icing problems; however, mechanical draft wet towers are predicted to produce a moderate frequency of occurrence of both fogging and icing.

(b) Saline drift from mechanical draft wet, wet/dry, and natural draft wet cooling towers may deposit on flora within several miles of the generating station. Although most indigenous and cultivated plants in the area are not expected to be injured by this drift, each type of tower is expected to produce a potential for injury to more susceptible plants, especially Canadian Hemlock. The extent and risk of injury from mechanical draft towers will be much greater than that from natural draft towers.

(c) Bioassay results indicate that the projected chemical concentrations in the cooling tower blowdown from any of the systems will not produce deleterious environmental effects.

(d) Use of a closed-cycle cooling system will reduce the dilution available for liquid radioactive releases.

These releases will be within the requirements of 10 CFR Part 20 and the present Technical Specifications.

(e) Noise emissions from mechanical draft and fan-assisted natural draft cooling tower systems will increase noise levels in the neighboring residential zone and risk adverse community reaction. Noise emissions from natural draft cooling towers are not expected to cause an adverse impact.

(f) The aesthetic impact of a natural draft cooling tower will be greater than that of mechanical draft cooling tower.

1.0 INTRODUCTION

1.1 INTRODUCTORY REMARKS

On January 13, 1975, the parties to the operating license proceeding conducted by the United States Nuclear Regulatory Commission with respect to the Indian Point Station, Unit No. 3 Facility ("Indian Point 3") entered into a stipulation to settle the contested issues in the proceeding. These parties were Consolidated Edison Company of New York, Inc. ("Con Edison"), the Regulatory Staff of the Commission, the Attorney General of the State of New York, the New York State Atomic Energy Council, the Hudson River Fishermen's Association, and the group entitled Save Our Stripers. Under paragraph 2(g) of that Stipulation, the full-term, full-power or other operating license issued to Con Edison or its successor in interest with respect to the plant would be conditioned to require the preparation of an economic and environmental impact evaluation of alternative closed-cycle cooling systems for Indian Point 3.

On December 12, 1975, the Director of Nuclear Reactor Regulation issued Facility Operating License No. DPR-64 authorizing fuel loading and certain testing operations. The license included the terms of the stipulation referred to above. Accordingly, this report is submitted in accordance with Condition 2.E.1(g) of that license, which incorporated Paragraph 2(g) of the stipulation.

On December 24, 1975, the NRC amended License No. DPR-64 to permit the Power Authority of the State of New York (PASNY) to become the owner of Indian Point Unit No. 3 with Con Edison retaining responsibility to the NRC for operating the plant and complying with licensing requirements. On December 31, 1975, PASNY acquired ownership of Indian Point Unit No. 3. This report has been prepared by Con Edison in accordance with its responsibility for complying with licensing requirements. In addition, this report was prepared while Con Edison was still the owner of the plant and time did not permit all changes, particularly in Section 5.0, "Economic Impact of Alternative Closed-Cycle Cooling Systems," which are necessary to reflect PASNY's ownership of Indian Point Unit No. 3.

A similar report was provided for in the full-term, full power operating license issued to Con Edison with respect to its Indian Point 2 facility in the Commission's Docket No. 50-247. That document, "Economic and Environmental Impacts of Alternative Closed-Cycle Cooling Systems for Indian Point Unit No. 2," was submitted to the then Atomic Energy Commission on December 2, 1974, and is now being reviewed by the Regulatory Staff of the Commission, which has indicated that an Environmental Impact Statement will be prepared in connection with the selection of a preferred alternative cooling system for Indian Point Unit No. 2.

The present Report contains data and analyses that are more current than some of those presented in the December 2, 1974 Report.

For purposes of assessing the impacts of various alternative closed-cycle cooling systems for Indian Point 3, Con Edison has assumed that a natural draft wet cooling tower will be in operation at Indian Point 2. As discussed in Section 6, this report presents the combined environmental effects of closed-cycle cooling systems considered for both Indian Point 2 and Indian Point 3.

Con Edison believes that the environmental impact of the possible alternative closed-cycle cooling systems at Indian Point 2 and Indian Point 3 are on the same order of magnitude. Therefore, the environmental effects of alternative closed-cycle cooling systems for Indian Point 3 alone may be estimated from the Cooling Tower Report submitted on December 2, 1974 for Indian Point 2.

The economic evaluation of alternative closed-cycle cooling systems for Indian Point 3 is set forth in Section 5 below. The methodology employed in this analysis is essentially identical with that used for the Indian Point 2 Report.

The License requires that operation of Indian Point 3 with its installed once-through cooling system terminate on September 15, 1980, subject to a variety of possible modifications. One such provision defers the cut-off date by one year for every year in which the plant does not operate at at least 40% of rated power for 45 or more full days (8:00 a.m. to 7:59 a.m.) during the period from May 15 to July 31. Only two such extensions may be granted, and no extension will be granted after Indian Point 3 has achieved such operation for two calendar years. The stipulated operating levels have not been achieved during calendar year 1975. Therefore, the date for termination of operation with the present cooling system has been extended to September 15, 1981.

1.2 EXISTING ONCE-THROUGH COOLING SYSTEM

The existing cooling system is a once-through, or open cycle system. The Indian Point No. 3 turbine generator converts the thermal energy of steam to electric energy. Steam from the steam generator expands in the turbine, performing work to drive the electric generator. Portions of the steam are used for reheating partially expanded turbine steam and preheating the condensate that is reused in the steam generator. After all recoverable energy has been extracted from the steam and converted to electricity, the residual energy is transferred to the condensers and discharged via the condenser cooling water to the discharge canal.

The discharge structure is designed to create mixing in such a way as to minimize water temperature differences in the river. It will accommodate the combined cooling water flow from all three Indian Point Units (about 2,058,000 gpm including service water). The outfall structure, as depicted schematically on Figure 1-1, is 270 feet long. Heated water is discharged through twelve (12) ports, 4 feet high by 15 feet wide, spaced 21 feet apart (center to center). The entire structure of ports is itself submerged to a depth of 12 feet (center to surface) at mean low water. The ports described above are equipped with adjustable gates.

Table 1-1 sets forth the design parameters for the existing once through cooling system.

TABLE 1-1

DESIGN PARAMETERS FOR INDIAN POINT UNIT NO. 3
ONCE-THROUGH COOLING SYSTEM

		Initial Guaranteed	Maximum Guaranteed	Maximum* Calculated
1.	Reactor Power, MWt	3,025	3,087	3,217
2.	Plant Net MWe	965	986	1,033
3.	Turbine Net MWe (@ 1.5" Hg Backpressure)	1,000	1,021	1,068
4.	Condenser Heat Load, 10^6 Btu/hr	6,910	7,050	7,350
5.	Condenser Coolant Flow, gpm	840,000	840,000	840,000
6.	Condenser Δt, °F	16.5	16.8	17.5
7.	Service Water Heat Load, 10^6 Btu/hr	110	120	140
8.	Service Water Flow, gpm	30,000	30,000	30,000
9.	Service Water Δt, °F	7.3	8.0	9.4
10.	Total Heat Load, (4) + (7), 10^6 Btu/hr	7,020	7,170	7,490
11.	Total Water Flow, (5) + (8), gpm	870,000	870,000	870,000
12.	Resultant Δt, °F	16.1	16.5	17.2

*Alternative cooling systems are sized for the "maximum calculated" conditions.

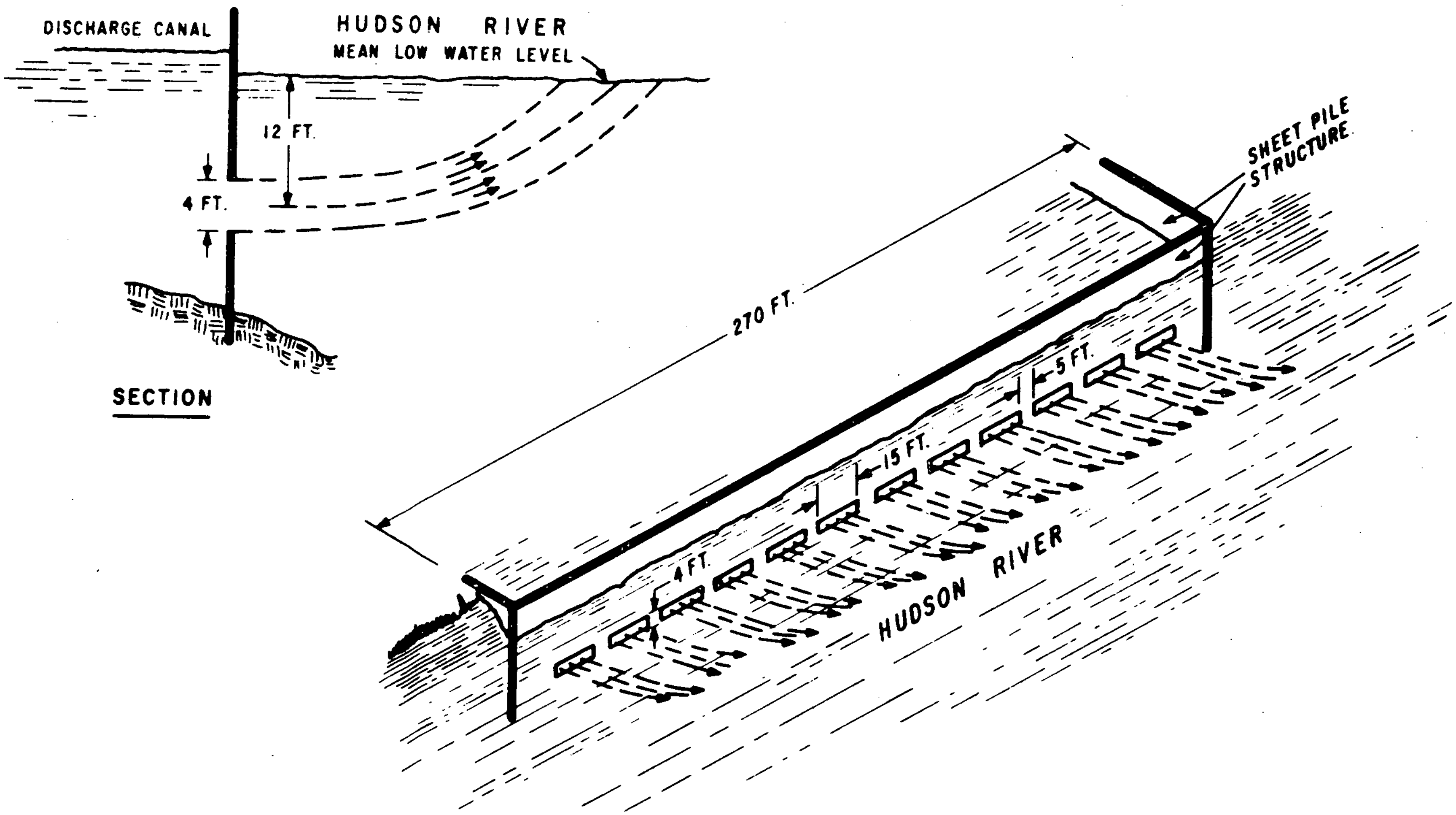


FIGURE I-1
DIAGRAMMATIC SKETCH OF
INDIAN POINT DISCHARGE STRUCTURE

2.0 DESCRIPTION OF ALTERNATIVE CLOSED-CYCLE COOLING SYSTEMS

2.1 ALTERNATIVE CLOSED-CYCLE SYSTEMS CONSIDERED

In its review of alternative closed-cycle cooling systems, Con Edison considered commercially available systems. The following systems were considered and are described in this section:

1. Wet(evaporative) cooling towers, both mechanical draft and natural draft;
2. Dry cooling towers, mechanical draft;
3. Wet/dry cooling towers, mechanical draft;
4. Natural cooling ponds; and
5. Spray ponds or canals with either fixed pipe or powered spray model (PSM) fixtures.

A diagram of a typical closed-cycle cooling system utilizing a cooling tower is shown in Figure 2-1.

The summary in Section 2.7 below sets forth the feasible alternative closed-cycle cooling system for Indian Point Unit No. 3. The further environmental and economic evaluations which Con

Edison conducted for those systems are described in Sections 5.0 and 6.0.

2.2 WET (EVAPORATIVE) COOLING TOWERS

Heat transmission in a wet cooling tower system is a combination of sensible heat transfer between hot water droplets and ambient air, and evaporative heat transfer from water droplets.

This process achieves cooling by pumping heated circulating water to a distribution system in the tower and allowing it to splash down in cascade fashion through numerous layers of "fill". Depending upon the arrangement of the air louvers installed on the side of the tower, air can be introduced to an evaporative tower creating either a counter current flow between air and water droplets (as in the "counter-flow tower") or a cross-flow pattern between water droplets and air (as in the "cross-flow tower").

In principle, the counter-flow tower is more efficient thermally because of its maximum use of air-water heat transfer time; however, the cross-flow tower offers less resistance to air flow and, consequently, lower energy consumption.

Wet cooling towers are further classified into mechanical draft and natural draft types, according to the method of inducing the heat absorbing ambient air to flow through the towers. The flow of air can be promoted by fans as in the mechanical induced-draft design or by the natural draft principle as in a hyperbolic tower.

In the natural draft hyperbolic tower, the temperature difference between ambient air and the heated exhaust air within the hyperbolic shell creates a density difference which induces air flow through the tower. Depending on the specific requirements of a facility and plant site, the base diameter of the hyperbolic structure of a natural draft cooling tower can range from about 300 feet to almost 500 feet, and its height from about 350 to 565 feet. Counter-flow and cross-flow natural draft towers are shown in Figures 2-2 and 2-3, respectively.

There are three different types of mechanical draft wet cooling towers commercially available. A conventional linear mechanical draft cooling tower system consists of one or more cooling cells arranged in a linear formation. A typical cooling cell, as shown in Figure 2-4 for counterflow design and Figure 2-5 for crossflow design, is about 35 to 40 feet long, 55 to 70 feet wide and 50 to 65 feet tall.

The multiple-fan round mechanical draft cooling tower system has been gaining attention recently. The unique physical feature of this system, as depicted in Figure 2-6, is its low profile with multiple fans forming a circular cluster near the center of the tower. The base diameter of the tower ranges from 200 to 300 feet and the overall height is about 60 to 70 feet. Preliminary model experiments conducted by the manufacturer indicates that individual jets of the multiple fans merge to form a single buoyant plume. The tower manufacturer also claims that the round tower reduces air recirculation and thus enhances tower performance. At present, only one such cooling system was placed in operation since April 1975 at the Jack Watson Plant (Mississippi), and several units are being constructed in this country. Preliminary tests of the Jack Watson unit indicate the thermal performance of the cooling tower not being as high as expected and major modifications are planned to upgrade the performance. Therefore, round mechanical draft wet cooling towers system is not yet considered a proven alternative for Indian Point Unit No. 3.

The single-fan round mechanical draft cooling towers have been used in Europe but have no operational experience in the United States. This design utilizes fan diameters up to 85 feet, which is about triple the size of the fans used in both the linear and the multiple-fan round mechanical draft cooling towers. The single-fan tower is also characterized by its comparatively large tower shell, up to 185 feet high as shown in Figure 2-7.

Some advantages of mechanical draft wet and wet/dry cooling tower systems over natural draft wet tower systems are: (1) lesser effect of ambient air humidity on tower performance, and (2) lesser aesthetic impact. Some disadvantages associated with mechanical draft wet and wet/dry cooling tower systems include: (1) high operating and maintenance costs, (2) a tendency to "recirculate" (see Note 2-1) during high wind conditions, (3) relatively greater noise problems, and (4) relatively larger amounts of drift.

Since evaporation takes place in all wet cooling towers, such adverse environmental effects as fogging, drift, and icing can be expected from both natural and mechanical draft wet cooling tower systems.

A hybrid or fan-assisted wet natural draft tower has been developed to retain certain performance characteristics of both the natural draft and mechanical draft systems. It is basically a hyperbolic tower with supplementary fans installed along its outer base perimeter resulting in a relatively low profile hyperbolic cooling element compared to a natural draft system (See Figure 2-8). Although several fan-assisted natural draft cooling towers have been used in Western Europe, they have not been operated in this country, and those operated in Western Europe are either associated with plants smaller than Indian Point Unit No. 3 or designed for part time basis. As Con Edison has no actual performance data and no quantifiable basis for evaluating system reliability, the fan-assisted natural draft cooling towers are not considered a viable alternative for Indian Point Unit No. 3; however, an economic and environmental analysis of this system (and the round mechanical draft cooling towers system) based on vendor information has been performed. The results of this analysis, which is included in this report, must be considered hypothetical until the performance and reliability of the fan-assisted natural draft tower has been substantiated to be favorable for an operation in the United States.

The linear mechanical draft wet, linear mechanical draft wet/dry, and natural draft wet cooling towers are considered technically feasible for Indian Point Unit No. 3 based upon the operating experience and testing in this country. Detailed economic and environmental evaluations of these cooling alternatives are presented later in this report.

2.3 DRY COOLING TOWERS

Dry cooling towers (see Figure 2-9) provide for circulating condenser cooling through finned-tube heat exchangers where the flow of cooling air absorbs and carries away heat without directly contacting the circulating water. (see Note 2-2)

In contrast to the wet cooling tower which uses evaporation as its principal method of heat transfer, the dry cooling tower has no evaporative loss from its system and, therefore, less adverse environmental impact than wet cooling tower systems from the standpoint of fogging and drift.

The installation of a dry cooling tower system for Indian Point Unit No. 3, however, would cause serious adverse effects on the plant turbine as a result of elevated turbine backpressure associated with high condenser cooling water temperature. Since ambient dry bulb temperature is theoretically the lowest temperature to which the condenser circulating water can be cooled, the associated high turbine exhaust steam temperatures and backpressure would make it impossible to operate the turbine as designed.

Compared with cooling ponds and evaporative-type cooling towers, dry cooling towers have a high design approach and range. Range and approach for a dry cooling tower system at Indian Point Unit No. 3 would be approximately 24°F and 30°F, respectively. In comparison, range and approach for a cooling pond at Indian Point Unit No. 3 would be 24°F and 10°F, and for a wet cooling tower system, 24°F and 16°F. Relating these approaches and ranges to a summer ambient of 75°F wet bulb and 95°F dry bulb, and allowing 10°F for the surface condenser "terminal temperature difference", the resulting steam temperatures and corresponding turbine backpressures at Indian Point Unit No. 3 would be:

Cooling Pond	109°F	(2.5 inches of mercury)
Wet Cooling Tower	125°F	(4.0 inches of mercury)
Dry Cooling Tower	159°F	(9.5 inches of mercury)

The Indian Point Unit No. 3 turbine is a 1,021 MWe conventional nuclear model designed and manufactured by Westinghouse Electric Corporation. At design operating conditions, its backpressure is 1.5 inches of mercury absolute. When operated at backpressures in excess of 5 inches of mercury absolute, the high exhaust steam temperature would damage the machine through excessive thermal expansion and thermal stress. Therefore, to incorporate a dry cooling tower system with the existing turbine condenser systems at Indian Point 3 is not feasible. Indeed, new turbines compatible with dry cooling towers in the size range required for Indian Point Unit No. 3 have not been built.

2.4 WET/DRY COOLING TOWERS

The wet/dry cooling tower system is only available in mechanical draft design (Figure 2-8). The wet/dry tower system combines the characteristics of both wet and dry cooling towers. During certain climatic conditions, such as a combination of low dry bulb temperature and high relative humidity, a conventional wet cooling tower would tend to produce a visible vapor plume and possible fog. A wet/dry cooling tower is designed to reduce visible plume occurrence by passing a portion of the plant thermal discharge through a finned-tube heat exchanger to decrease the relative humidity at the point of exit of the cooling air. The wet/dry system, however, does not eliminate the drift and noise problems of the mechanical draft wet cooling tower system.

The basic principles of visible plume abatement of wet/dry cooling towers can be demonstrated on a psychrometric chart (Figure 2-11). The ambient air (Point 1) passing through the dry section (heat exchanger) is heated at constant specific humidity line 1-2. The ambient air passing through the wet cooling section (fill section) is heated and humidified along line 1-3. These two air streams are mixed and result in an unsaturated exhaust or invisible plume (Point 4) along the mixing air streams (line 2-3) which in turn are dependent on the ambient, tower design and operating criteria. The line 1-3, representing the "performance" of a wet cooling tower, intersects the saturation line at Point 5. From Point 3 to Point 5, the mixture of cooler ambient air and saturated exhaust becomes supersaturated, small droplets of water condense and a visible plume forms.

Although the wet/dry design offers a method of controlling fogging and icing, the noise and drift effects related to the mechanical draft wet/dry systems are considered comparable to those of the mechanical draft wet systems. In addition, the wet/dry design would have higher capital and operating costs than a mechanical draft wet cooling system, due to the addition of finned-tube heat exchanger surfaces.

Wet/dry (mechanical draft) cooling towers are considered technically feasible for Indian Point Unit No. 3. More detail on this design is given later in the report.

2.5 NATURAL COOLING PONDS

A natural cooling pond resembles a once-through cooling system except that warm condenser circulating water is channeled to a pond or lake rather than directly to the river. Heat transfer by various physical processes, such as radiation, convection and evaporation takes place in the pond and the cooled water is then recirculated to the condenser inlet (for closed-cycle operation) or returned to the river (for open cycle operation).

The principal disadvantage of such a system is the extensive surface area required for the installation of this system (2 to 3 acres/MWe for a nuclear plant). This surface area requirement eliminates a natural cooling pond as a possible alternative closed-cycle cooling method for Indian Point Unit No. 3 where approximately 3,000 acres of land would be needed. Such acreage is not available at the site.

2.6 SPRAY PONDS AND SPRAY CANALS

Spray ponds are a modification of natural cooling ponds and perform in a manner similar to wet cooling towers. In spray ponds, heat from the condenser cooling water is transferred to ambient air partly by evaporation and partly by convection.

Spray cooling systems use nozzles to spray warm pond water into the air in a manner to give improved heat transfer area per unit volume of water. Both the spray height and spray drop size, which depends on the design of the spray pump system, influence system thermal performance and drift loss. Higher spray pressure produces an increased dispersion of fine spray that will be transported by the wind. Lower spray pressure produces larger droplets, which provide smaller surface area per unit weight and shorter travelling time resulting in diminished heat transfer.

Two types of spray systems are commercially available at the present time: The conventional fixed-pipe spray system, shown in Figure 2-12, and the relatively new "powered spray module" (PSM) or spray canal system, shown in Figure 2-13. In the fixed-pipe system, the heated water is pumped into an extensive piping system to multiple spray nozzles. The water is sprayed into the air, splashes down into a pond, and finally returns either to the river or to the condenser.

The PSM is a system of independently operated units arranged in a series of parallel rows. A floating control pump assembly in each unit pumps water from a canal and discharges it through floating spray nozzles. After the water is cooled by being sprayed through the initial spray modules, it falls back into the canal and is sprayed again by other spray modules installed downstream.

Spray cooling ponds and canals have all the adverse environmental effects characteristic of other evaporative cooling systems.

Local fogging, icing, and drift occur. The performance of spray cooling is strongly dependent upon wind characteristics.

The land requirement for fixed-pipe spray ponds is generally about 5 percent of that for natural cooling ponds, but is about twice that of a PSM spray canal. Indian Point Unit No. 3 would require a fixed-pipe spray pond of about 100 acres or a PSM spray canal of about 55 acres.

It is concluded that neither type of spray cooling system is suitable for Indian Point Unit No. 3 because of land availability at the Indian Point site.

"Thermal Rotor System" is another spray cooling system currently undergoing field evaluation. In this system, water spray is produced by spinning disks to get adequate cooling performance. Although this system is still in its development stage, its land requirements are not expected to be significantly less than other spray type systems.

2.7 SUMMARY

Based on the foregoing, it has been concluded that:

(1) Natural cooling ponds and spray canals are not practical or feasible closed-cycle cooling alternatives for Indian Point Unit No. 3 because the large land area required for

the installation of those systems is not available at the Indian Point Site.

(2) A dry cooling tower system is not a practical cooling alternative for Indian Point Unit No.3 because the high turbine backpressures associated with operation of dry cooling towers are not compatible with the design of the Indian Point Unit No. 3 turbine.

(3) Fan-assisted natural draft and round mechanical draft wet cooling towers are considered technically unproven cooling alternatives for Indian Point Unit No. 3. An economic and environmental analysis of these systems, however, is provided for comparison with other systems which are of demonstrated feasibility for Indian Point Unit No. 3.

(4) Natural draft wet, linear mechanical draft wet, and mechanical draft wet/dry cooling towers are considered feasible alternative closed-cycle cooling systems for Indian Point Unit No. 3. Detailed environmental and economic evaluations of these feasible alternative closed-cycle cooling systems are set forth in the following sections in this report.

Table 2-1 delineates the approximate land requirements for all cooling alternatives considered and turbine performance expressed in terms of turbine backpressure.

NOTES

2-1 "Recirculate" means that some vapors discharged from the fan stack re-enter the tower through the louvers, reducing thermal performance.

2-2 The dry cooling system described here is different from both the "indirect" (or "Heller") and the "direct" (or German "GEA") dry-type cooling tower, which process the <u>turbine exhaust</u>, instead of <u>condenser coolant</u>. These systems are technically incompatible with the existing Indian Point installation.

TABLE 2-1

ESTIMATES OF LAND REQUIREMENT AND TURBINE BACKPRESSURE OF ALTERNATIVE CLOSED-CYCLE COOLING SYSTEMS FOR INDIAN POINT UNIT NO. 3

Type of Alternative Closed-Cycle Cooling System	Land Area Acres	Turbine Backpressure (1) Inches Hg
Mechanical Draft Dry Cooling Tower (2)	20	10.0
Natural Draft Wet Cooling Tower	7	4.
Linear Mechanical Draft Wet Cooling Tower	15	4.
Mechanical Draft Wet/Dry Cooling Tower	17	4.
Round Mechanical Draft Wet Cooling Tower	11	4.
Fan-Assisted Natural Draft Wet Cooling Tower (2)	11	4.
Natural Cooling Ponds (2)	3,000	2.5
Spray Ponds - Fixed Pipe (2)	100	2.5
Spray Canal - Powered Module (2)	55	2.5

(1) Based on "Maximum Calculated" Turbine conditions with 74°F wet-bulb temperatures and 10°F TTD.

(2) These alternatives have been determined to be not feasible for backfitting at Indian Point Unit No. 3.

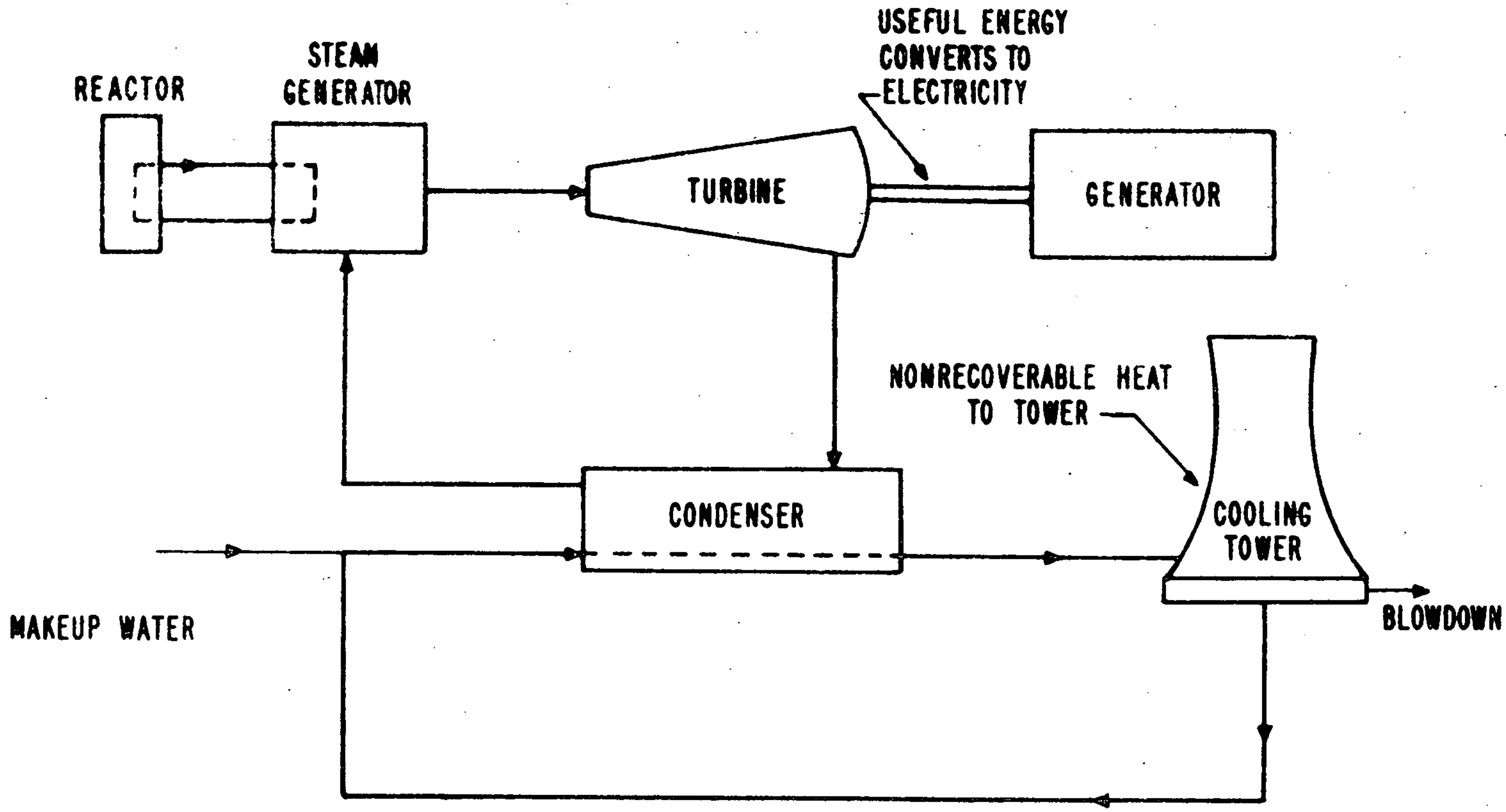


FIGURE 2-1
CLOSED-CYCLE COOLING SYSTEM

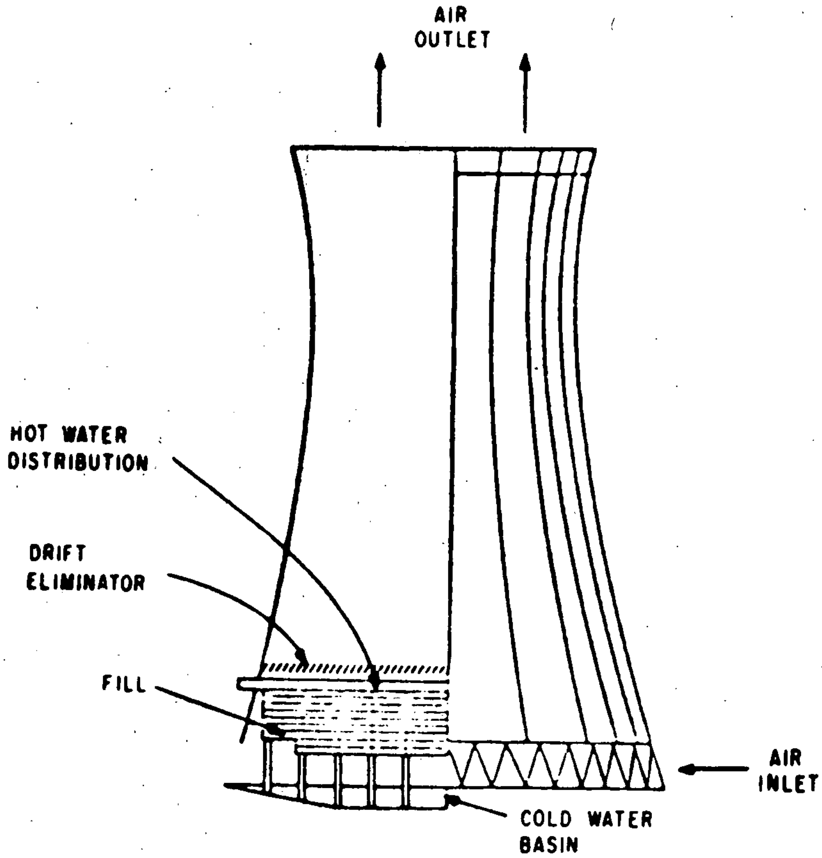


FIGURE 2-2

NATURAL-DRAFT WET COOLING TOWER
(COUNTER-FLOW)

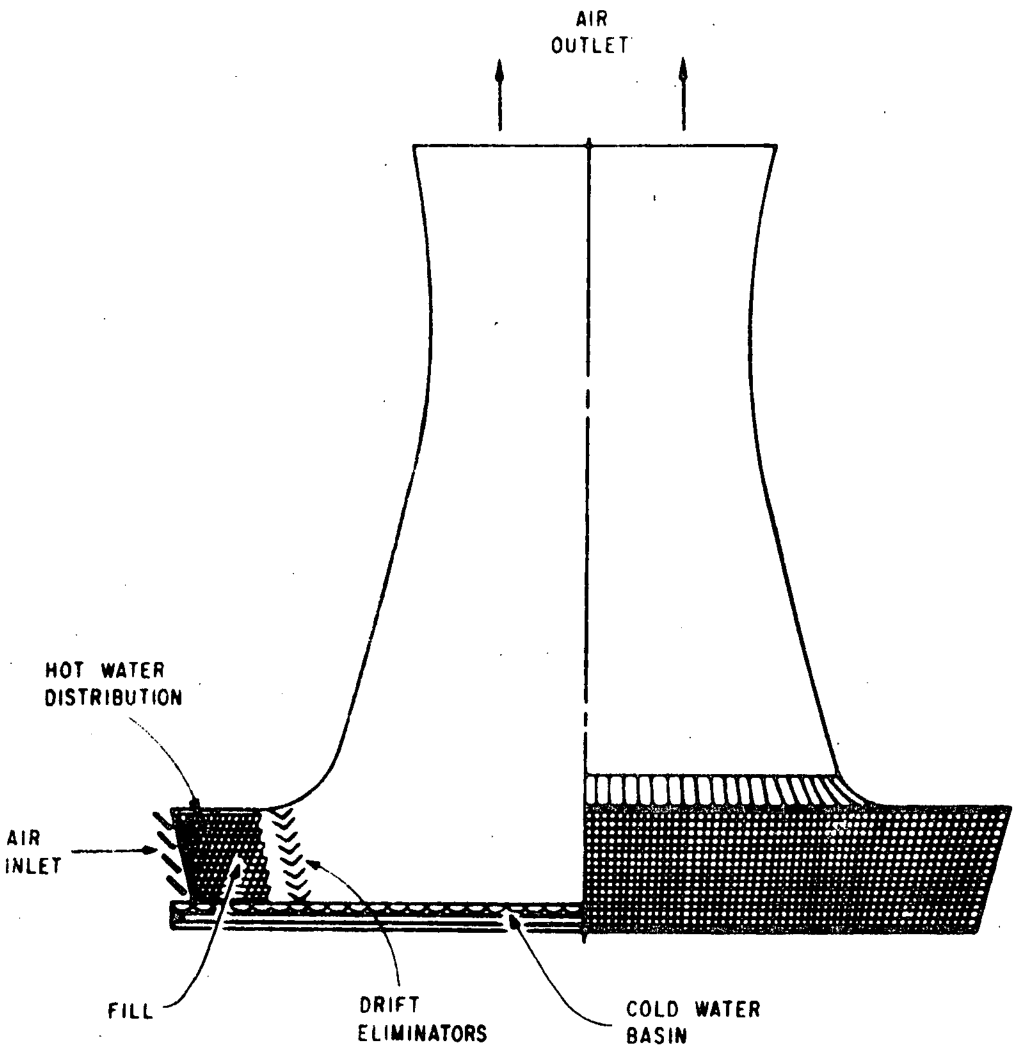


FIGURE 2-3

NATURAL - DRAFT WET COOLING TOWER
(CROSS - FLOW)

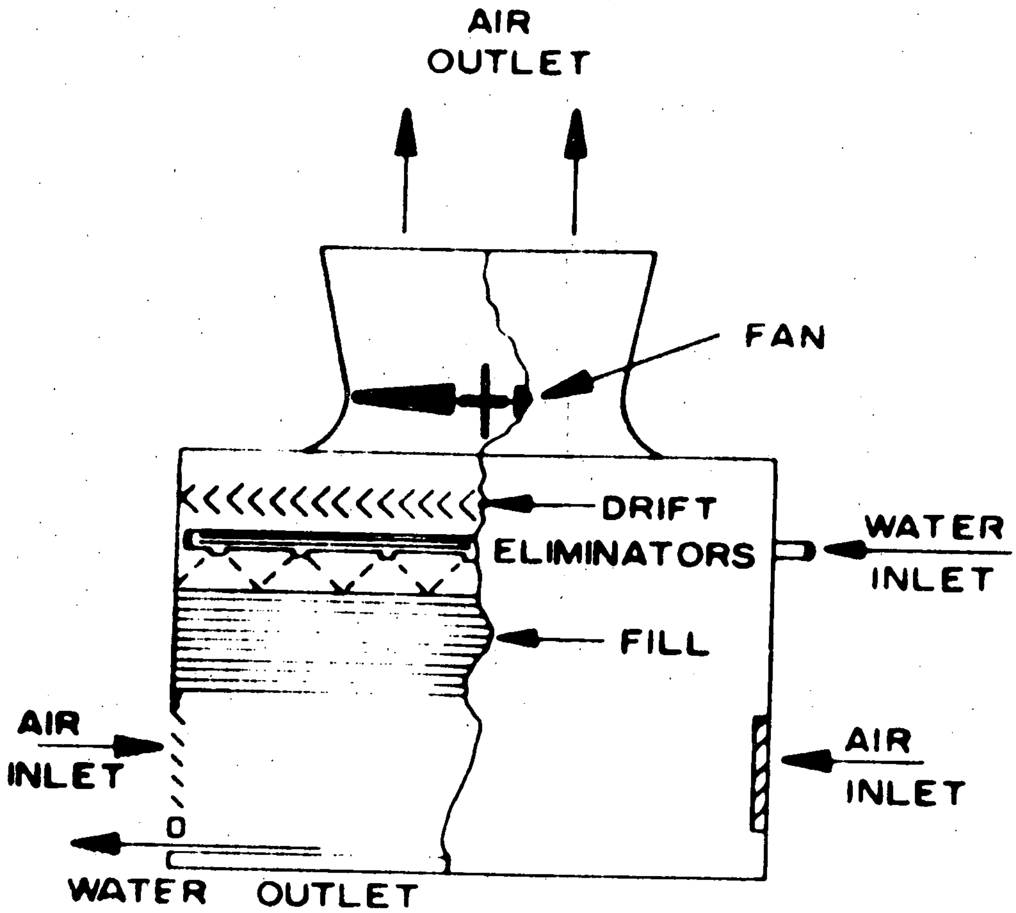


FIGURE 2-4
MECHANICAL - DRAFT WET COOLING TOWER
(COUNTER - FLOW)

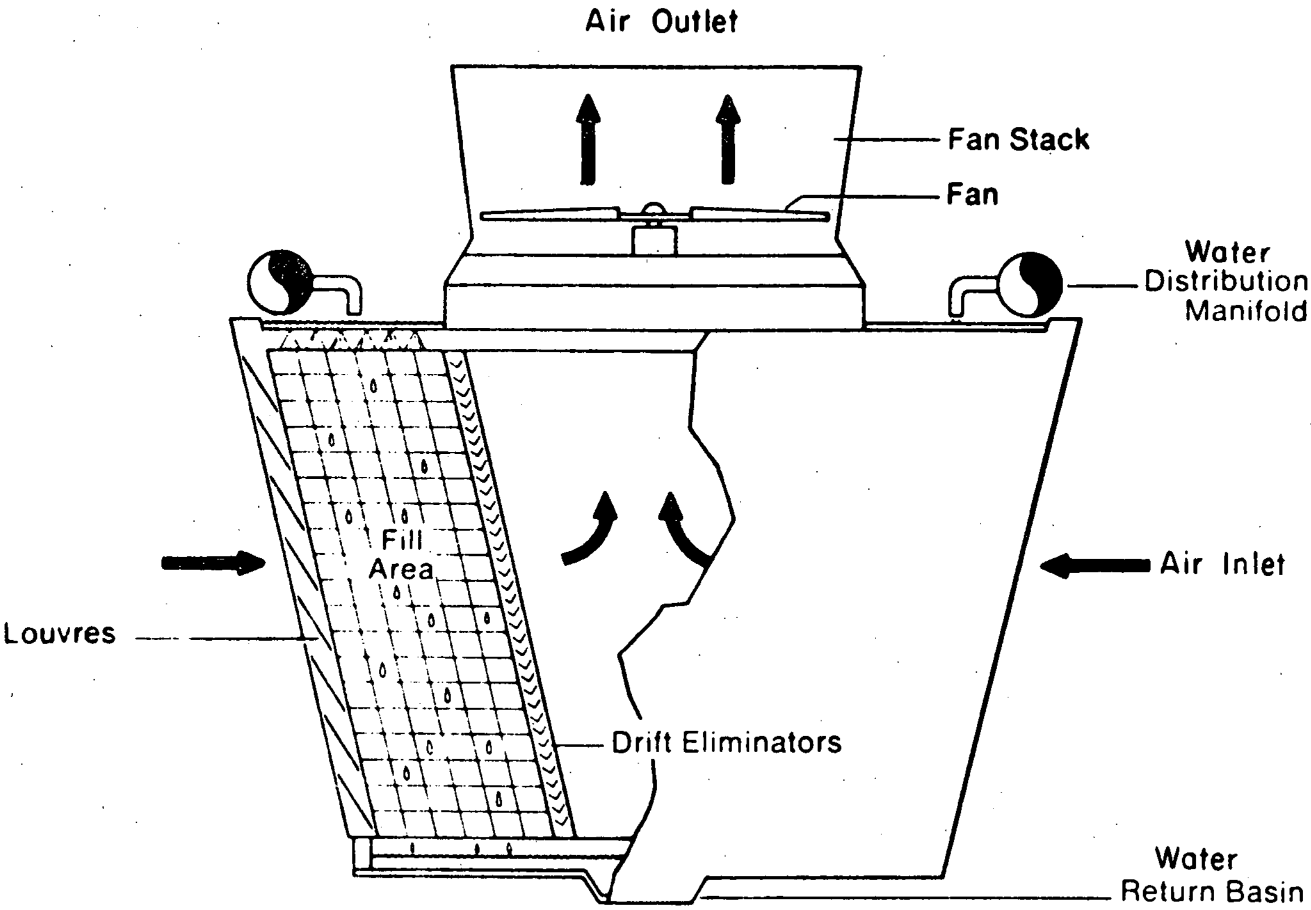


FIGURE 2-5

MECHANICAL-DRAFT WET COOLING TOWER
(CROSS FLOW)

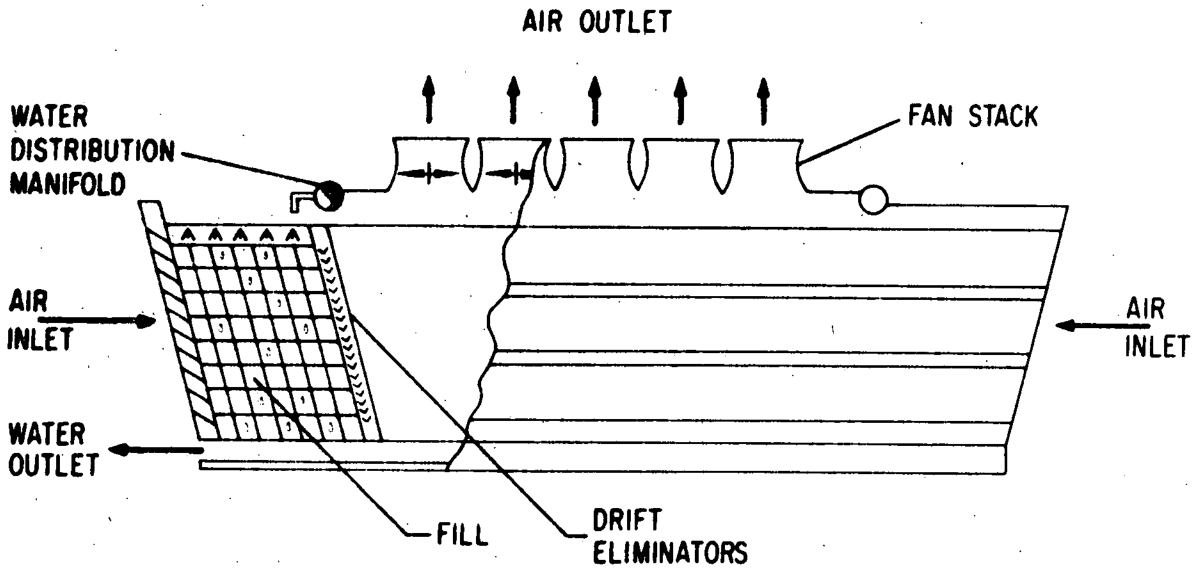


FIGURE 2-6
MULTIPLE - FAN ROUND
MECHANICAL - DRAFT WET COOLING TOWER

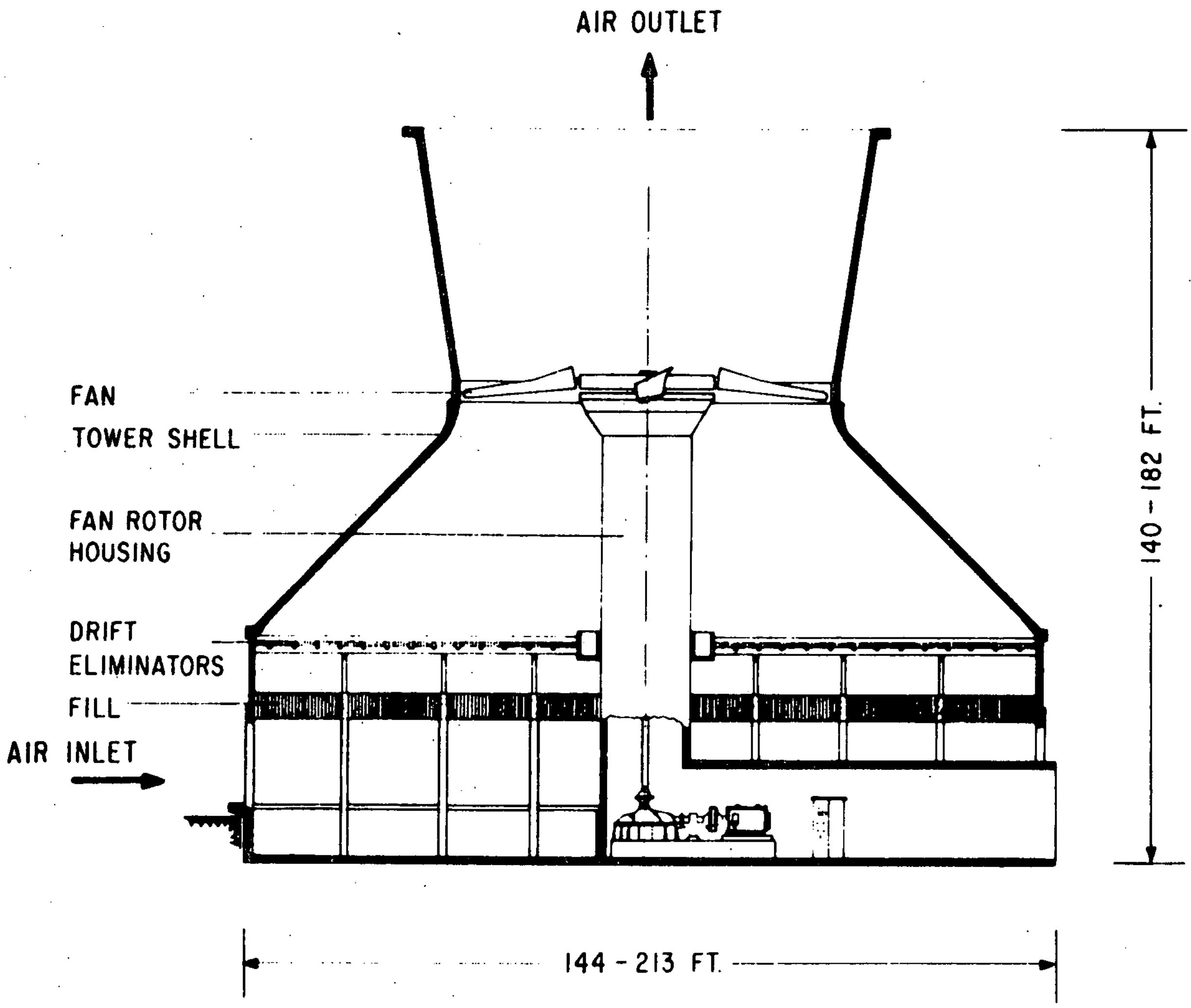


FIGURE 2-7
SINGLE - FAN ROUND
MECHANICAL- DRAFT WET COOLING TOWER

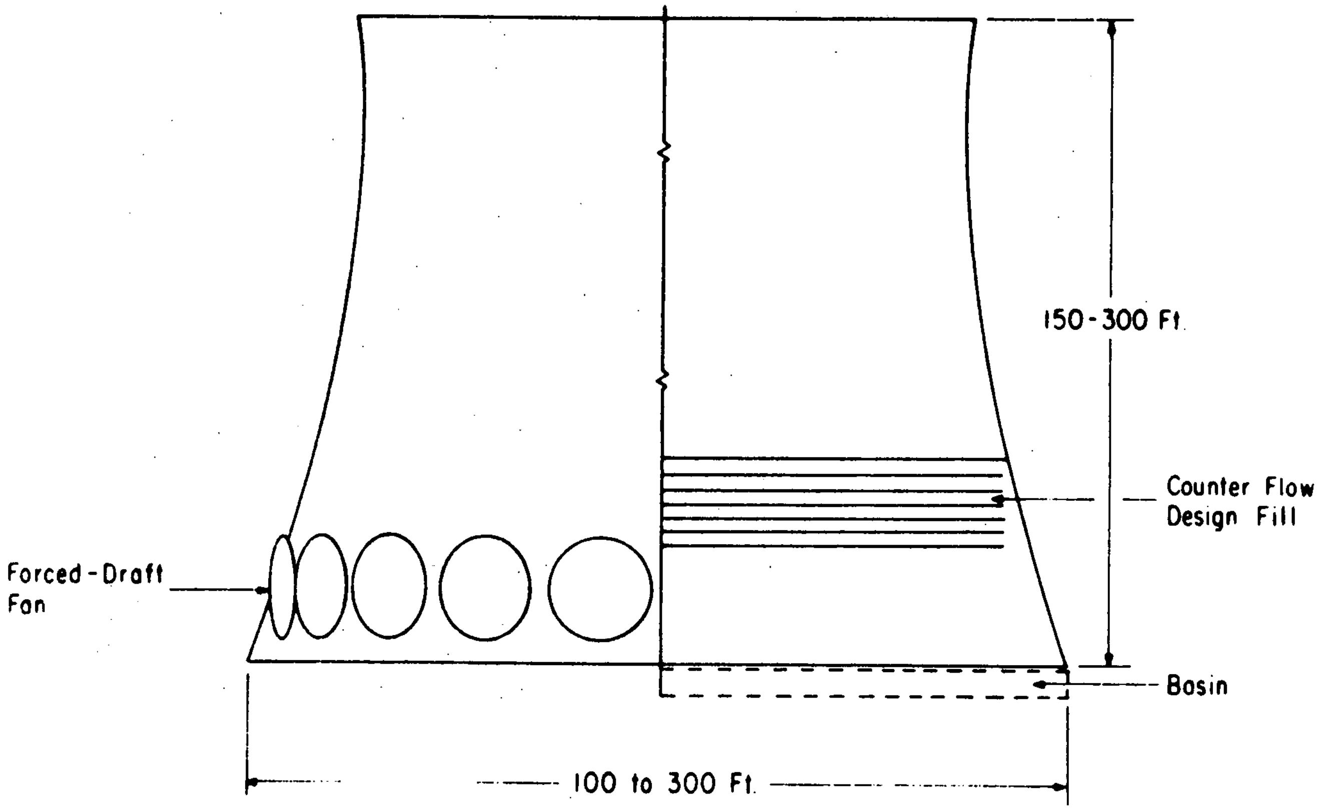


FIGURE 2-8

FAN-ASSISTED NATURAL-DRAFT COOLING TOWER

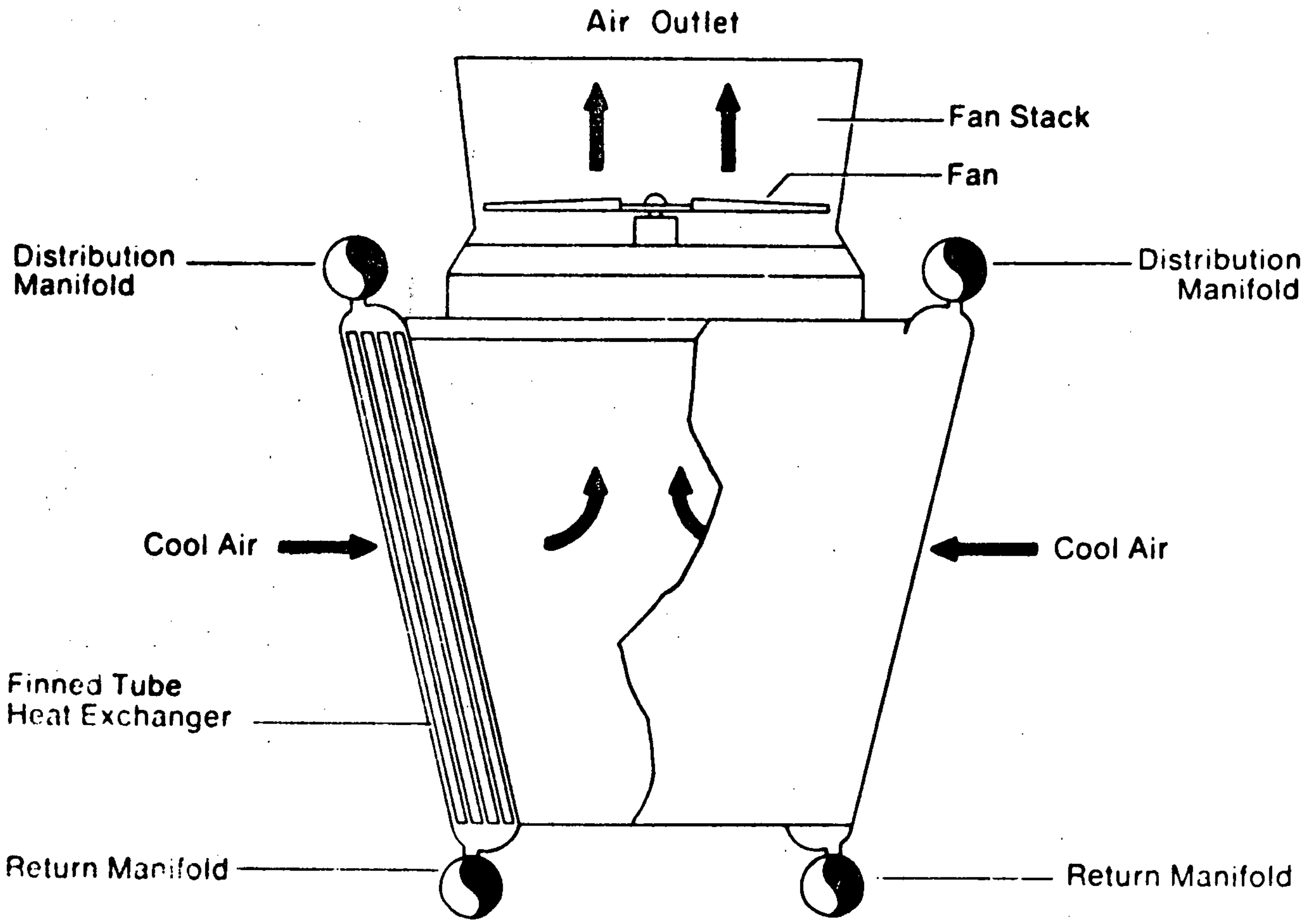


FIGURE 2- 9
MECHANICAL-DRAFT DRY COOLING TOWER

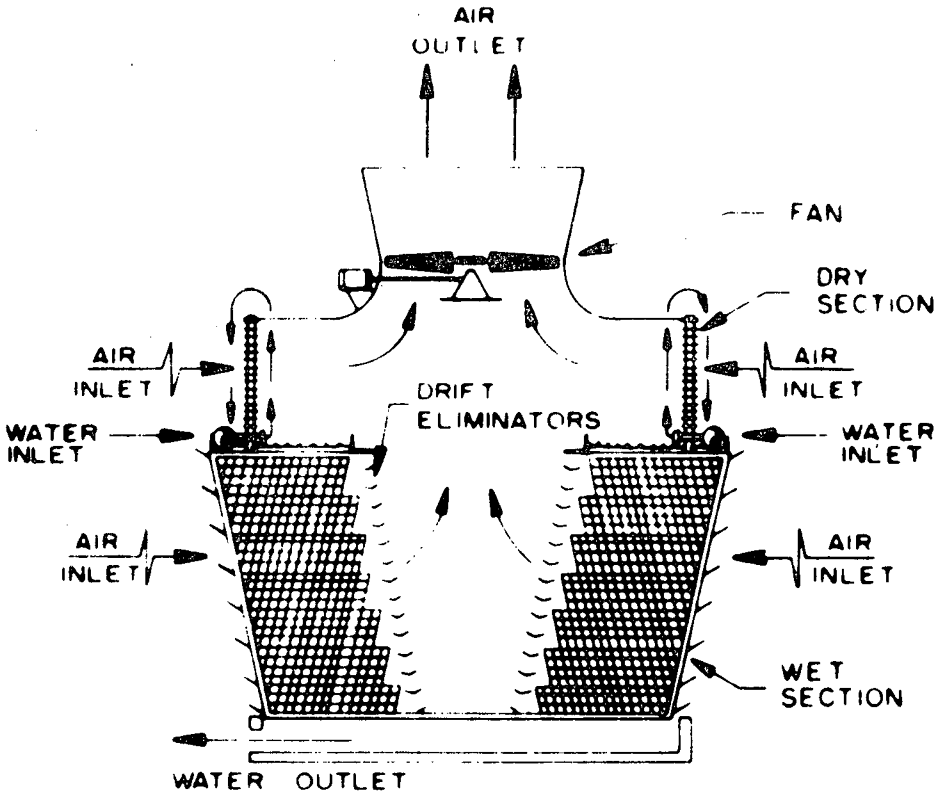


FIGURE 2-10
MECHANICAL - DRAFT WET-DRY COOLING TOWER

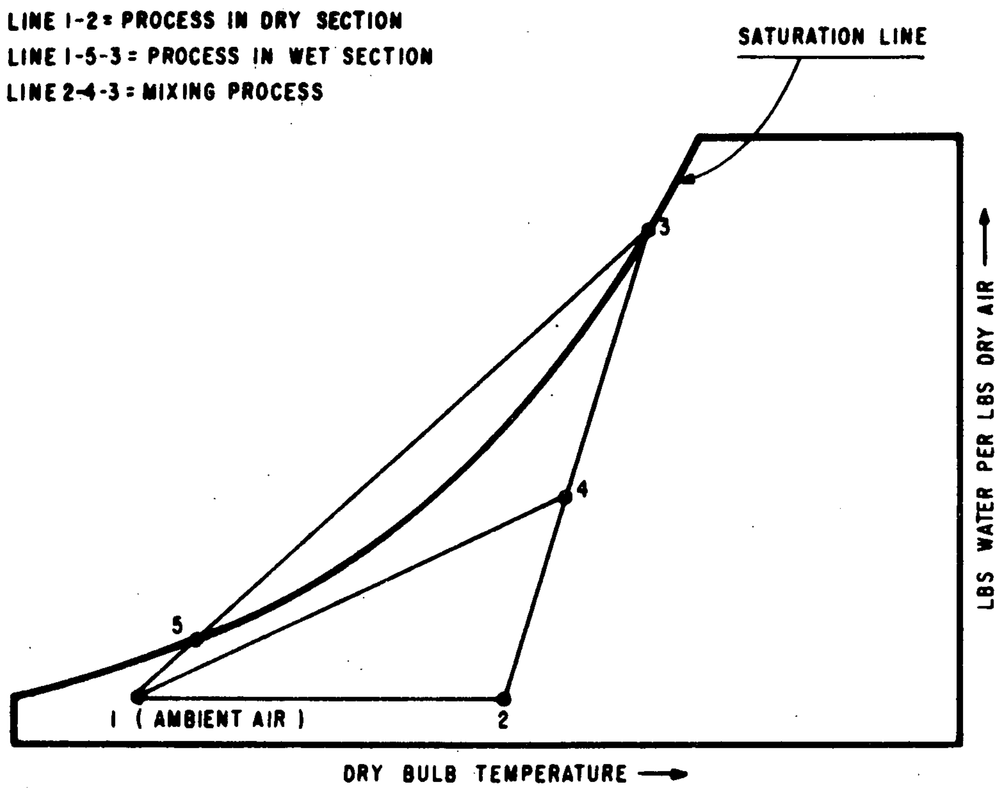


FIGURE 2- 11
PSYCHROMETRIC CHART OF WET-DRY
MECHANICAL-DRAFT COOLING TOWER

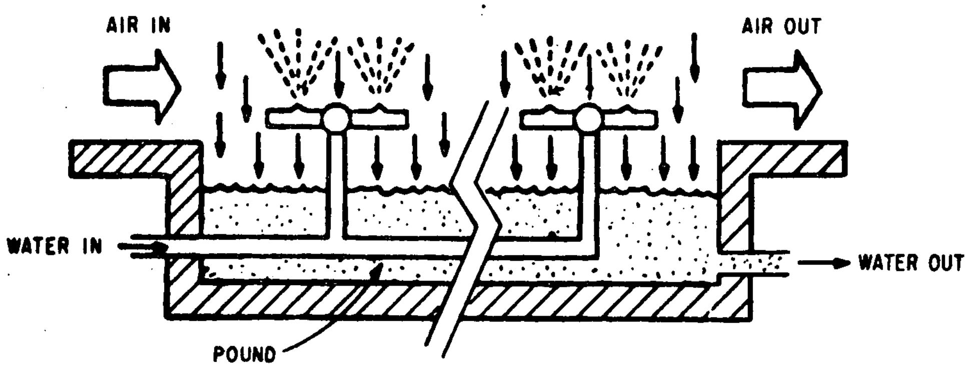


FIGURE 2-12
SPRAY-POND COOLING WITH FIXED PIPES

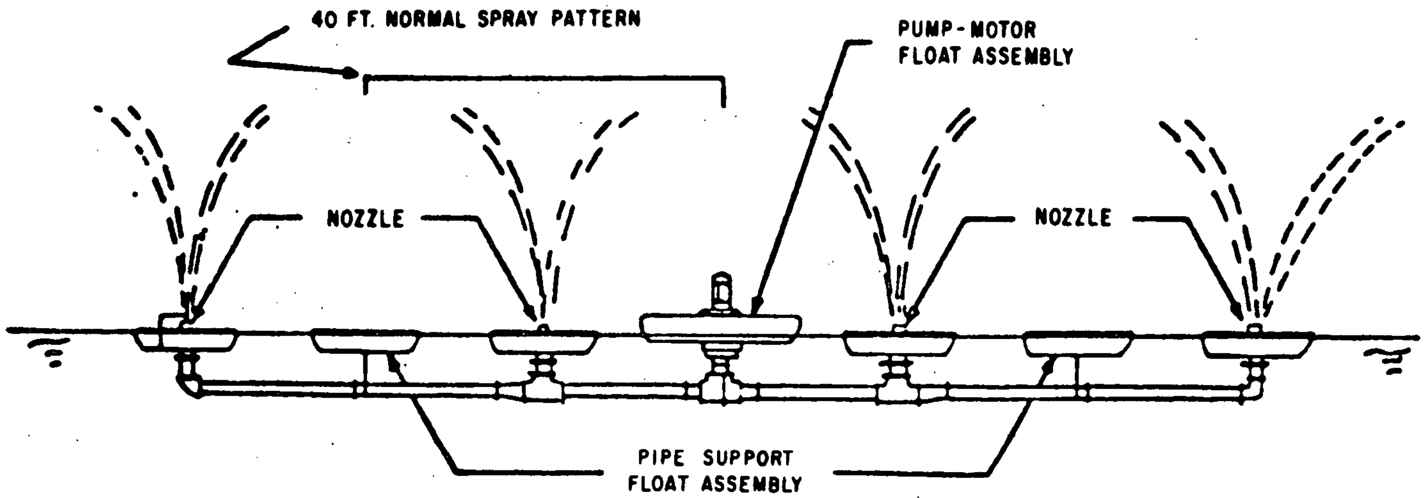


FIGURE 2-13
SPRAY-CANAL COOLING WITH POWER SPRAY MODULES

3.0 DESIGN OF FEASIBLE ALTERNATIVE CLOSED-CYCLE COOLING SYSTEMS

3.1 DESIGN CRITERIA

Thermal design criteria for the various alternatives are shown in Table 3-1.

Selection of the proper summer wet-bulb temperature design value is important in determining a cooling tower size. An unnecessarily high design wet-bulb temperature can result in an oversized tower while an unnecessarily low wet-bulb temperature can result in inadequate tower capacity. The wet-bulb temperature selected as the basis for design is one that approximates local maximum wet-bulb temperature for the summer months and is not exceeded during more than 5 percent of the time during the normal summer months from June to September. For the Indian Point location, a 74°F wet-bulb temperature design value has been selected as meeting this criterion.

Two terms frequently utilized in the discussion that follows are defined here:

(1) "Approach" is the difference between temperature of cold water leaving the tower and ambient wet-bulb temperature.

(2) "Range" is the difference between the temperature of water entering and leaving the tower.

Selection of optimum cooling range depends upon the operational characteristics of the turbine-condenser. The actual cooling range will be compatible with the temperature rise of the circulating water, when a thermal equilibrium state is established for closed-cycle operation. For Indian Point Unit No. 3, the selection range is 25°F. This range applies to the nuclear reactor operated at a power level of 3,217 MWt and a cooling tower water flow of 600,000 gpm, which is the sum of the 600,000 gpm condenser water flow and the 30,000 gpm make up water.

Approach, defined above, is a significant cooling tower design criterion. For a given heat load, the size of the cooling tower increases with decreasing approach. For Indian Point Unit No. 3, 16°F has been selected as the design approach for a natural draft wet cooling tower and 17°F for mechanical draft cooling towers of either wet or wet/dry design.

The selection of design conditions for a wet/dry cooling tower involves the application of new concepts in cooling tower technology. The Indian Point Unit No. 3 wet/dry cooling towers are analyzed on the basis of a given thermal requirement and the need to abate tower induced visible plume during critical winter conditions. The wet section of the tower is capable of dissipating the total condenser heat load (3,675 x 10^6 BTU/Hr) during critical summer conditions represented by a 74°F wet bulb temperature and 55% relative humidity. The dry section of the wet-dry cooling tower would be designed to dissipate half of the condenser heat load (3,675 x 10^6 BTU/Hr) at critical winter conditions of 20°F dry bulb temperature and 80% relative humidity. The critical winter conditions selected as the basis for dry section design are those that approximate the local minimum dry-bulb temperature coincidental with high relative humidity for the winter months (December, January, and February) and are not exceeded more than 5 percent of the time during a normal winter. Under these conditions, the cooling tower will have a cooling capacity of 7,350 x 10^6 BTU/Hr and the tower plume would not be predicted to be visible.

Table 3-2 shows the estimated reduced MWe capability of Indian Point Unit No. 3 with five different cooling towers operated at the "maximum calculated" condition with a 77°F ambient wet-bulb temperature, which represents the peak conditions at 1 percent of probability of occurrence during the summer months.

Shown in the table are the turbine net MWe at the indicated backpressure, total derating for each alternative cooling system, net plant MWe after deducting all auxiliary loads, and other evaluation items. The corresponding rating for the existing once-through cooling system is also included for comparison.

With the once-through system, high turbine backpressure is primarily attributable to high river water temperature. For the alternative cooling system operated in closed-cycle, high turbine backpressure is caused by elevated cooling water temperatures associated with high wet-bulb temperature. The total deratings, due to the alternative cooling systems evaluated at summer peak conditions, are estimated to be 77.5, 82.5, 83.5, 82.5 and 79.5 MWe for natural draft wet, linear mechanical draft wet, mechanical draft wet/dry, round mechanical draft wet and fan - assisted natural draft towers, respectively.

Similarly, Table 3-3 shows the yearly average turbine derating and the changes in plant net heat rate of Indian Point Unit No. 3 operated at "maximum calculated" conditions. The plant net heat rate, which is defined as the ratio of total thermal input to the net power output (electrical output), is estimated on "yearly-average" conditions by dividing the year into two time periods: a three-month summer, characterized by a 65°F wet-bulb temperature, and a nine-month non-summer period, characterized by a 35°F wet-bulb temperature. Plant net heat rates are first calculated for each period separately and the effective "yearly average" net heat rate is then obtained by combining these two values according to their weighted ratio. The plant net heat rates are estimated to be 10970, 11130, 11140, 11130 and 10990 BTU/Kwh for natural draft wet, linear mechanical draft wet, mechanical draft wet/dry, round mechanical draft wet and fan-assisted natural draft cooling towers, respectively.

3.2 SYSTEM DESCRIPTION

Physical descriptions of the important cooling systems components of natural draft wet, linear mechanical draft wet, mechanical draft wet/dry, round mechanical draft wet and fan-assisted natural draft cooling towers are listed in Table 3-4. Descriptions of each cooling alternatives, in particularly the physical dimensions of the towers, are considered tentative because these data are based upon the preliminary analysis performed by the manufacturers. Final tower dimensions would not be established until a comprehensive analysis is completed by the successful cooling tower vendor.

The natural draft cooling tower system is a single hyperbolic structure with a height which may be as much as 565 feet and a base diameter of approximately 460 feet,located south of the Indian Point Unit No. 3 containment building at base elevation of 45 feet above MSL (mean sea level) as depicted in Figure 3-1. The linear mechanical draft wet cooling tower system (Figure 3-2) consists of three (3) towers, with a total of 26 cooling cells. Each tower is about 320 to 360 feet long, 75 feet wide and 68 feet tall. The mechanical draft wet/dry cooling tower system also includes three (3) linear towers, (Figure 3-3), with a total of 28 cooling cells. Each wet/dry tower is approximately 430 to 480 feet long, 70 feet wide and 74 feet high. The round mechanical draft wet cooling tower system consists of two (2) towers (Figure 3-4). Each tower is about 67 feet high with a base diamter of about 285 feet. The fan-assisted natural draft tower system, as depicted in Figure 3-5, consists of two towers. Each concrete tower is about 205 feet high with a base diameter of about 267 feet.

Flow diagrams of the five cooling tower systems identified above are shown in Figures 3-6, 3-7, 3-8, 3-9 and 3-10, respectively. During closed-cycle operation, the condenser cooling water would be pumped from the condenser waterbox and discharged to the cooling tower hot water distribution system by three vertical, mixed-flow circulating water pumps. The cooled water from the tower basin would then flow by gravity back to the condensers via new conduits. The existing vertical circulating water pumps located in the screenhouse would not be used during closed-cycle operation. However, these existing vertical pumps will be available for return to once-through operation to obtain maximum system flexibility. The changeover from one operating mode to the other can be accomplished by proper operation of the isolation valves installed in the cooling system (refer to Figures 3-6 through 3-10).

Preliminary mechanical and structural designs are shown in Figures 3-11 through 3-14 for the natural draft cooling tower system. Electrical design for this system is shown in Figures 3-15 to 3-21. Since the overall arrangement of the natural draft cooling tower system is practically identical to those of the other four cooling tower systems, with the exception of the cooling units per se and minor piping alterations, no separate engineering drawings for either the linear mechanical draft wet, mechanical draft wet/dry, round mechancial draft wet or fan-assisted natural draft wet cooling towers have been included. Figures 3-11 through 3-21 were used as a basis for preparing the cost estimates and project schedules for all five cooling systems.

3.3 SITE PREPARATION

The first phase of site preparation would consist of the relocation of the Algonquin gas lines which lie south of the plant. To avoid interference with the planned excavation, this work, shown on Figures 3-1, 3-2, 3-3, 3-4 and 3-5 for each cooling alternative arrangement, would be performed by the Algonquin Gas Transmission Company.

The existing main plant road system would be utilized for access to the site during both construction and normal operation. Temporary construction roads to the tower site would be required to limit construction traffic in the plant area to an acceptable level. It is possible that an additional new temporary road would be required for disposal of excavated material. The existing plant wharf would be available for delivery of construction materials, but its use would be limited by plant operational requirements. Also available would be the beaching facilities in nearby Lents Cove. Permanent access roads to the cooling tower and pump pit would be extended from the existing Unit No. 3 turbine building and screenwell area. Roadways would be asphalt paved. The clearing and grubbing of trees and vegetation would be limited as much as possible to the immediate area to be excavated and graded.

3.4 CIRCULATING WATER PUMPS

The vertical, mixed-flow circulating water pumps for closed cycle operation would be installed in a pump pit south of the Indian Point Unit No. 3 Turbine-Generator Building (Figures 3-1, 3-2, 3-3, 3-4 and 3-5). The bottom of the pump inlets will be approximately at an elevation of 16-1/2 feet below MSL, and the pit structure will be supported directly on bedrock (see Figures 3-11 and 3-12). Service to the pumps will be provided by a mobile crane which will travel on an access road around the pump pit.

3.5 PIPING SYSTEM

The system circulating water piping would be cement-lined carbon steel. The piping would be both underground and above ground as a function of terrain and access, as shown in Figures 3-11 and 3-12. For underground installation, the piping would generally be placed on a compacted sand bed within excavated trenches. Where unsatisfactory bearing material is encountered in excavating, the method of utilizing graded rock with support saddles for the piping would be considered. The existing condenser waterboxes and discharge pipes will be modified for the installation of mechanical tube cleaning retrieval devices. Valves are provided to divert the flow as desired, for either closed-cycle or open-cycle operation. For both modes, the condenser flow leads into the existing discharge tunnel as shown in Figure 3-11. This tunnel in turn leads to the new pump pit which connects with three 8-1/2' diameter pipes that connect to the tower, as also shown in Figure 3-11. On the discharge side of the tower there would also be three lines which would each be bifurcated into two 6' diameter pipes and thereafter connected to the existing 7' diameter pipes which supply each individual waterbox.

3.6 MAKE-UP WATER SYSTEM

Two new vertical make-up pumps would be installed in Bays No. 31 and No. 36 of the existing intake structure as shown in Figure 3-6. These pumps will have the capability to operate as circulating water pumps during once-through operation and make-up pumps during closed-cycle operation.

3.7 CHEMICAL TREATMENT FACILITIES

Facilities will be provided for sulfuric acid addition to the cooling system. This is necessary in order to reduce the bicarbonate content of the circulating water to prevent scale formation.

Also, to prevent organic growth, intermittent chlorination of the circulating water will be provided utilizing the existing chlorination system of Unit No. 3. A new chlorine residual analyzer would be installed at the blowdown release point.

3.8 BLOWDOWN

Water in the circulating system would have to be continuously blown down to prevent build-up of solids, which could result in subsequent precipitation in the condenser tubes and tower basin. The blowdown line will be taken off one or more of the cold circulating water lines before entering the condenser. The flow control value will be sized to pass approximately 15,000 gpm. This blowdown is to be piped into the Indian Point common discharge canal. A "two cycle concentration" is tentatively being selected to prevent solid concentration from exceeding the maximum river salinity for most of the year and to minimize the need for water treatment. (Refer to Section 6-7 for details).

3.9 ELECTRICAL EQUIPMENT

Power for the closed-cycle cooling system would be available from two independent sources each having the capability to supply the total new load. One feed would be from 138/6.9 KV Station Auxiliary Transformer and the other from a second 22/6.9 KV Unit Auxiliary Transformer connected to the main generator leads. The

6.9 KV feeders will terminate in the 6.9 KV switchgear located at the pump area.

The 6.9 KV switchgear would supply power to the new circulating water pump motors and the 480 volt motor control center via 6.9 KV/480v transformers. The motor control center would provide for large motor operated valves and supply feeds to a second motor control center at the tower. This motor control center would supply auxiliary power to the aircraft-warning lights on the cooling tower, roadway lighting and other smaller motor operated valves. (Refer to Figures 3-15 through 3-21 for details).

3.10 SAFETY CONSIDERATIONS

In its evaluation, Con Edison has given attention to the construction and operation implications of backfitting a closed-cycle cooling system on an operating nuclear facility. This section of the report discusses those implications.

1. Blasting for excavation during construction will be subject to limitations on explosive charge quantities and fuse delays to prevent excessive ground accelerations. At the Indian Point site, a controlled geotechnical investigation has been conducted to determine the appropriate restrictions on blasting operations. A monitoring program for such blasting will be conducted and

any additional modifications to the restrictions on excavation blasting will be made as necessary.

Con Edison has considerable experience with construction work and blasting on the site of an operating nuclear power plant. Both Indian Point Units 2 and 3 were excavated and built while Indian Point Unit No. 1 was operating. Prior to and during this period of construction, a controlled geotechnical investigation and monitroing program was conducted to assure that proper restrictions on blasting operations and construction practices were established and maintained. Similar precautions will be taken during the construction of the hyperbolic natural draft cooling tower for Indian Point Unit No. 3 to assure that no adverse effects to plant structures important to safety will take place.

As part of this program, Con Edison will establish limits on explosive charge quantities and fuse delays to assure that excavation blasting will not yield ground velocities or peak particle velocities (PPV)in excess of 1.0 inch/sec. while Indian Point Unit No. 3 is operational. These PPV readings will be measured by 3 component seismographs located at 2 sites selected for proximity to both the blasting location and Indian Point structures and equipment.

Con Edison will also restrict initial blasting to locations further than 150 feet from the nearest existing Indian Point structure. Vibration data will be monitored by a full-time independent seismic consultant and plotted as scaled distance against PPV. As data is collected, the charge sizes will be adjusted to assure that the limiting PPV values are not exceeded. Blasting closer than 150 feet will not be allowed until a minimum of 25 blasts have been fired at a greater distance.

Dewatering during construction is not expected to have any effect on Unit No. 3 structures. Excavation for underground piping and tunnels near the Unit No. 3 turbine building and containment will result in a temporary lowering of the ground water table in the area, but because the major portion of the excavation will be in rock and all structures in the area are founded on rock, no risk of instability will result. Construction of the natural draft cooling tower is sufficiently distant from the other structures at Indian Point and is sufficiently elevated with the tower basin at about 45 feet above the river to have no effect on ground water table level at the site.

2. An analysis of the radioactive releases to the Hudson River with the closed-cycle operation of Indian Point Unit No. 3 has been conducted. This analysis, which is further

discussed in Section 6.3 below, demonstrates that such releases, without the dilution benefit of condenser cooling water, will meet the requirements of 10 CFR Part 20.

3. A portion of the existing service water piping system of Indian Point Unit No. 3 will be modified. The single discharge line will be relocated to empty into the common discharge tunnel which flows to the river. The two supply lines will not be affected by the new piping and will therefore remain at their present locations.

The alteration to the discharge line of the service water system, which is estimated to be completed in four days, will require certain advance preparation. Since there is only one discharge line that directs flow to the discharge canal, the service water system will have to be secured during this phase of the work. Therefore, the reactor will be brought to a cold shutdown conditon. Without service water flow, the auxiliary coolant systems normally used for dissipation of decay heat from the core during cold shutdown will not be available. Instead, the reactor will be maintained in the cold shutdown condition for the four-day alteration period by using the four steam generators, the auxiliary feedwater system and the main steam relief valves.

4. The location of the hyperbolic cooling element for the preferred closed-cycle cooling system has been selected on the basis of economic considerations as well as to provide assurance that any structural damage to the cooling element will not physically impair Class 1 facilities.

A failure of the tower shell is expected to be characterized by an inward collapse similar to that which occurred at Ferrybridge, England. Such a failure mode would not jeopardize important plant facilities.

A hyperbolic shell, which is a large, ventilated structure, is expected to be able to survive an actual tornado. Missiles generated by a tornado are expected only to penetrate the cooling tower locally without causing failure.

TABLE 3-1

THERMAL DESIGN CRITERIA OF COOLING TOWERS

	Natural Draft (Wet)	Linear Mech. Draft (Wet)	Linear Mech. Draft (Wet/Dry)	Round Mech. Draft (Wet)	Fan-Assisted Natural Draft (Wet)
Condenser Heat Load 10^6 BTU/hr	7,350	7,350	7,350	7,350	7,350
Cooling Water Flow gpm	600,000	600,000	600,000	600,000	600,000
Cooling Range, $^{\circ}F$	25	25	25	25	25
Tower Approach, $^{\circ}F$	16	17	17	17	16
Design Summer Wet - Bulb Temp., $^{\circ}F$	74	74	74	74	74
Design Summer Relative Humidity, %	55	55	55	55	55
Design Winter Dry-Bulb Temp., $^{\circ}F$	--	--	20	--	--
Design Winter Relative Humidity, %	--	--	80	--	--

TABLE 3-2

REDUCED MWe CAPABILITY OF INDIAN POINT UNIT NO. 3
TURBINE-GENERATOR OPERATED AT REACTOR POWER
3217 MWt MAXIMUM CALCULATED LOAD
AT SUMMER PEAK CONDITIONS (1)

COOLING SYSTEMS (2)	OT	NW	LMW	MWD	RMW	FN
1. Turbine Net MWe (Backpressure, in. Hg)	1054 (2.35)	994 (4.30)	992 (4.40)	992 (4.40)	992 (4.40)	994 (4.30)
2. Loss of Turbine Capacity, MWe	0	60	62	62	62	60
3. Cooling System Auxiliaries, MWe	0	17.5	20.5	21.5	20.5	19.5
4. Total Derating due to Alternative Cooling System, MWe (2) + (3)	0	77.5	82.5	83.5	82.5	79.5
5. Normal Plant Auxiliary Load, MWe	35	35	35	35	35	35
6. Total Loss, MWe (4) + (5)	35	112.5	117.5	118.5	117.5	114.5
7. Plant Net, MWe 1054-(6)	1019	941.5	936.5	935.5	936.5	939.5

NOTES: (1) 77°F Wet Bulb Temperture & 79°F River Water Temperature
(2) OT - Once through; NW-Natural Draft Wet Tower; LMW-Linear Mechanical Draft Wet Tower; MWD-Mechanical Draft Wet/Dry Tower; RMW-Round Mechanical Draft Wet Tower; FN - Fan-Assisted Natural Draft Wet Tower.

TABLE 3-3

CHANGE IN PLANT NET HEAT RATE OF INDIAN POINT UNIT NO. 3
TURBINE-GENERATOR OPERATED AT REACTOR POWER AT
3217 MWT MAXIMUM CALCULATED LOAD
AT YEARLY AVERAGE CONDITIONS (1)

Cooling Systems (2)	OT	NW	LMW	MWD	RMW	FN
1. Turbine Net, MWe	1,068	1,052	1,040	1,040	1,040	1,052
2. Loss of Turbine Capacity, Avg MWe	0	16	28	28	28	16
3. Cooling System Auxiliaries, MWe	0	17.5	20.5	21.5	20.5	19.5
4. Total Derating due to Alternative Cooling System, MWe, (2) + (3)	0	33.5	48.5	49.5	48.5	35.5
5. Normal Plant Auxiliary Load, MWe	35	35	35	35	35	35
6. Total Loss, MWe (4) + (5)	35	68.5	83.5	84.5	83.5	70.5
7. Plant Net, MWe 1068 - (6)	1,033	999.5	984.5	983.5	984.5	997.5
8. Plant Net Heat Rate	10,630	10,970	11,130	11,140	11,130	10,990

NOTES: (1) 65°F Wet Bulb Temp & 74°F River Temp for a 3-month Summer; 35°F Wet Bulb Temp & 49°F River Temp for a 9-month non-summer period.

(2) OT - Once Through; NW - Natural Draft Wet Tower; LMN - Linear Mechanical Draft Wet Tower; MWD - Mechanical Draft Wet/Dry Tower; RMW - Round Mechanical Draft Wet Tower; FN - Fan-Assisted Natural Draft Wet Tower.

TABLE 3-4

PHYSICAL DESCRIPTION OF MAJOR COMPONENTS FOR CONSTRUCTION OF CLOSED-CYCLE COOLING TOWER SYSTEMS

	Natural Draft (Wet)	Linear Mech. Draft (Wet)	Mechanical Draft (Wet/Dry)	Round Mech. Draft (Wet)	Fan-Assisted Natural Draft (Wet)
1. Cooling Elements					
(a) No. of Towers	1	3 (26 cells)	3 (28 cells)	2	2
(b) Dimensions (each)	462' base dia. and 565' high	1-320' long; 2-360' long; 75' wide and 68' high	1-480' long; 2-430' long; 70' wide and 74' high	285' base dia. and 67' high	267' base dia. and 205' high
(c) Total no. of Fans (Brake HP each)	--	26 (200 HP)	28 (200 HP)	26 (200 HP)	48 (132 HP)
2. Circulating Water Pumps					
(a) No.	3	3	3	4	4
(b) Cap. (each), gpm	200,000	200,000	200,000	150,000	150,000
(c) BHP (each)	7,000	7,000	7,000	5,250	5,250
3. Piping from Pumps to Cooling Tower	Three 8½' dia. (300' long)	Three 8½' dia. (500' long)	Three 8½' dia. (500' long)	Four 7½' dia. (500' long)	Four 7½' dia. (500' long)
4. Make-up pumps					
(a) No.	2	2	2	2	2
(b) Cap. (each), gpm	30,000	30,000	30,000	30,000	30,000
(c) BHP (each)	500	500	500	500	500

TABLE 3-4 (continued)

	Natural Draft (Wet)	Linear Mech. Draft (Wet)	Mechanical Draft (Wet/Dry)	Round Mech. Draft (Wet)	Fan-Assisted Natural Draft (Wet)
5. Piping from tower to existing Condenser Feed Lines	Three 8½' dia. pipes (500' long) each with two 6' branches each	Three 8½' dia pipes (700' long) each with two 6' branches each	Three 8½' dia. pipe (700' long) each with two 6' branches each	Two 11' dia. pipes (11' long) with three 6' branches each	Two 11' dia. pipes (600' long) with three 6' branches each
6. New Unit Auxiliary Transformers	20 MVA	30 MVA	30 MVA	30 MVA	30 MVA
7. New Station Auxiliary Transformers	20 MVA	75 MVA	75 MVA	75 MVA	75 MVA
8. 480 V Motor Control Centers	3	4	4	4	4
9. 2400 V Motor Control Centers	Not required	3	3	2	Not required
10. 6.9 KV Breakers					
a. 2000 amp	4	4	4	4	4
b. 1200 amp	4	8	8	6	6
11. 4160 V Breakers	Not required	2	2	1	Not required
12. 2400 V Reversing Starters	Not required	26	28	26	Not required
13. Excavation, Cubic Yds.					
a. Tower foundation	241,330	466,629	577,907	139,400	139,400
b. Tunnel, Piping and Pump Pits	27,150	38,618	38,618	34,900	34,900
14. Elevation, ft. MSL					
(a) Sprayer discharge	110	103	101	103	103
(b) Top of fill	108	102	88	102	101
(c) Bottom of basin	45	45	45	45	45
(d) Grade	53	53	53	53	53

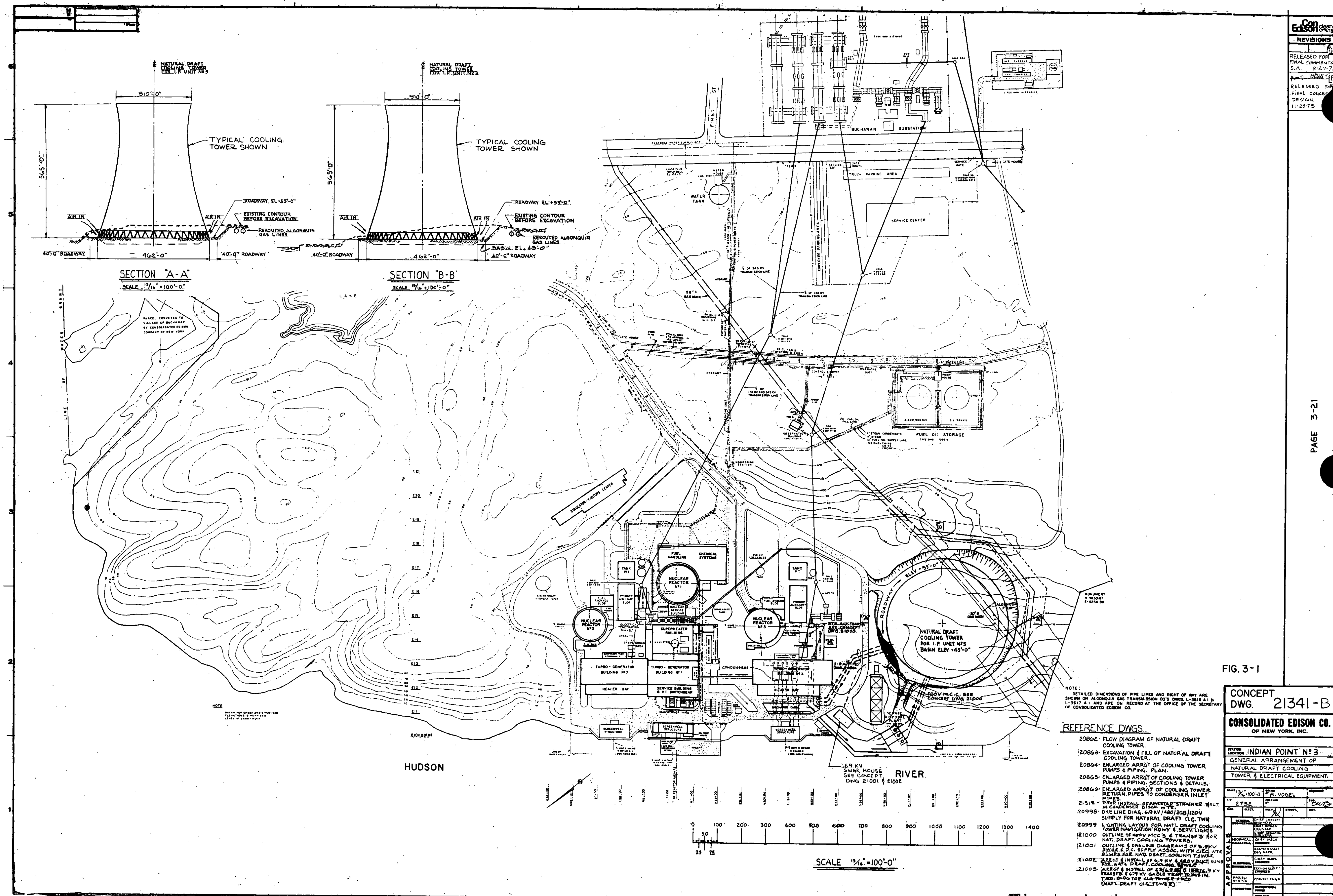

Con Edison clean energy
REVISIONS
RELEASED FOR FINAL COMMENTS S.A. 2-27-75
RELEASED FOR FINAL CONCEPT DESIGN 11-28-75
NATURAL DRAFT COOLING TOWER FOR I.P. UNIT NO.3
310'-0"
565'-0"
TYPICAL COOLING TOWER SHOWN
ROADWAY EL.+53'-0"
EXISTING CONTOUR BEFORE EXCAVATION
REROUTED ALGONQUIN GAS LINES
AIR IN
40'-0" ROADWAY
462'-0"
BASIN EL.+45'-0"
SECTION "A-A"
SECTION "B-B"
SCALE 13/16" = 100'-0"
LAKE
BUCHANAN SUBSTATION
TRUCK PARKING AREA
SERVICE CENTER
WATER TANK
FUEL OIL STORAGE
OIL TANKS
FUEL HANDLING
CHEMICAL SYSTEMS
NUCLEAR REACTOR NO.1
NUCLEAR REACTOR NO.2
NUCLEAR REACTOR NO.3
SUPERHEATER BUILDING
TURBO-GENERATOR BUILDING NO.2
TURBO-GENERATOR BUILDING NO.1
TURBO-GENERATOR BUILDING NO.3
SERVICE BUILDING & H.T. SWITCHGEAR
HEATER BAY
CONDENSATE STORAGE TANK
SCREENWELL STRUCTURE
SIMULATOR-VISITORS CENTER
ROADWAY
ELEV.+53'-0"
NATURAL DRAFT COOLING TOWER FOR I.P. UNIT NO.3 BASIN ELEV.+45'-0"
480V M.C.C. SEE CONCEPT DWG 21000
6.9 KV SWGR HOUSE SEE CONCEPT DWG 21001 & 21002
HUDSON RIVER
SCALE 13/16" = 100'-0"
NOTE:
DETAILED DIMENSIONS OF PIPE LINES AND RIGHT OF WAY ARE SHOWN ON ALGONQUIN GAS TRANSMISSION CO'S DWGS. L-3616 A1 & L-3617 A1 AND ARE ON RECORD AT THE OFFICE OF THE SECRETARY OF CONSOLIDATED EDISON CO.
REFERENCE DWGS
20862 - FLOW DIAGRAM OF NATURAL DRAFT COOLING TOWER.
20863 - EXCAVATION & FILL OF NATURAL DRAFT COOLING TOWER.
20864 - ENLARGED ARRGT OF COOLING TOWER PUMPS & PIPING. PLAN.
20865 - ENLARGED ARRGT OF COOLING TOWER PUMPS & PIPING. SECTIONS & DETAILS.
20866 - ENLARGED ARRGT OF COOLING TOWER RETURN PIPES TO CONDENSER INLET PIPES.
21318 - PROP INSTALL. OF AMERTAP STRAINER SECT. IN CONDENSER DISCH. WTR.
20998 - ONE LINE DIAG. 6.9KV/480/208/120V SUPPLY FOR NATURAL DRAFT CLG. TWR.
20999 LIGHTING LAYOUT FOR NAT'L DRAFT COOLING TOWER NAVIGATION RDWY & SERV. LIGHTS
21000 OUTLINE OF 480V MCC'S & TRANSF'S FOR NAT. DRAFT COOLING TOWERS.
21001 OUTLINE & ONELINE DIAGRAMS OF 6.9KV SWGR & D.C. SUPPLY ASSOC. WITH CIRC WTR PUMPS FOR NAT'L DRAFT COOLING TOWER
21002 ARRGT & INSTALL OF 6.9 KV & 480 V DUCT RUNS FOR NAT'L DRAFT COOLING TOWER
21003 ARRGT & INSTALL OF 22/6.9 KV & 13.8/6.9 KV TRANSF'S & 6.9 KV CABLE TRAY RUNS IN TURB. BLDG FOR CLG TOWER (NAT'L DRAFT CLG TOWER)
CONCEPT DWG. 21341-B
CONSOLIDATED EDISON CO. OF NEW YORK, INC.
STATION LOCATION INDIAN POINT NO.3
GENERAL ARRANGEMENT OF NATURAL DRAFT COOLING TOWER & ELECTRICAL EQUIPMENT.
SCALE 13/16" = 100'-0"
DRAWN BY R. VOGEL
J.O. 2752
APPROVALS

FIG. 3-1

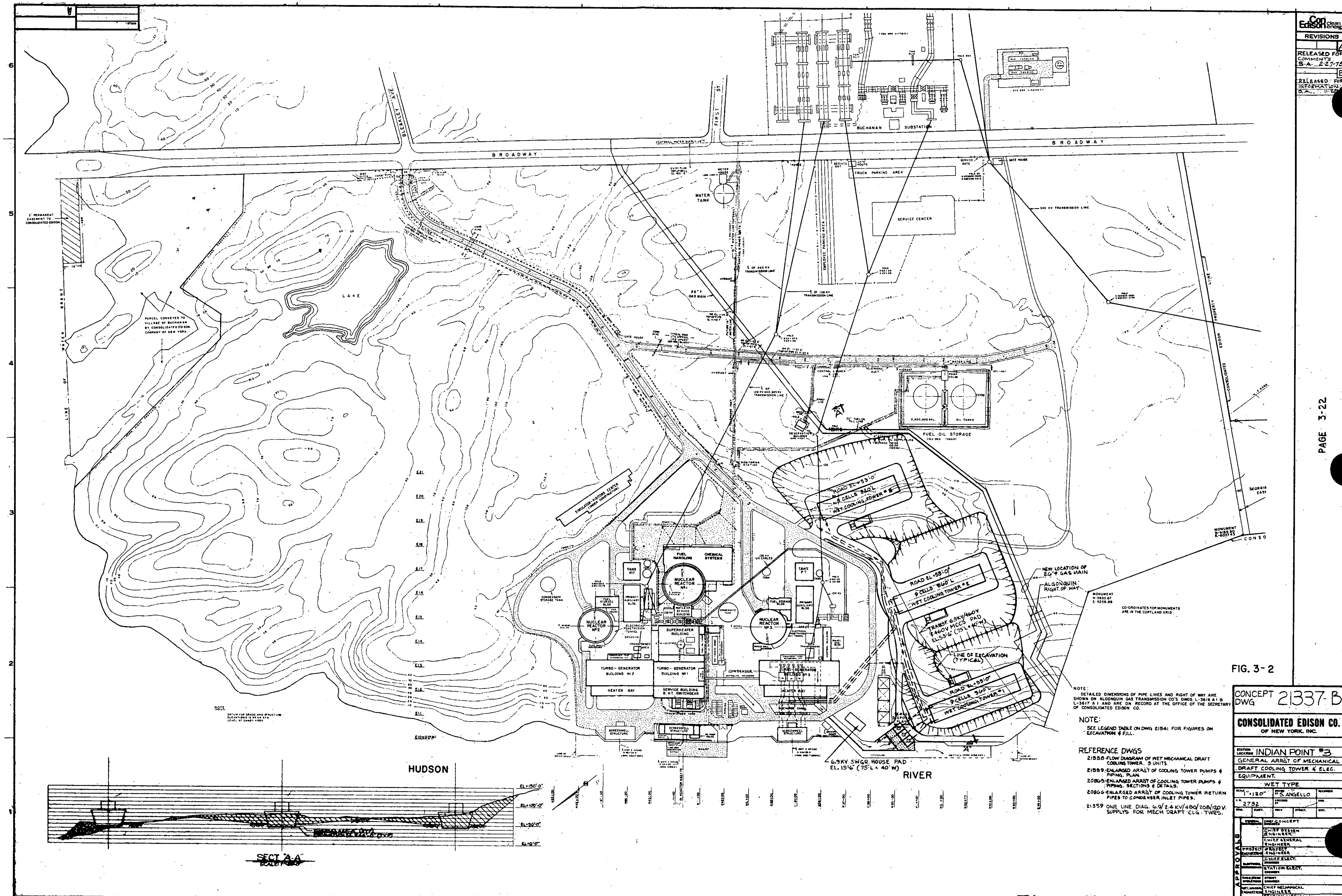
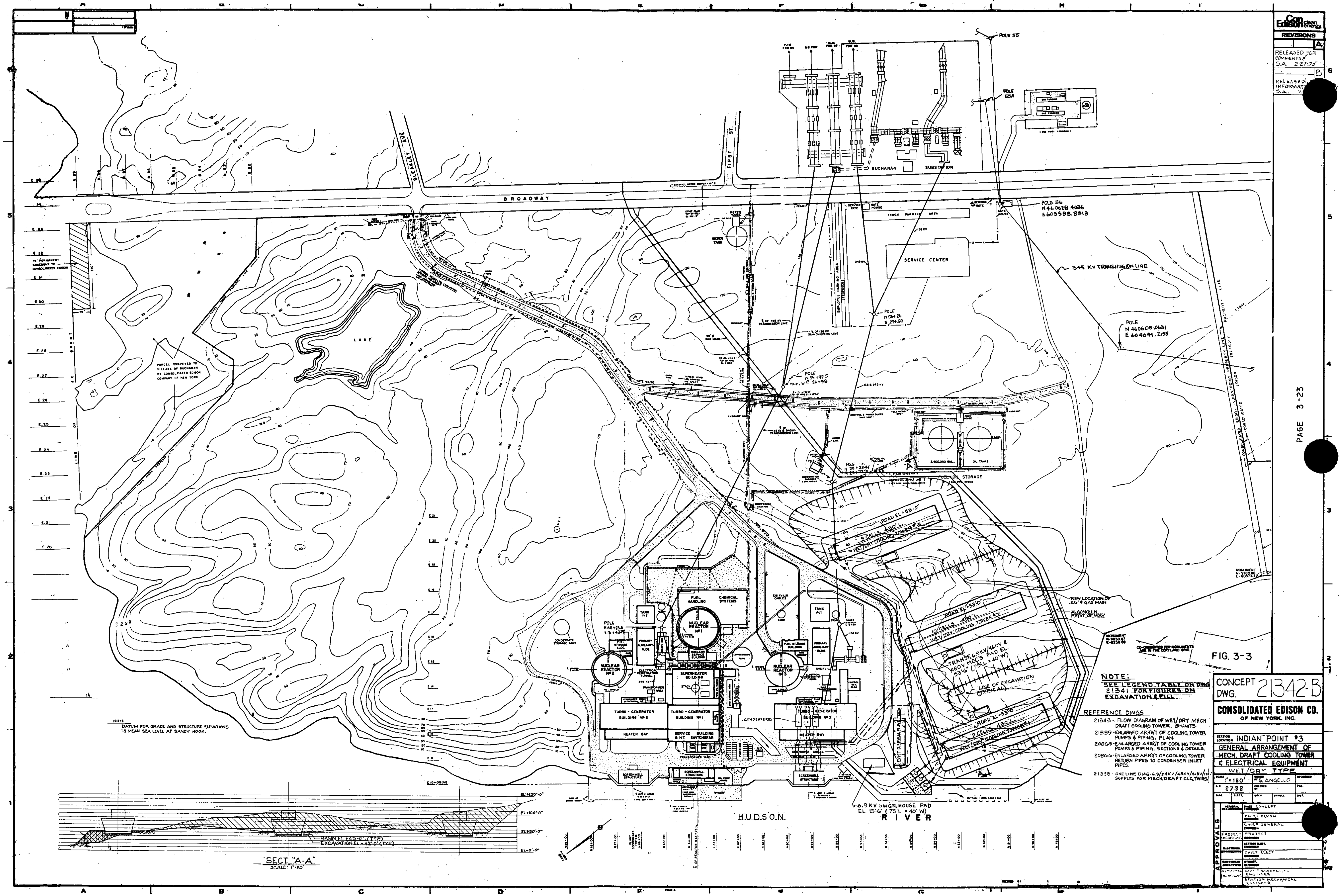

REVISIONS
RELEASED FOR COMMENTS S.A. 2-27-75
RELEASED FOR INFORMATION
BROADWAY
BLEAKLEY AVE
FIRST ST
BUCHANAN SUBSTATION
TRUCK PARKING AREA
SERVICE CENTER
WATER TANK
LAKE
PARCEL CONVEYED TO VILLAGE OF BUCHANAN BY CONSOLIDATED EDISON COMPANY OF NEW YORK
5' PERMANENT EASEMENT TO CONSOLIDATED EDISON
WATER GRANT LINE OF
26"φ GAS MAIN
FUEL OIL STORAGE
OIL TANKS
SIMULATOR-VISITORS CENTER
ROAD EL+53'-0"
8 CELLS 520' L
WET COOLING TOWER #3
ROAD EL+53'-0"
9 CELLS 560' L
WET COOLING TOWER #2
TRANSF. 6.9KV/460V & 460V MCCS PAD EL+53'-6" (75'L x 40'W)
LINE OF EXCAVATION (TYPICAL)
ROAD EL+53'-0"
9 CELLS 560' L
WET COOLING TOWER #1
NEW LOCATION OF 26"φ GAS MAIN
ALGONQUIN RIGHT OF WAY
CO-ORDINATES FOR MONUMENTS ARE IN THE CORTLAND GRID
CONSOLIDATED EDISON PROPERTY LINE
FUEL HANDLING
CHEMICAL SYSTEMS
NUCLEAR REACTOR Nº1
NUCLEAR REACTOR Nº2
NUCLEAR REACTOR Nº3
SUPERHEATER BUILDING
TURBO-GENERATOR BUILDING Nº2
TURBO-GENERATOR BUILDING Nº1
SERVICE BUILDING & H.T. SWITCHGEAR
HEATER BAY
CONDENSER
SCREENWELL STRUCTURE
6.9KV SWGR. HOUSE PAD EL. 15'-6" (75'L x 40'W)
HUDSON
RIVER
SECT "A-A"
EL+150'-0"
EL+100'-0"
EL+50'-0"
EL+0'-0"
NOTE:
DETAILED DIMENSIONS OF PIPE-LINES AND RIGHT OF WAY ARE SHOWN ON ALGONQUIN GAS TRANSMISSION CO'S DWGS. L-3616 A1 & L-3617 A1 AND ARE ON RECORD AT THE OFFICE OF THE SECRETARY OF CONSOLIDATED EDISON CO.
NOTE:
SEE LEGEND TABLE ON DWG 21341 FOR FIGURES ON EXCAVATION & FILL.
REFERENCE DWGS
21338-FLOW DIAGRAM OF WET MECHANICAL DRAFT COOLING TOWER. 3 UNITS.
21339-ENLARGED ARRG'T OF COOLING TOWER PUMPS & PIPING. PLAN.
20865-ENLARGED ARRG'T OF COOLING TOWER PUMPS & PIPING. SECTIONS & DETAILS.
20866-ENLARGED ARRG'T OF COOLING TOWER RETURN PIPES TO CONDENSER INLET PIPES.
21359 ONE LINE DIAG. 6.9/2.4 KV/480/208/120V. SUPPLYS FOR MECH DRAFT CLG. TWRS.
CONCEPT DWG 21337-B
CONSOLIDATED EDISON CO.
OF NEW YORK, INC.
STATION LOCATION INDIAN POINT #3
GENERAL ARRG'T OF MECHANICAL DRAFT COOLING TOWER & ELEC. EQUIPMENT.
WET TYPE
SCALE 1"=120"
DRAWN BY S. ANGELLO
J.O. 2732
APPROVALS
CHIEF CONCEPT ENGINEER
CHIEF DESIGN ENGINEER
CHIEF GENERAL ENGINEER
PROJECT ENGINEER
CHIEF ELECT. ENGINEER
STATION ELECT. ENGINEER
STRUCT. ENGINEER
CHIEF MECHANICAL ENGINEER
STATION MECHANICAL ENGINEER

FIG. 3-2


REVISIONS
RELEASED FOR COMMENTS
S.A. 2-27-75
RELEASED FOR INFORMATION
POLE 55
POLE 63A
BUCHANAN SUBSTATION
BROADWAY
BLEAKLEY AVE
FIRST ST
POLE 56
N 460628.4026
E 605388.8513
SERVICE CENTER
TRUCK PARKING AREA
EMPLOYEE PARKING AREA
345 KV TRANSMISSION LINE
WATER TANK
LAKE
PARCEL CONVEYED TO VILLAGE OF BUCHANAN BY CONSOLIDATED EDISON COMPANY OF NEW YORK
POLE
N 460605.0631
E 604641.2155
GATE HOUSE
OIL TANKS
FUEL OIL STORAGE
ROAD EL+53'-0"
9 CELLS 430' L
WET/DRY COOLING TOWER #1
ROAD EL+53'-0"
10 CELLS 480' L
WET/DRY COOLING TOWER #2
TRANS 6.9 KV/460V & 460V MCC'S PAD EL 53'-6" (75' L x 40' W)
LINE OF EXCAVATION (TYPICAL)
ROAD EL+53'-0"
9 CELLS 430' L
WET/DRY COOLING TOWER #3
NEW LOCATION OF 26" Ø GAS MAIN
ALGONQUIN RIGHT OF WAY
MONUMENT
N-9030.67
E-6258.68
CO-ORDINATES FOR MONUMENTS ARE IN THE CORTLAND GRID
FUEL HANDLING
CHEMICAL SYSTEMS
NUCLEAR REACTOR Nº1
NUCLEAR REACTOR Nº2
NUCLEAR REACTOR Nº3
CONDENSATE STORAGE TANK
SUPERHEATER BUILDING
TURBO-GENERATOR BUILDING Nº2
TURBO-GENERATOR BUILDING Nº1
TURBO-GENERATOR BUILDING Nº3
HEATER BAY
SERVICE BUILDING & H.T. SWITCHGEAR
TRANSFORMER YARD
SCREENWELL STRUCTURE
CONDENSER
6.9 KV SWGR. HOUSE PAD EL. 15'-6" (75' L x 40' W)
HUDSON RIVER
NOTE
DATUM FOR GRADE AND STRUCTURE ELEVATIONS IS MEAN SEA LEVEL AT SANDY HOOK.
BASIN EL+45'-0" (TYP)
EXCAVATION EL+42'-0" (TYP)
SECT "A-A"
SCALE: 1"=80'
NOTE:
SEE LEGEND TABLE ON DWG 21341 FOR FIGURES ON EXCAVATION & FILL.
REFERENCE DWGS
21343 - FLOW DIAGRAM OF WET/DRY MECH DRAFT COOLING TOWER. 3-UNITS.
21339 - ENLARGED ARR'G'T OF COOLING TOWER PUMPS & PIPING. PLAN.
20865 - ENLARGED ARR'G'T OF COOLING TOWER PUMPS & PIPING. SECTIONS & DETAILS.
20866 - ENLARGED ARR'G'T OF COOLING TOWER RETURN PIPES TO CONDENSER INLET PIPES.
21358 - ONE LINE DIAG. 6.9/2.4KV/480V/208V/120V SUPPLYS FOR MECH.DRAFT CLG.TWRS.
CONCEPT DWG. 21342-B
CONSOLIDATED EDISON CO. OF NEW YORK, INC.
STATION LOCATION INDIAN POINT #3
GENERAL ARRANGEMENT OF MECH. DRAFT COOLING TOWER & ELECTRICAL EQUIPMENT
WET/DRY TYPE
SCALE 1"=120'
DRAWN BY S. ANGELLO
2732
APPROVALS
CHIEF CONCEPT ENGINEER
CHIEF DESIGN ENGINEER
CHIEF GENERAL ENGINEER
PROJECT ENGINEER
STATION ELECT. ENGINEER
CHIEF ELECT ENGINEER
CHIEF MECHANICAL ENGINEER
STATION MECHANICAL ENGINEER
FIG. 3-3

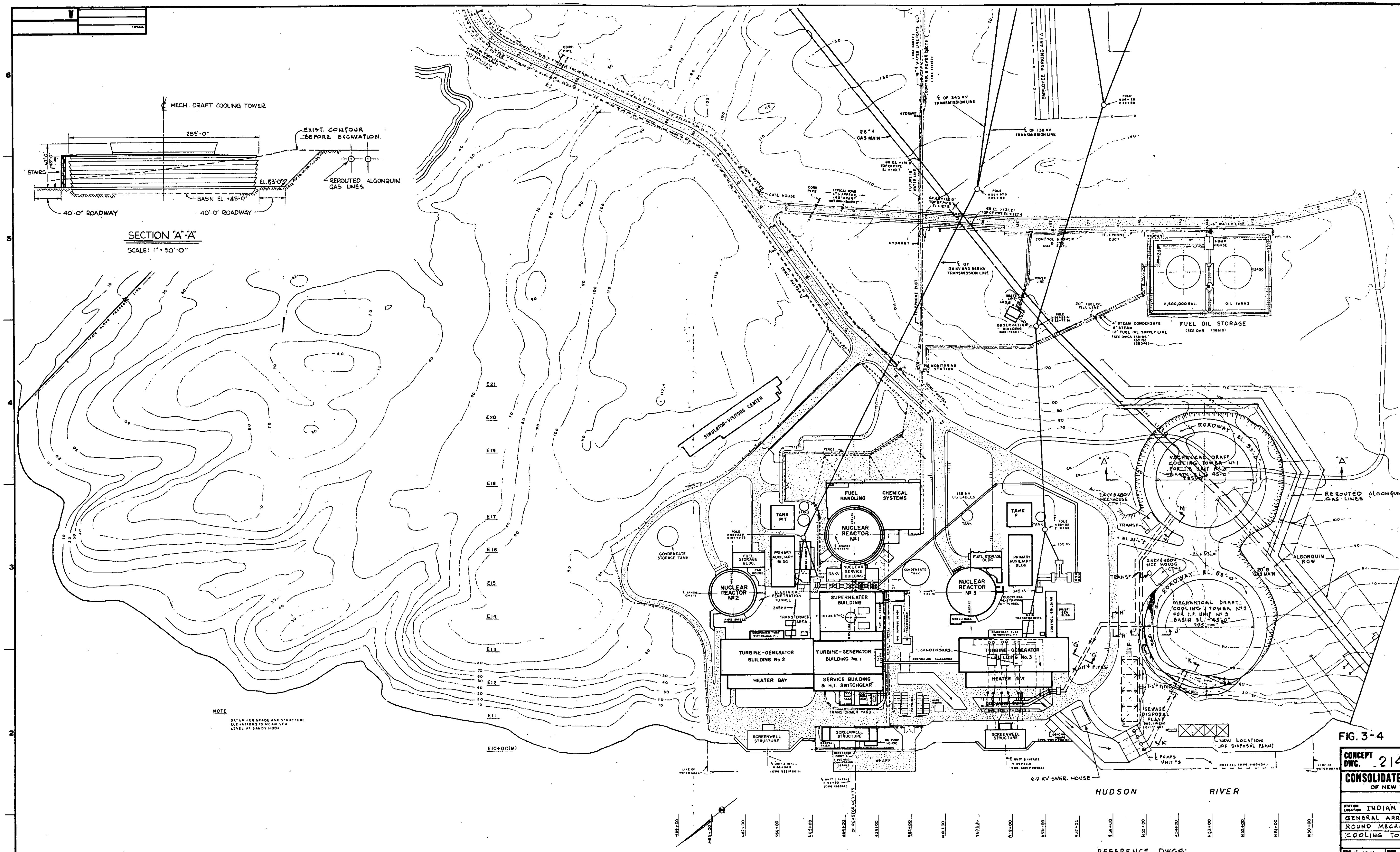


FIG. 3-4

REFERENCE DWGS:

21441 - FLOW DIAGRAM OF (2) ROUND MECHANICAL COOLING TOWERS.

21442 - ENLARGED ARRG'T. OF (2) ROUND MECHANICAL COOLING TOWERS PUMPS & PIPING.

21439 - ONE LINE DIAG. 6.9/2.4KV/460/208V/120V. SUPPLYS FOR MECH. DRAFT COOLING TOWERS (WET TYPE) 2 ROUND TOWERS.

WORK THIS DWG WITH CONCEPT DWG 21441

REVISIONS
A RELEASED FOR INFORMATION 6-18-75 HS
B RELEASED FOR INFORMATION S.A. 11-28-75

CONCEPT DWG. 21440-B

CONSOLIDATED EDISON CO. OF NEW YORK, INC.

STATION LOCATION: INDIAN POINT Nº 3

GENERAL ARRANGEMT OF (2) ROUND MECHANICAL DRAFT COOLING TOWERS

SCALE 1" = 100' | DRAWN BY M.S. | 2732

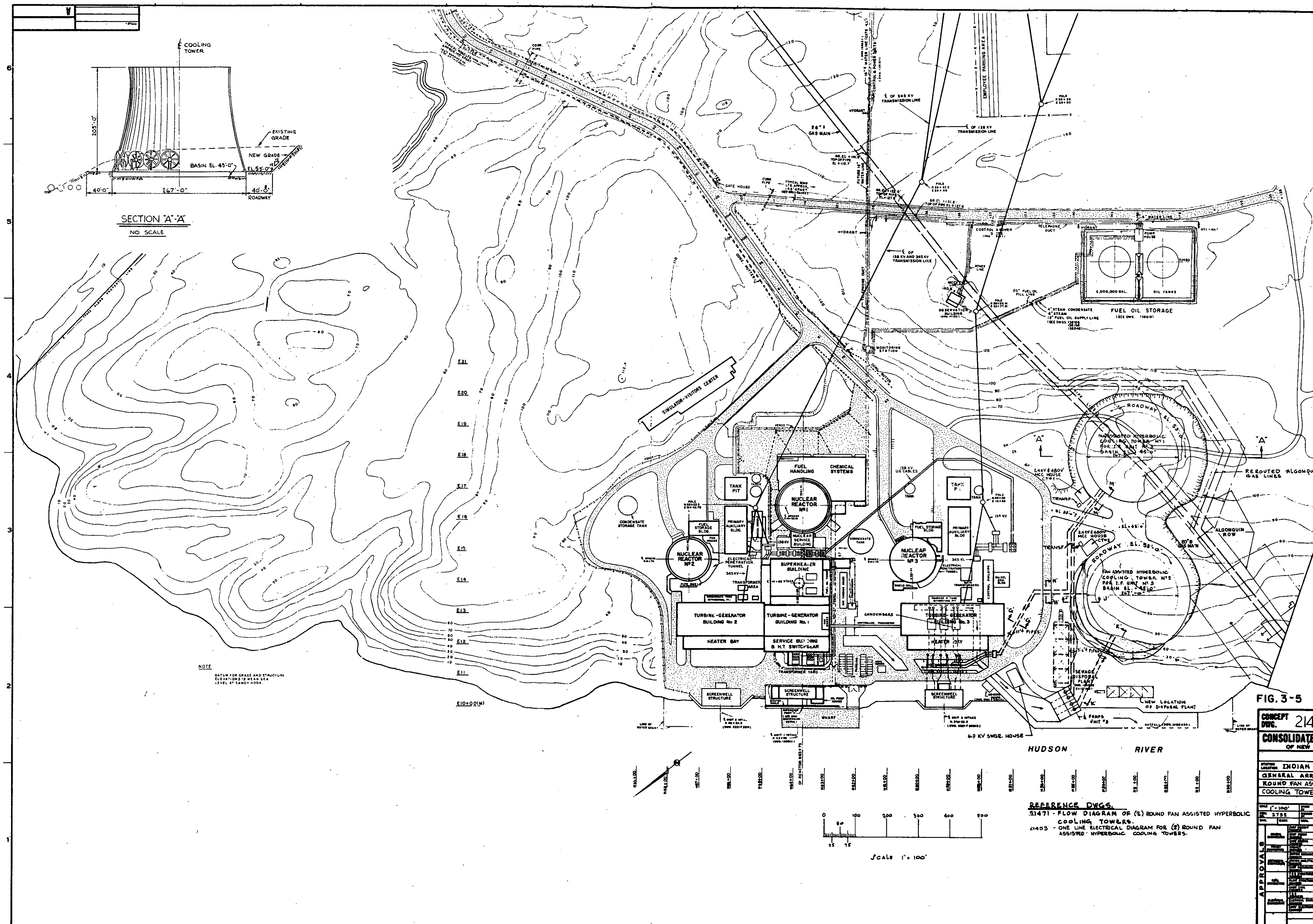
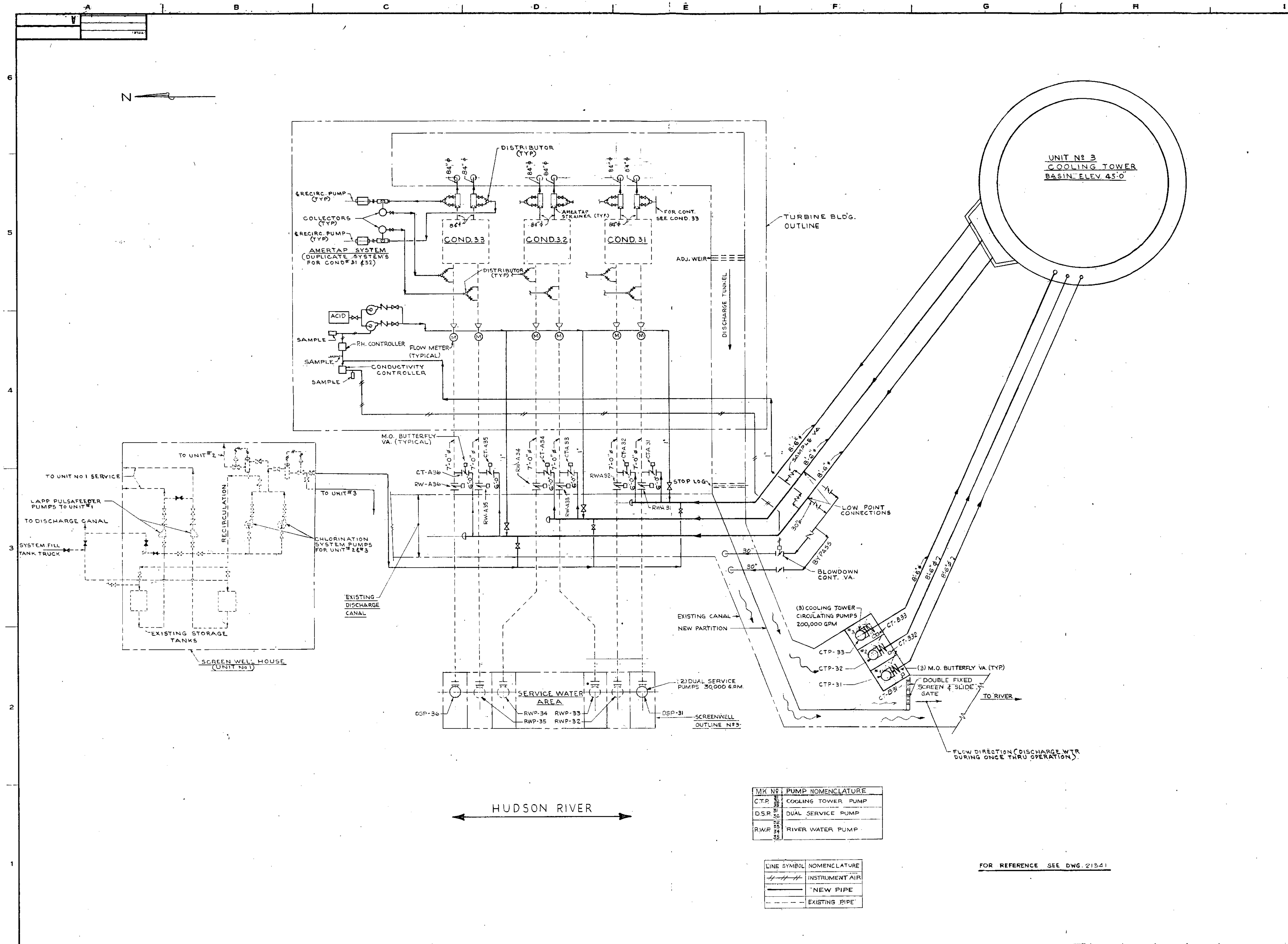

SECTION "A"-"A"
NO SCALE
COOLING TOWER
EXISTING GRADE
NEW GRADE
BASIN EL. 45'-0"
EL.55'-0"
205'-0"
40'-0"
267'-0"
ROADWAY
NOTE
DATUM FOR GRADE AND STRUCTURE ELEVATIONS IS MEAN SEA LEVEL AT SANDY HOOK.
SIMULATOR-VISITORS CENTER
EMPLOYEE PARKING AREA
GATE HOUSE
FUEL OIL STORAGE
2,500,000 GAL.
OIL TANKS
OBSERVATION BUILDING
MONITORING STATION
CONDENSATE STORAGE TANK
NUCLEAR REACTOR Nº2
NUCLEAR REACTOR Nº1
NUCLEAR REACTOR Nº3
FUEL HANDLING
CHEMICAL SYSTEMS
TANK PIT
PRIMARY AUXILIARY BLDG.
FUEL STORAGE BLDG.
NUCLEAR SERVICE BUILDING
SUPERHEATER BUILDING
ELECTRICAL PENETRATION TUNNEL
TRANSFORMER AREA
TURBINE-GENERATOR BUILDING No 2
TURBINE-GENERATOR BUILDING No. 1
TURBINE-GENERATOR BUILDING No. 3
HEATER BAY
SERVICE BUILDING & H.T. SWITCHGEAR
CONDENSERS
TRANSFORMER YARD
SCREENWELL STRUCTURE
WHARF
6.9 KV SWGR. HOUSE
SEWAGE DISPOSAL PLANT
NEW LOCATION OF DISPOSAL PLANT
FAN ASSISTED HYPERBOLIC COOLING TOWER Nº1 FOR I.P. UNIT Nº 3 BASIN EL. 45'-0"
FAN ASSISTED HYPERBOLIC COOLING TOWER Nº2 FOR I.P. UNIT Nº 3 BASIN EL. 45'-0"
ROADWAY
REROUTED ALGONQUIN GAS LINES
ALGONQUIN ROW
HUDSON RIVER
REFERENCE DWGS.
21471 - FLOW DIAGRAM OF (2) ROUND FAN ASSISTED HYPERBOLIC COOLING TOWERS.
21453 - ONE LINE ELECTRICAL DIAGRAM FOR (2) ROUND FAN ASSISTED HYPERBOLIC COOLING TOWERS.
SCALE 1" = 100'
REVISIONS
RELEASED FOR INFORMATION
CONCEPT DWG. 21482 -C
CONSOLIDATED EDISON CO. OF NEW YORK, INC.
INDIAN POINT Nº 3
GENERAL ARRANGEMT OF (2) ROUND FAN ASSISTED HYPERBOLIC COOLING TOWERS.
APPROVALS

FIG. 3-5



MK Nº		PUMP NOMENCLATURE
C.T.P.	31 32 33	COOLING TOWER PUMP
D.S.P.	31 36	DUAL SERVICE PUMP
R.W.P.	32 33 34 35	RIVER WATER PUMP

LINE SYMBOL	NOMENCLATURE
—//—//—	INSTRUMENT AIR
———	NEW PIPE
– – –	EXISTING PIPE

REVISIONS

A	RELEASED FOR ESTIMATE J.O 2732 1-23-74
B	RELEASED FOR INFORMATION 5-28-74
C	RELEASED FOR INFORMATION 6-3-74 R.V.
D	RELEASED FOR COMMENTS 7-25-74 MS
E	REV. COOLING TOWER CIRC. PUMPS H.P. & T.D.H. & FOR ESTIMATE 10-2-74 JAC
F	RELEASED FOR COMMENTS 12-30-74
G	RELEASED FOR FINAL COMMENTS S.A. 3-27-75
H	RELEASED FOR FINAL CONCEPTUAL DESIGN 11-28-75 MS

FIG. 3-6

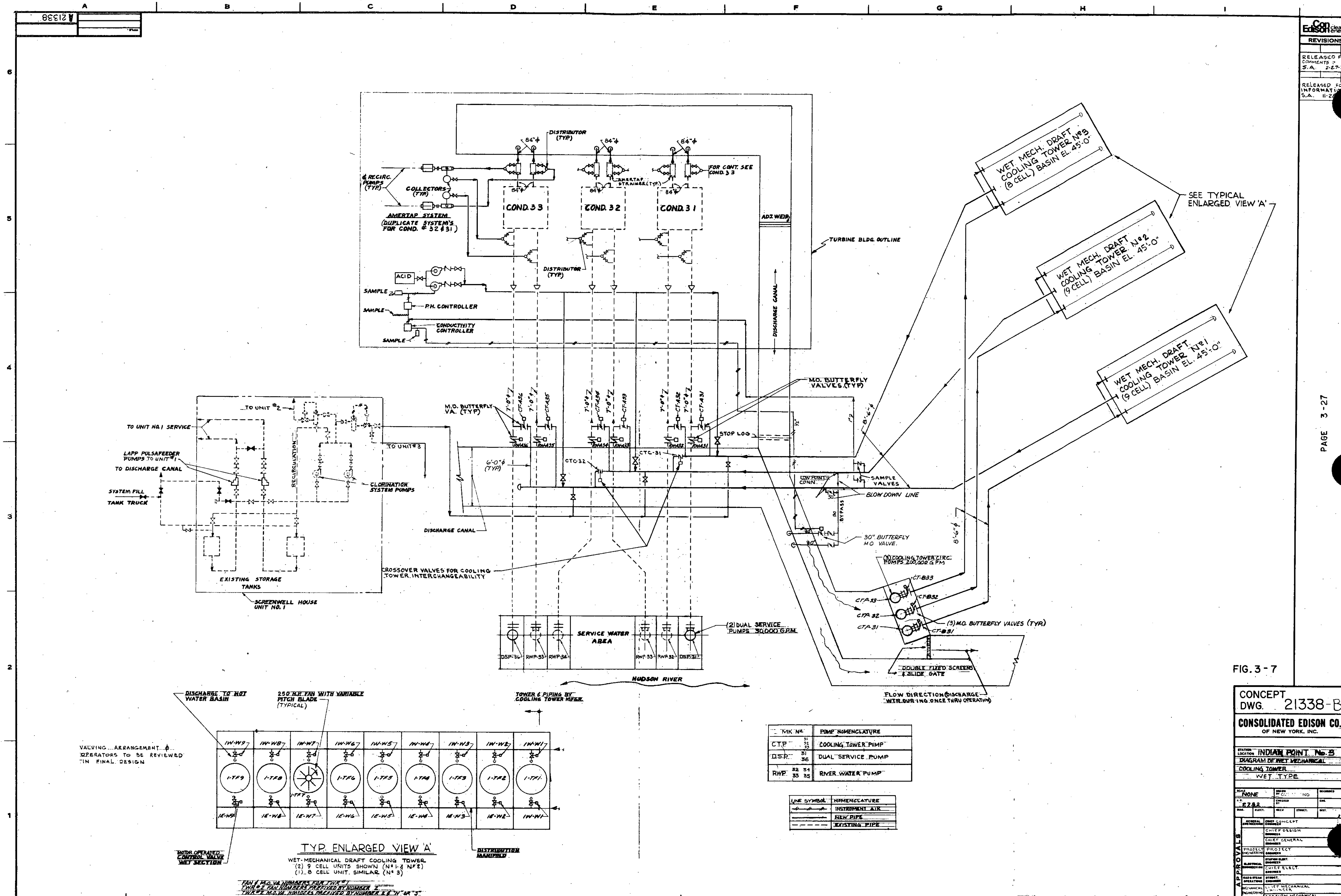
CONCEPT DWG. 20862-H

CONSOLIDATED EDISON CO.
OF NEW YORK, INC.

STATION LOCATION INDIAN POINT No. 3
FLOW DIAGRAM OF NATURAL DRAFT COOLING TOWER

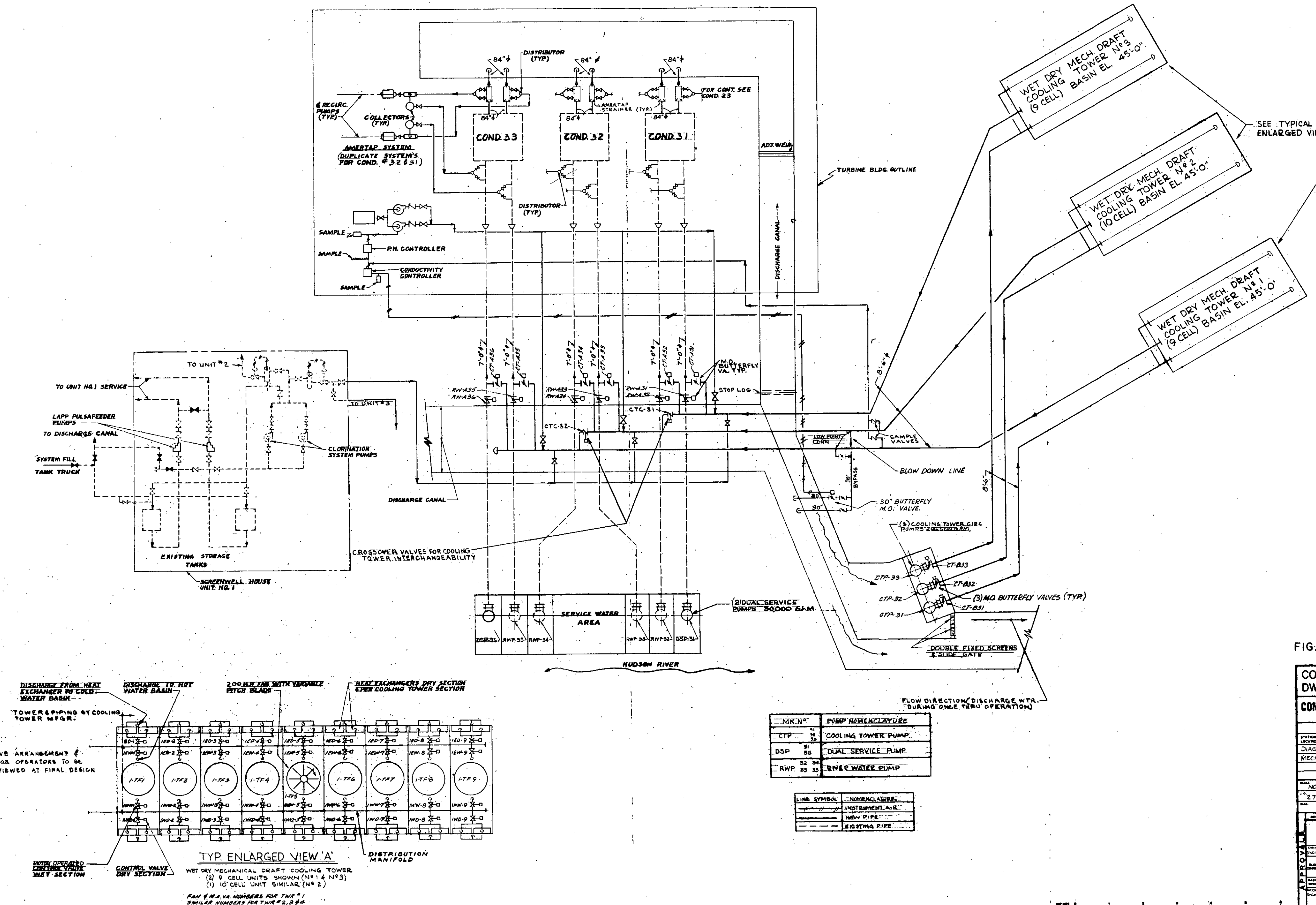
SCALE NONE	DRAWN BY F. DUNAU	RECORDED
J.O. 2732	CHECKED BY	ENG.

APPROVALS: GENERAL ENGINEERING — CHIEF CONCEPT ENGINEER, CHIEF DESIGN ENGINEER, CHIEF GENERAL ENGINEER; MECHANICAL ENGINEERING — CHIEF MECH ENGINEER, STATION MECH ENGINEER; ELECTRICAL ENGINEERING — CHIEF ELECT. ENGINEER, STATION ELECT. ENGINEER; PROJECT ENG'RG — PROJECT ENGR; PRODUCTION — CONVENTIONAL POWER, NUCLEAR POWER



WET MECH. DRAFT COOLING TOWER No 3 (8 CELL) BASIN EL. 45'-0"
WET MECH. DRAFT COOLING TOWER No 2 (9 CELL) BASIN EL. 45'-0"
WET MECH. DRAFT COOLING TOWER No 1 (9 CELL) BASIN EL. 45'-0"
SEE TYPICAL ENLARGED VIEW 'A'
DISTRIBUTOR (TYP)
COND. 33
COND. 32
COND. 31
FOR CONT. SEE COND. 33
AMERTAP STRAINER (TYP)
COLLECTORS (TYP)
AMERTAP SYSTEM (DUPLICATE SYSTEM'S FOR COND. # 32 & 31)
ADJ. WEIR
TURBINE BLDG. OUTLINE
DISCHARGE CANAL
ACID
SAMPLE
P.H. CONTROLLER
CONDUCTIVITY CONTROLLER
M.O. BUTTERFLY VALVES (TYP)
M.O. BUTTERFLY VA. (TYP)
STOP LOG
6'-0" ϕ (TYP)
CTC-32
CTC-31
LOW POINT CONN.
SAMPLE VALVES
BLOW DOWN LINE
BYPASS
30" BUTTERFLY M.O. VALVE
8'-6" ϕ
TO UNIT #2
TO UNIT #3
TO UNIT NO. 1 SERVICE
LAPP PULSAFEEDER PUMPS TO UNIT #1
TO DISCHARGE CANAL
SYSTEM FILL TANK TRUCK
RECIRCULATION
CLORINATION SYSTEM PUMPS
EXISTING STORAGE TANKS
SCREENWELL HOUSE UNIT NO. 1
DISCHARGE CANAL
CROSSOVER VALVES FOR COOLING TOWER INTERCHANGEABILITY
SERVICE WATER AREA
(2) DUAL SERVICE PUMPS 30,000 G.P.M.
DSP-36
RWP-35
RWP-34
RWP-33
RWP-32
DSP-31
HUDSON RIVER
(3) COOLING TOWER CIRC. PUMPS 200,000 G.P.M.
CT-B33
CT-B32
CT-B31
CTP-33
CTP-32
CTP-31
(3) M.O. BUTTERFLY VALVES (TYP)
DOUBLE FIXED SCREENS & SLIDE GATE
FLOW DIRECTION (DISCHARGE WTR. DURING ONCE THRU OPERATION)
TOWER & PIPING BY COOLING TOWER MFGR.
DISCHARGE TO HOT WATER BASIN
250 H.P. FAN WITH VARIABLE PITCH BLADE (TYPICAL)
VALVING ARRANGEMENT & OPERATORS TO BE REVIEWED IN FINAL DESIGN
1W-W9
1W-W8
1W-W7
1W-W6
1W-W5
1W-W4
1W-W3
1W-W2
1W-W1
1-TF9
1-TF8
1-TF7
1-TF6
1-TF5
1-TF4
1-TF3
1-TF2
1-TF1
1E-W9
1E-W8
1E-W7
1E-W6
1E-W5
1E-W4
1E-W3
1E-W2
1E-W1
MOTOR OPERATED CONTROL VALVE WET SECTION
DISTRIBUTION MANIFOLD
TYP. ENLARGED VIEW 'A'
WET-MECHANICAL DRAFT COOLING TOWER
(2) 9 CELL UNITS SHOWN (No 1 & No 2)
(1) 8 CELL UNIT SIMILAR (No 3)
FAN & M.O. VA. NUMBERS FOR TWR #1
TWR #2 FAN NUMBERS PREFIXED BY NUMBER "2"
TWR #3 M.O. VA. NUMBERS PREFIXED BY NUMBER 2 & "H" OR "3"
MK No | PUMP NOMENCLATURE
C.T.P. 31 32 33 | COOLING TOWER PUMP
D.S.P. 31 36 | DUAL SERVICE PUMP
RWP 32 34 33 35 | RIVER WATER PUMP
LINE SYMBOL | NOMENCLATURE
INSTRUMENT AIR
NEW PIPE
EXISTING PIPE
Con Edison clean energy
REVISIONS
A RELEASED FOR COMMENTS S.A. 2-27-75
B RELEASED FOR INFORMATION S.A.
CONCEPT DWG. 21338-B
CONSOLIDATED EDISON CO. OF NEW YORK, INC.
INDIAN POINT No. 3
DIAGRAM OF WET MECHANICAL COOLING TOWER WET TYPE
SCALE NONE
APPROVALS

FIG. 3-7



MK. Nº	PUMP NOMENCLATURE
CTP 31 32 33	COOLING TOWER PUMP
DSP 31 36	DUAL SERVICE PUMP
RWP. 32 33 34 35	RIVER WATER PUMP

LINE SYMBOL	NOMENCLATURE
—//—//—	INSTRUMENT AIR
———	NEW PIPE
– – – –	EXISTING PIPE

FIG. 3-8

CONCEPT DWG. 21343-B

CONSOLIDATED EDISON CO.
OF NEW YORK, INC.

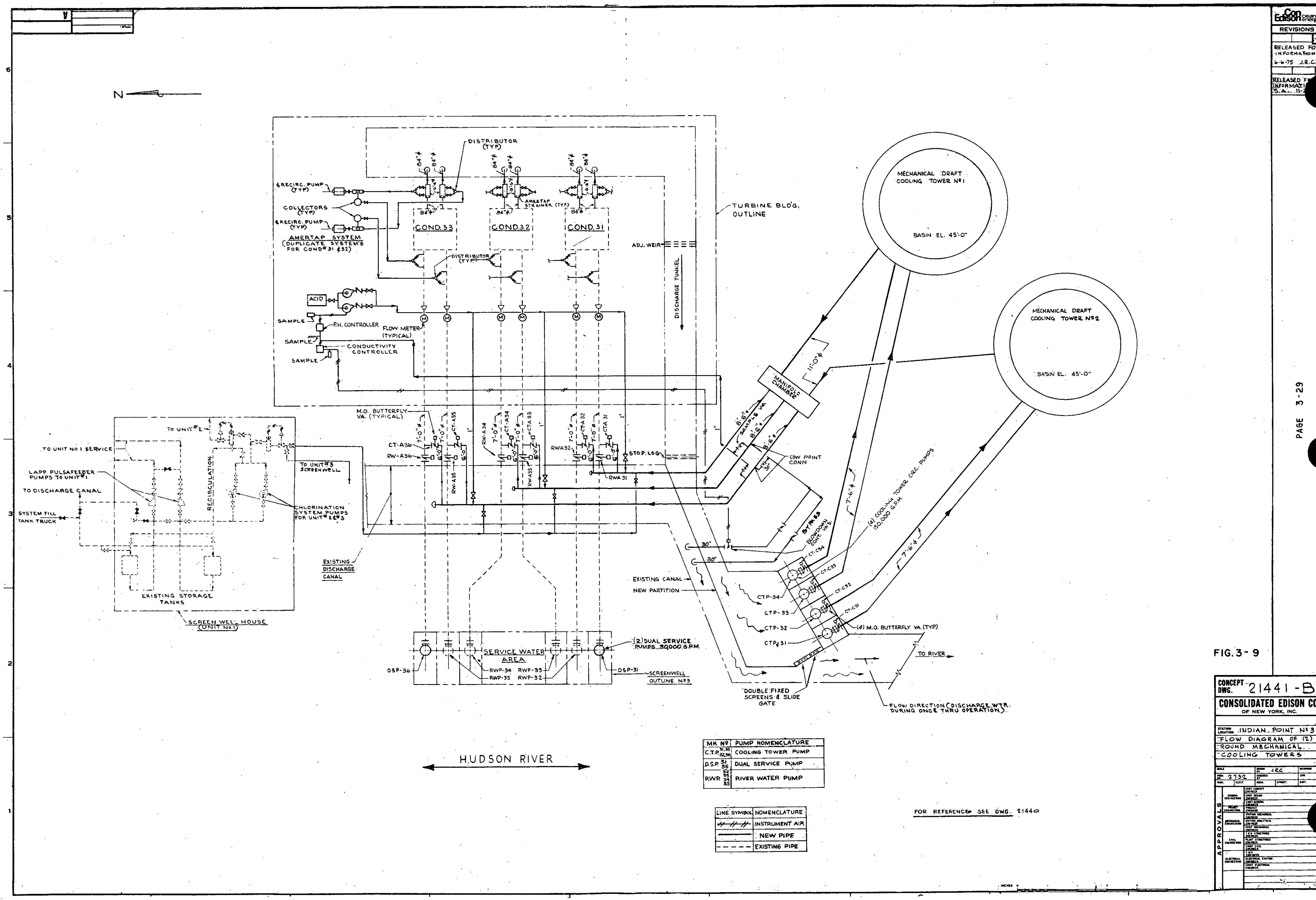
STATION LOCATION: INDIAN POINT # 3
DIAGRAM OF WET-DRY
MECHANICAL COOLING TOWER

WET DRY TYPE

SCALE: NONE | DRAWN BY: CONSTANTINO | J.O. 2732

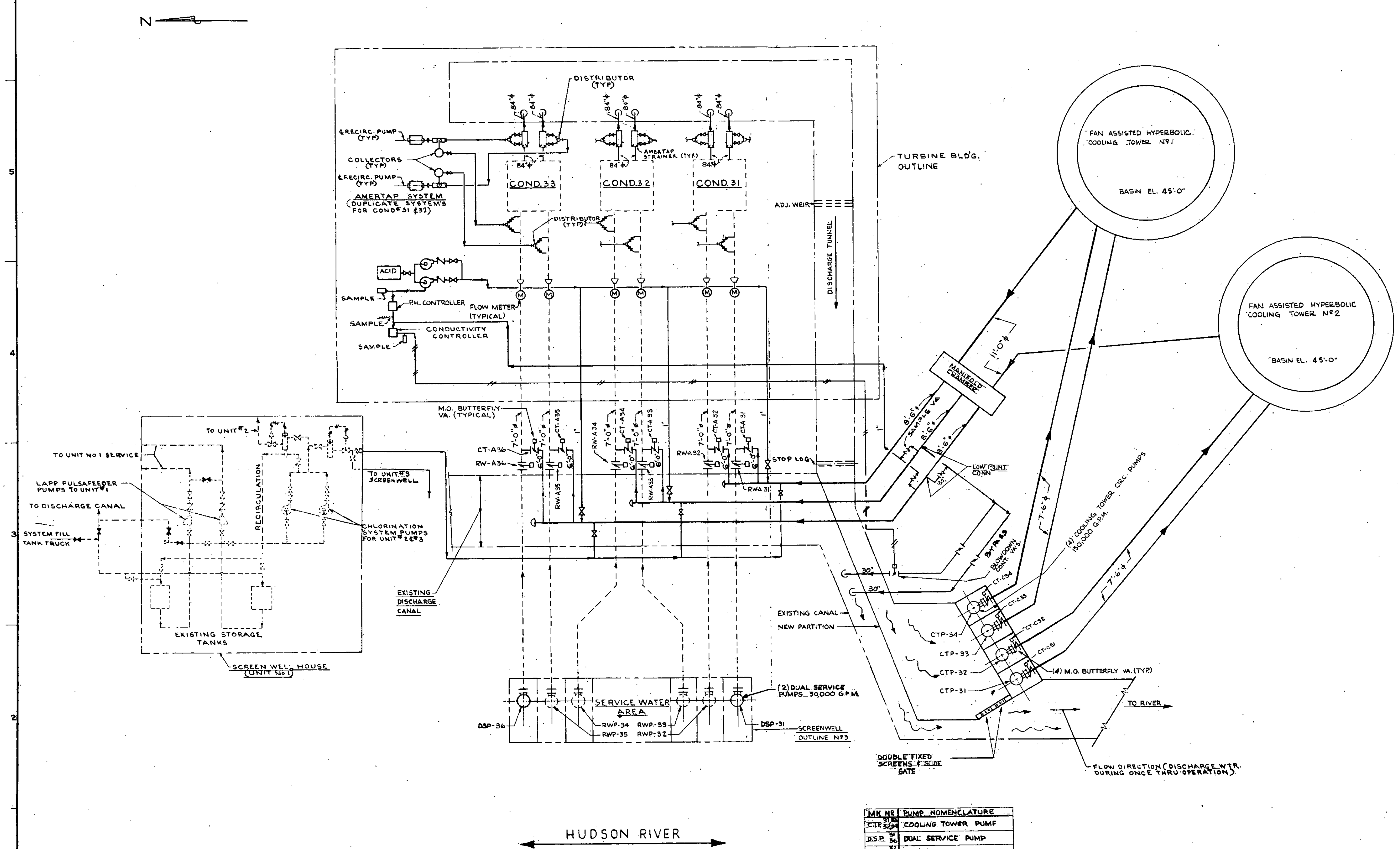
REVISIONS: A — RELEASED FOR COMMENTS S.A. 2-27-75; B — RELEASED FOR INFORMATION S.A. 11-2

APPROVAL: GENERAL ENGINEERING — CHIEF CONCEPT ENGINEER; CHIEF DESIGN ENGINEER; CHIEF GENERAL ENGINEER. PROJECT ENGINEERING — PROJECT ENGINEER. ELECTRICAL ENGINEERING — STATION ELECT. ENGINEER; CHIEF ELECT. ENGINEER. GAS & STEAM OPERATIONS — STRUCT. ENGINEER. MECHANICAL ENGINEERING — CHIEF MECHANICAL ENGINEER; STATION MECHANICAL ENGINEER



MECHANICAL DRAFT COOLING TOWER Nº1
BASIN EL. 45'-0"
MECHANICAL DRAFT COOLING TOWER Nº2
BASIN EL. 45'-0"
DISTRIBUTOR (TYP)
COLLECTORS (TYP)
℄ RECIRC. PUMP (TYP)
AMERTAP SYSTEM (DUPLICATE SYSTEMS FOR COND# 31 & 32)
AMERTAP STRAINER (TYP)
COND. 33
COND. 32
COND. 31
TURBINE BLD'G. OUTLINE
ADJ. WEIR
DISCHARGE TUNNEL
ACID
SAMPLE
P.H. CONTROLLER
FLOW METER (TYPICAL)
CONDUCTIVITY CONTROLLER
MANIFOLD CHAMBER
SAMPLE VA.
LOW POINT CONN
STOP LOG
M.O. BUTTERFLY VA. (TYPICAL)
TO UNIT Nº2
TO UNIT NO 1 SERVICE
TO UNIT #3 SCREENWELL
LAPP PULSAFEEDER PUMPS TO UNIT #1
TO DISCHARGE CANAL
SYSTEM FILL TANK TRUCK
RECIRCULATION
CHLORINATION SYSTEM PUMPS FOR UNIT # 2 & 3
EXISTING STORAGE TANKS
SCREEN WELL HOUSE (UNIT No 1)
EXISTING DISCHARGE CANAL
EXISTING CANAL
NEW PARTITION
BYPASS
BLOWDOWN CONT. VA'S.
(4) COOLING TOWER CIRC. PUMPS 150,000 GPM
(4) M.O. BUTTERFLY VA. (TYP)
CTP-34
CTP-33
CTP-32
CTP-31
TO RIVER
DOUBLE FIXED SCREENS & SLIDE GATE
FLOW DIRECTION (DISCHARGE WTR. DURING ONCE THRU OPERATION)
SERVICE WATER AREA
(2) DUAL SERVICE PUMPS 30,000 G.P.M.
DSP-36
DSP-31
RWP-34
RWP-35
RWP-33
RWP-32
SCREENWELL OUTLINE Nº3
HUDSON RIVER
MK Nº | PUMP NOMENCLATURE
C.T.P. 31, 32, 33, 34 | COOLING TOWER PUMP
D.S.P. 31, 36 | DUAL SERVICE PUMP
RWP 32, 33, 34, 35 | RIVER WATER PUMP
LINE SYMBOL | NOMENCLATURE
INSTRUMENT AIR
NEW PIPE
EXISTING PIPE
FOR REFERENCE SEE DWG. 21440
REVISIONS
RELEASED FOR INFORMATION 6-6-75 J.R.C.
CONCEPT DWG. 21441-B
CONSOLIDATED EDISON CO. OF NEW YORK, INC.
INDIAN POINT Nº3
FLOW DIAGRAM OF (2) ROUND MECHANICAL COOLING TOWERS
APPROVALS

FIG. 3-9



MK Nº		PUMP NOMENCLATURE
C.T.P.	31-32-33-34	COOLING TOWER PUMP
D.S.P.	31 36	DUAL SERVICE PUMP
R.W.P.	32 33 34 35	RIVER WATER PUMP

LINE SYMBOL	NOMENCLATURE
-//-//-//-	INSTRUMENT AIR
———	NEW PIPE
- - - -	EXISTING PIPE

FOR REFERENCE SEE DWG:

21482 - GENERAL ARRANGEMENT OF (2) ROUND FAN ASSISTED HYPERBOLIC COOLING TOWERS.
21483 - ONE LINE ELECTRICAL DIAGRAM FOR (2) ROUND FAN ASSISTED HYPERBOLIC COOLING TOWERS.

FIG. 3-10

Con Edison

REVISIONS

A RELEASED FOR INFORMATION J.R.C.

B RELEASED FOR INFORMATION S.A. 11-2

CONCEPT DWG. 21471-B

CONSOLIDATED EDISON CO. OF NEW YORK, INC.

STATION LOCATION: INDIAN POINT Nº 3

FLOW DIAGRAM OF FAN-ASSISTED HYPERBOLIC COOLING TOWERS.

SCALE NONE — DRAWN BY JRC — 2732

APPROVALS

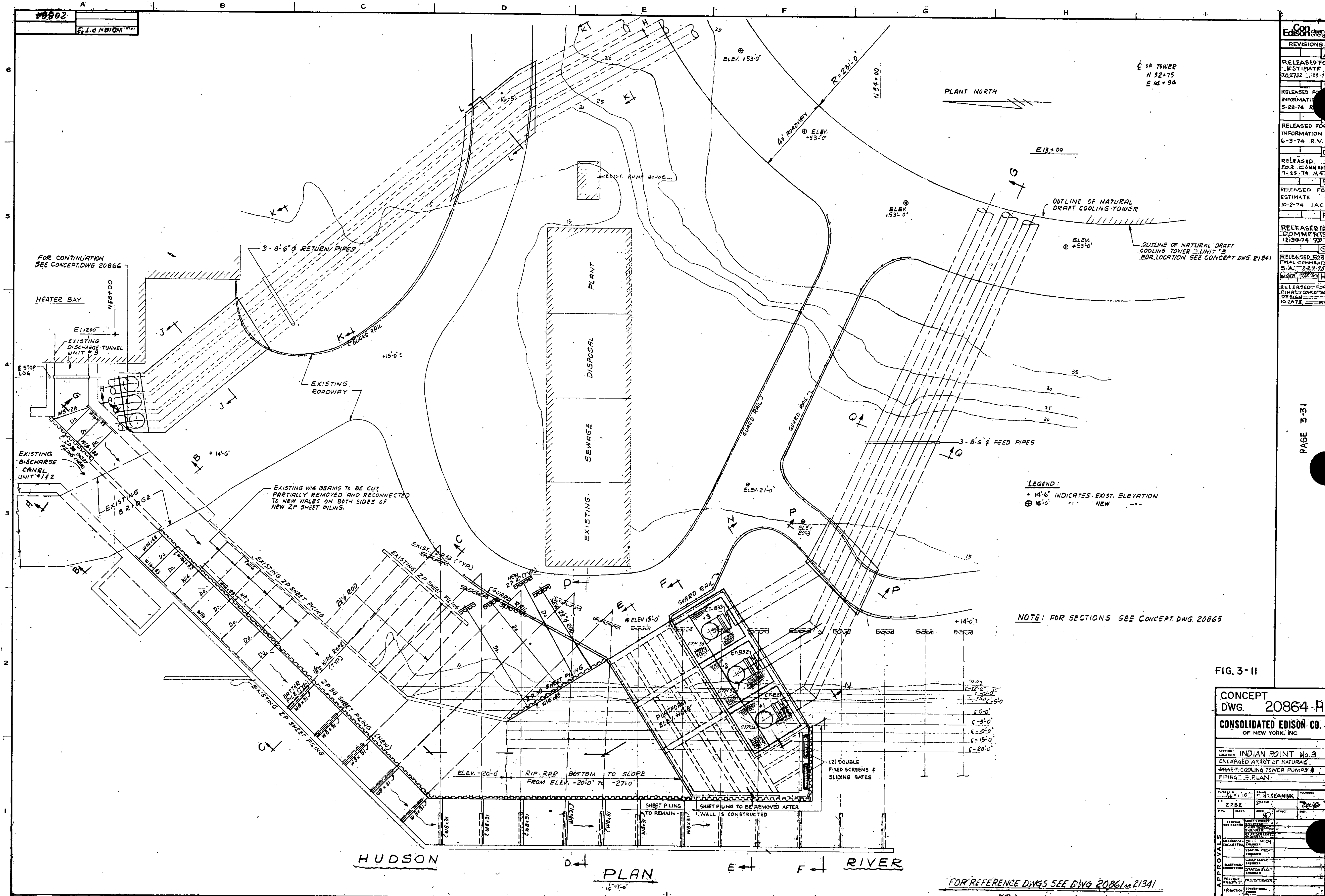
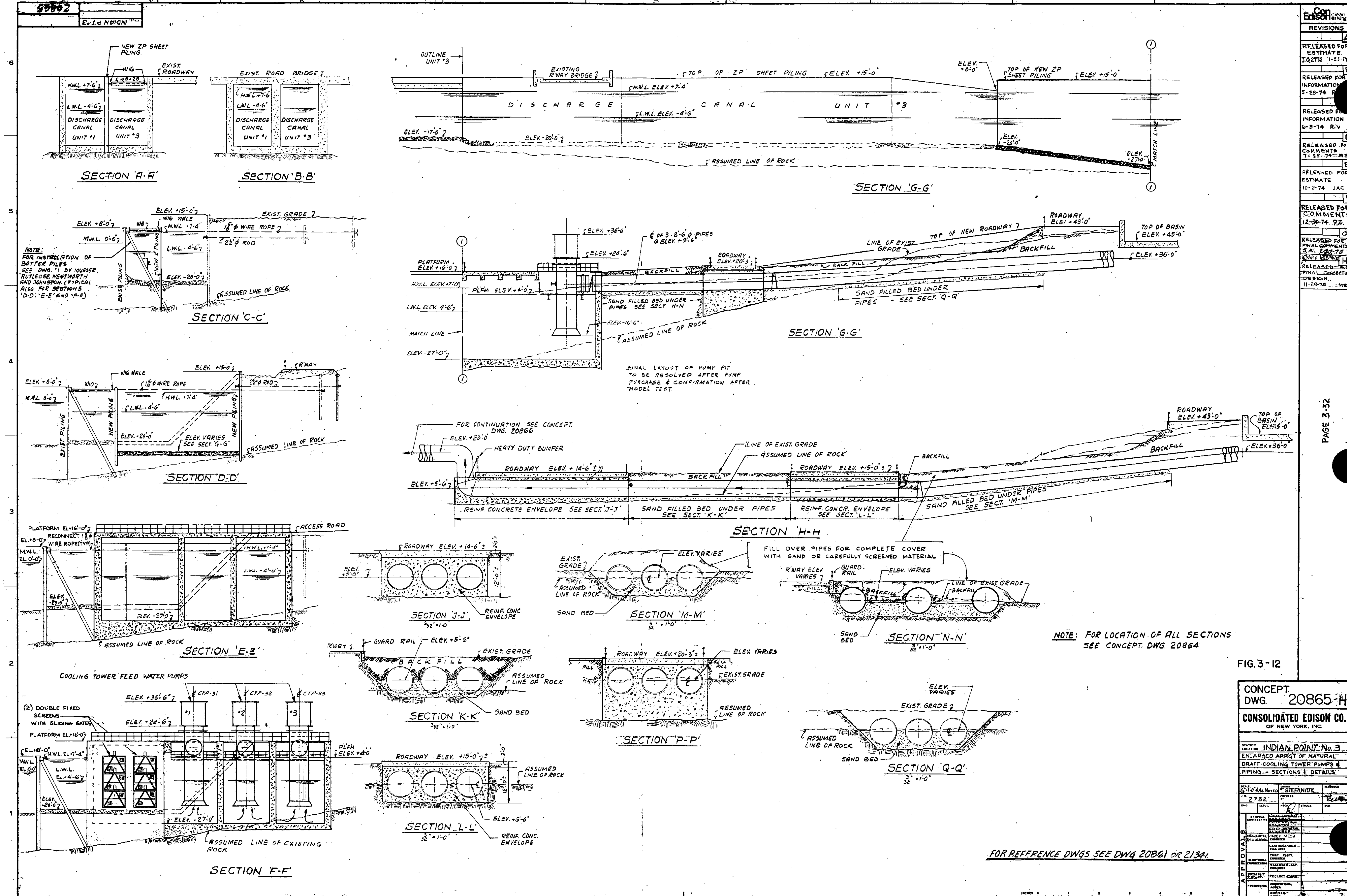

PLANT NORTH
℄ OF TOWER N 52+75 E 14+94
R=231'-0"
N54+00
40' ROADWAY
ELEV. +53'-0"
E13+00
OUTLINE OF NATURAL DRAFT COOLING TOWER
OUTLINE OF NATURAL DRAFT COOLING TOWER - UNIT #3 FOR LOCATION SEE CONCEPT DWG. 21341
EXIST. PUMP HOUSE
3 - 8'-6" ϕ RETURN PIPES
FOR CONTINUATION SEE CONCEPT DWG 20866
HEATER BAY
N58+00
E1+200
EXISTING DISCHARGE TUNNEL UNIT #3
STOP LOG
EXISTING DISCHARGE CANAL UNIT #1 / 2
EXISTING BRIDGE
EXISTING ROADWAY
GUARD RAIL
EXISTING SEWAGE DISPOSAL PLANT
3 - 8'-6" ϕ FEED PIPES
LEGEND:
+ 14'-6" INDICATES EXIST. ELEVATION
⊕ 16'-0" " NEW "
EXISTING W14 BEAMS TO BE CUT, PARTIALLY REMOVED AND RECONNECTED TO NEW WALES ON BOTH SIDES OF NEW ZP SHEET PILING.
EXISTING ZP SHEET PILING
ZP 38 SHEET PILING (NEW)
BATTER PILE (TYP.)
1 3/8" ϕ WIRE ROPE (TYP.)
PLATFORM ELEV. +16'-0"
NOTE: FOR SECTIONS SEE CONCEPT DWG. 20865
(2) DOUBLE FIXED SCREENS & SLIDING GATES
ELEV. -20'-0"
RIP-RAP BOTTOM TO SLOPE FROM ELEV. -20'-0" TO -27'-0"
SHEET PILING TO REMAIN
SHEET PILING TO BE REMOVED AFTER WALL IS CONSTRUCTED
HUDSON RIVER
PLAN
1/16" = 1'-0"
FOR REFERENCE DWGS SEE DWG 20861 OR 21341
REVISIONS
RELEASED FOR ESTIMATE
RELEASED FOR INFORMATION 5-28-74
RELEASED FOR INFORMATION 6-3-74 R.V.
RELEASED FOR COMMENTS 7-25-74 M.S.
RELEASED FOR ESTIMATE 10-2-74 JAC
RELEASED FOR COMMENTS 12-30-74
RELEASED FOR FINAL COMMENTS
RELEASED FOR FINAL CONCEPTUAL DESIGN
CONCEPT DWG. 20864-H
CONSOLIDATED EDISON CO. OF NEW YORK, INC
INDIAN POINT No. 3
ENLARGED ARRGT OF NATURAL DRAFT COOLING TOWER PUMPS & PIPING - PLAN
STEFANIUK
2732
APPROVALS

FIG. 3-11


SECTION 'A-A'
NEW ZP SHEET PILING.
EXIST. ROADWAY
H.W.L. +7'-6"
L.W.L. -4'-6"
DISCHARGE CANAL UNIT #1
DISCHARGE CANAL UNIT #3
SECTION 'B-B'
EXIST. ROAD BRIDGE
SECTION 'G-G'
OUTLINE UNIT #3
EXISTING R'WAY BRIDGE
TOP OF ZP SHEET PILING ELEV. +15'-0"
H.W.L. ELEV. +7'-4"
L.W.L. ELEV. -4'-6"
DISCHARGE CANAL UNIT #3
ELEV. -17'-0"
ELEV. -20'-0"
ASSUMED LINE OF ROCK
TOP OF NEW ZP SHEET PILING
ELEV. +15'-0"
ELEV. -27'-0"
MATCH LINE
SECTION 'C-C'
NOTE: FOR INSTALLATION OF BATTER PILES SEE DWG. #1 BY MUESER, RUTLEDGE, WENTWORTH AND JOHNSTON. (TYPICAL ALSO FOR SECTIONS 'D-D', 'E-E' AND 'F-F')
ELEV. +8'-0"
M.H.L. 0'-0"
ELEV. +15'-0"
EXIST. GRADE
1 1/8" φ WIRE ROPE
2 1/4" φ ROD
ELEV. -20'-0"
ASSUMED LINE OF ROCK
EXIST. PILING
NEW Z PILING
SECTION 'G-G'
ELEV. +36'-6"
ELEV. +24'-6"
℄ OF 3-8'-6" φ PIPES & ELEV. +9'-6"
PLATFORM ELEV. +16'-0"
H.W.L. ELEV. +7'-0"
PL'FM ELEV. +4'-0"
L.W.L. ELEV. -4'-6"
MATCH LINE
ELEV. -27'-0"
ROADWAY ELEV. +20'-3"
BACKFILL
SAND FILLED BED UNDER PIPES SEE SECT. 'N-N'
ELEV. -16'-6"
ASSUMED LINE OF ROCK
LINE OF EXIST. GRADE
TOP OF NEW ROADWAY
ROADWAY ELEV. +43'-0"
TOP OF BASIN ELEV. +45'-0"
ELEV. +36'-0"
SAND FILLED BED UNDER PIPES - SEE SECT. 'Q-Q'
FINAL LAYOUT OF PUMP PIT TO BE RESOLVED AFTER PUMP PURCHASE & CONFIRMATION AFTER MODEL TEST.
SECTION 'D-D'
WIG WALE
ELEV. +15'-0"
R'WAY
ELEV. +8'-0"
M.H.L. 0'-0"
1 1/8" φ WIRE ROPE
2 1/4" φ ROD
H.W.L. +7'-4"
L.W.L. -4'-6"
ELEV. -20'-0"
ELEV. VARIES SEE SECT. 'G-G'
ASSUMED LINE OF ROCK
EXIST. PILING
NEW PILING
SECTION 'H-H'
FOR CONTINUATION SEE CONCEPT. DWG. 20866
ELEV. +23'-0"
HEAVY DUTY BUMPER
LINE OF EXIST. GRADE
ASSUMED LINE OF ROCK
BACKFILL
ROADWAY ELEV. +14'-6"±
ROADWAY ELEV. +15'-0"±
ELEV. +5'-6"
REINF. CONCRETE ENVELOPE SEE SECT. 'J-J'
SAND FILLED BED UNDER PIPES SEE SECT. 'K-K'
REINF. CONCR. ENVELOPE SEE SECT. 'L-L'
SAND FILLED BED UNDER PIPES SEE SECT. 'M-M'
ROADWAY ELEV. +43'-0"
TOP OF BASIN EL. +45'-0"
ELEV. +36'-0"
SECTION 'E-E'
PLATFORM EL. +16'-0"
RECONNECT 1 1/8" φ WIRE ROPE (TYP.)
ACCESS ROAD
EL. +8'-0"
M.W.L. EL. 0'-0"
H.W.L. +7'-4"
L.W.L. -4'-6"
ELEV. -20'-0"
ELEV. -27'-0"
ASSUMED LINE OF ROCK
SECTION 'J-J' 3/32" = 1'-0"
ROADWAY ELEV. +14'-6"±
ELEV. +5'-6"
REINF. CONC. ENVELOPE
SECTION 'M-M' 3/32" = 1'-0"
EXIST. GRADE
ELEV. VARIES
ASSUMED LINE OF ROCK
SAND BED
FILL OVER PIPES FOR COMPLETE COVER WITH SAND OR CAREFULLY SCREENED MATERIAL
SECTION 'N-N' 3/32" = 1'-0"
R'WAY ELEV. VARIES
GUARD RAIL
ELEV. VARIES
LINE OF EXIST. GRADE
BACKFILL
SAND BED
NOTE: FOR LOCATION OF ALL SECTIONS SEE CONCEPT. DWG. 20864
SECTION 'K-K' 3/32" = 1'-0"
R'WAY
GUARD RAIL
ELEV. +5'-6"
EXIST. GRADE
BACKFILL
ASSUMED LINE OF ROCK
SAND BED
SECTION 'P-P'
ROADWAY ELEV. +20'-3"±
ELEV. VARIES
EXIST. GRADE
ASSUMED LINE OF ROCK
SECTION 'Q-Q' 3/32" = 1'-0"
ELEV. VARIES
EXIST. GRADE
ASSUMED LINE OF ROCK
SAND BED
SECTION 'F-F'
COOLING TOWER FEED WATER PUMPS
(2) DOUBLE FIXED SCREENS WITH SLIDING GATES
ELEV. +36'-6"
ELEV. +24'-6"
℄ CTP-31
℄ CTP-32
℄ CTP-33
PLATFORM EL. +16'-0"
PL'FM ELEV. +4'-0"
EL. +8'-0"
H.W.L. EL. +7'-4"
M.W.L. EL. 0'-0"
L.W.L. EL. -4'-6"
ELEV. -20'-0"
ELEV. -27'-0"
ASSUMED LINE OF EXISTING ROCK
SECTION 'L-L' 3/32" = 1'-0"
ROADWAY ELEV. +15'-0"±
ASSUMED LINE OF ROCK
ELEV. +5'-6"
REINF. CONC. ENVELOPE
FOR REFFRENCE DWGS SEE DWG 20861 OR 21341
FIG. 3-12
PAGE 3-32
Con Edison clean energy
REVISIONS
A RELEASED FOR ESTIMATE J.O. 2732 1-23-74
B RELEASED FOR INFORMATION 5-28-74
C RELEASED FOR INFORMATION 6-3-74 R.V.
D RELEASED FOR COMMENTS 7-25-74 M.S.
E RELEASED FOR ESTIMATE 10-2-74 JAC
F RELEASED FOR COMMENTS 12-30-74
G RELEASED FOR FINAL COMMENTS
H RELEASED FOR FINAL CONCEPTUAL DESIGN 11-28-75 M.E.
CONCEPT. DWG. 20865-H
CONSOLIDATED EDISON CO. OF NEW YORK, INC.
INDIAN POINT No. 3
ENLARGED ARR'GT. OF NATURAL DRAFT COOLING TOWER PUMPS & PIPING - SECTIONS & DETAILS
SCALE 1" = 1'-0" As Noted
DRAWN STEFANIUK
J.O. 2732
APPROVALS

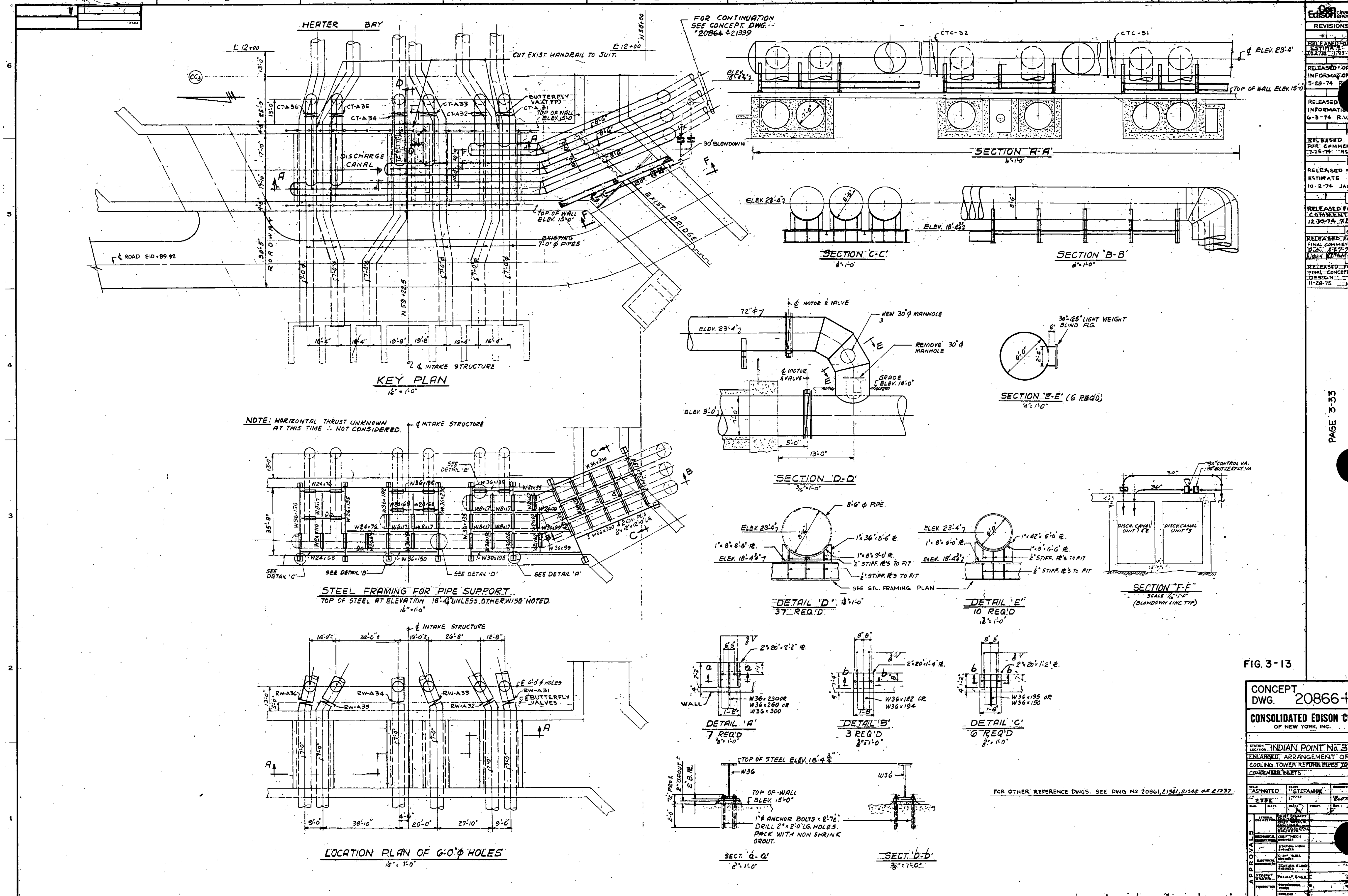
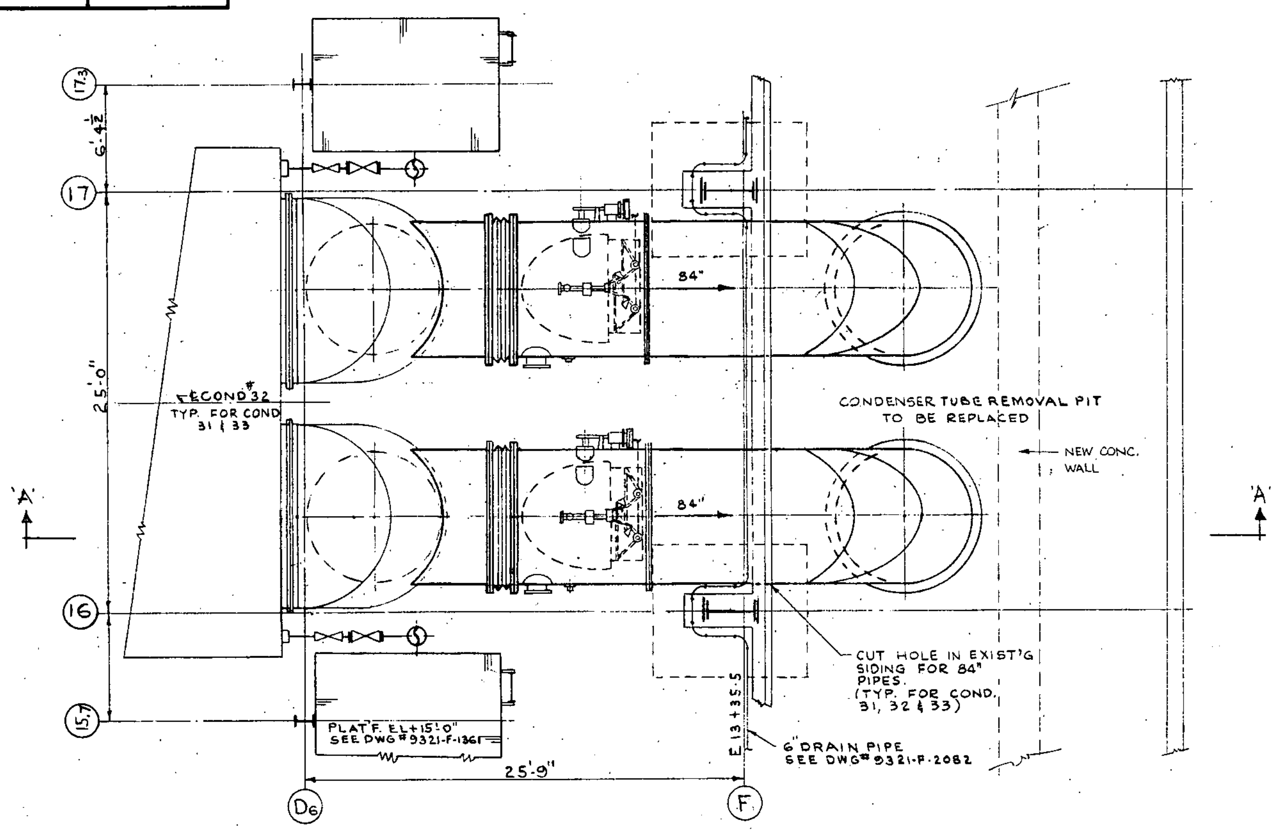
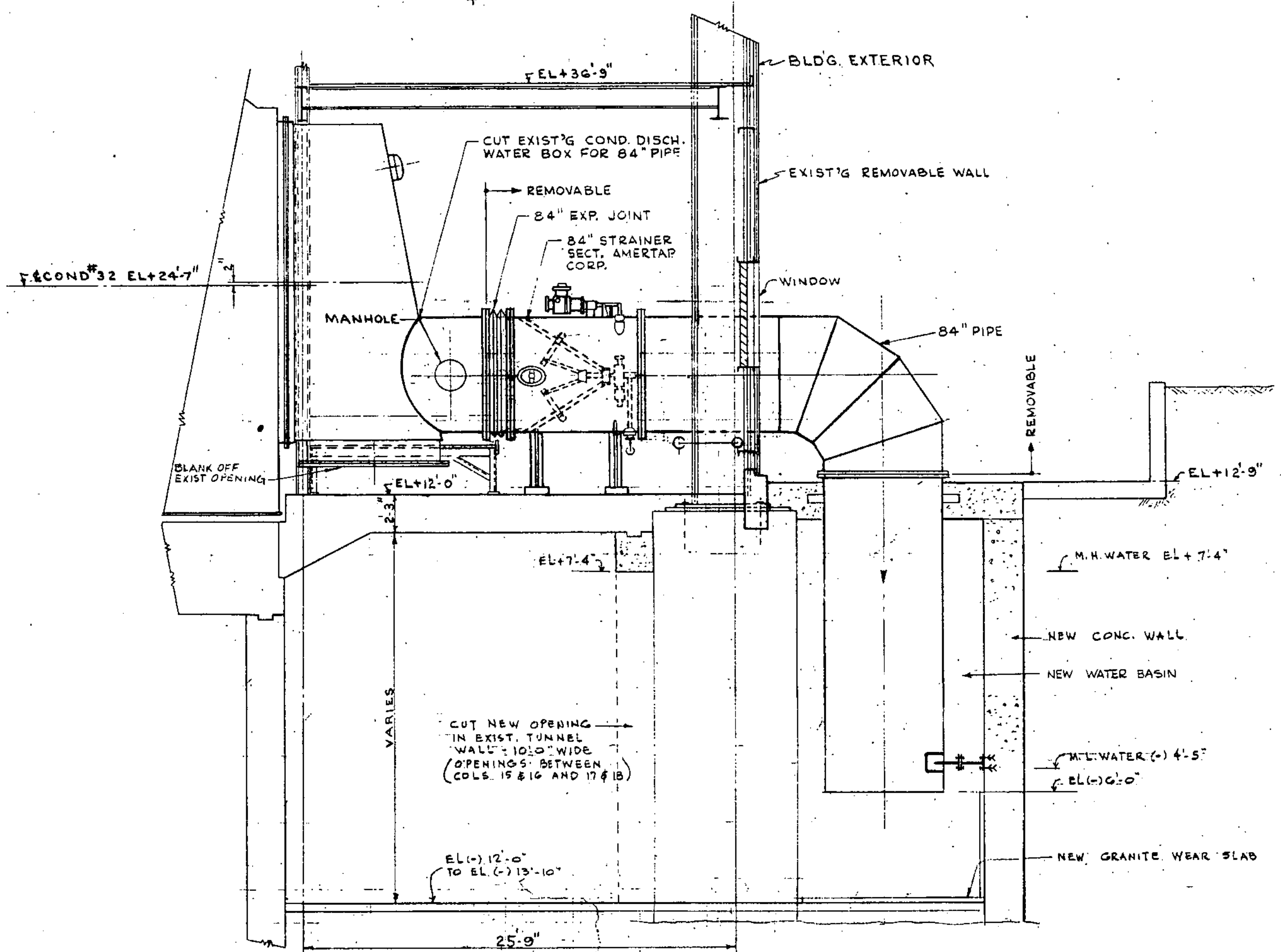

HEATER BAY
FOR CONTINUATION SEE CONCEPT. DWG. #20864 & 21339
CUT EXIST. HANDRAIL TO SUIT.
E 12+00
DISCHARGE CANAL
BUTTERFLY VA. (TYP)
TOP OF WALL ELEV. 15'-0"
30" BLOWDOWN
EXIST. BRIDGE
EXISTING 7'-0" Ø PIPES
℄ ROAD E10+89.92
ROADWAY
℄ INTAKE STRUCTURE
KEY PLAN
1/16" = 1'-0"
SECTION 'A-A'
SECTION 'C-C'
SECTION 'B-B'
ELEV. 23'-4"
ELEV. 18'-4 3/4"
TOP OF WALL ELEV. 15'-0"
℄ MOTOR & VALVE
NEW 30" Ø MANHOLE
REMOVE 30" Ø MANHOLE
GRADE ELEV. 14'-0"
SECTION 'D-D'
30"-125# LIGHT WEIGHT BLIND FLG.
SECTION 'E-E' (6 REQ'D)
NOTE: HORIZONTAL THRUST UNKNOWN AT THIS TIME ∴ NOT CONSIDERED.
STEEL FRAMING FOR PIPE SUPPORT
TOP OF STEEL AT ELEVATION 18'-4 3/4" UNLESS OTHERWISE NOTED.
8'-6" Ø PIPE
DETAIL 'D' 37 REQ'D
DETAIL 'E' 10 REQ'D
SEE STL. FRAMING PLAN
30" CONTROL VA. 30" BUTTERFLY VA.
DISCH. CANAL UNIT 1 & 2
DISCH. CANAL UNIT 3
SECTION 'F-F'
SCALE 1/16" = 1'-0" (BLOWDOWN LINE TYP)
LOCATION PLAN OF 6'-0" Ø HOLES
℄ 6'-0" Ø HOLES
℄ BUTTERFLY VALVES
DETAIL 'A' 7 REQ'D
DETAIL 'B' 3 REQ'D
DETAIL 'C' 6 REQ'D
TOP OF STEEL ELEV. 18'-4 3/4"
TOP OF WALL ELEV. 15'-0"
1" Ø ANCHOR BOLTS × 2'-7 1/2" DRILL 2" × 2'-0" LG. HOLES. PACK WITH NON SHRINK GROUT.
SECT. 'a-a'
SECT. 'b-b'
FOR OTHER REFERENCE DWGS. SEE DWG. No 20861, 21341, 21362 & 21337
REVISIONS
CONCEPT DWG. 20866-H
CONSOLIDATED EDISON CO. OF NEW YORK, INC.
INDIAN POINT No. 3
ENLARGED ARRANGEMENT OF COOLING TOWER RETURN PIPES TO CONDENSER INLETS
AS NOTED
APPROVALS
PAGE 3-33

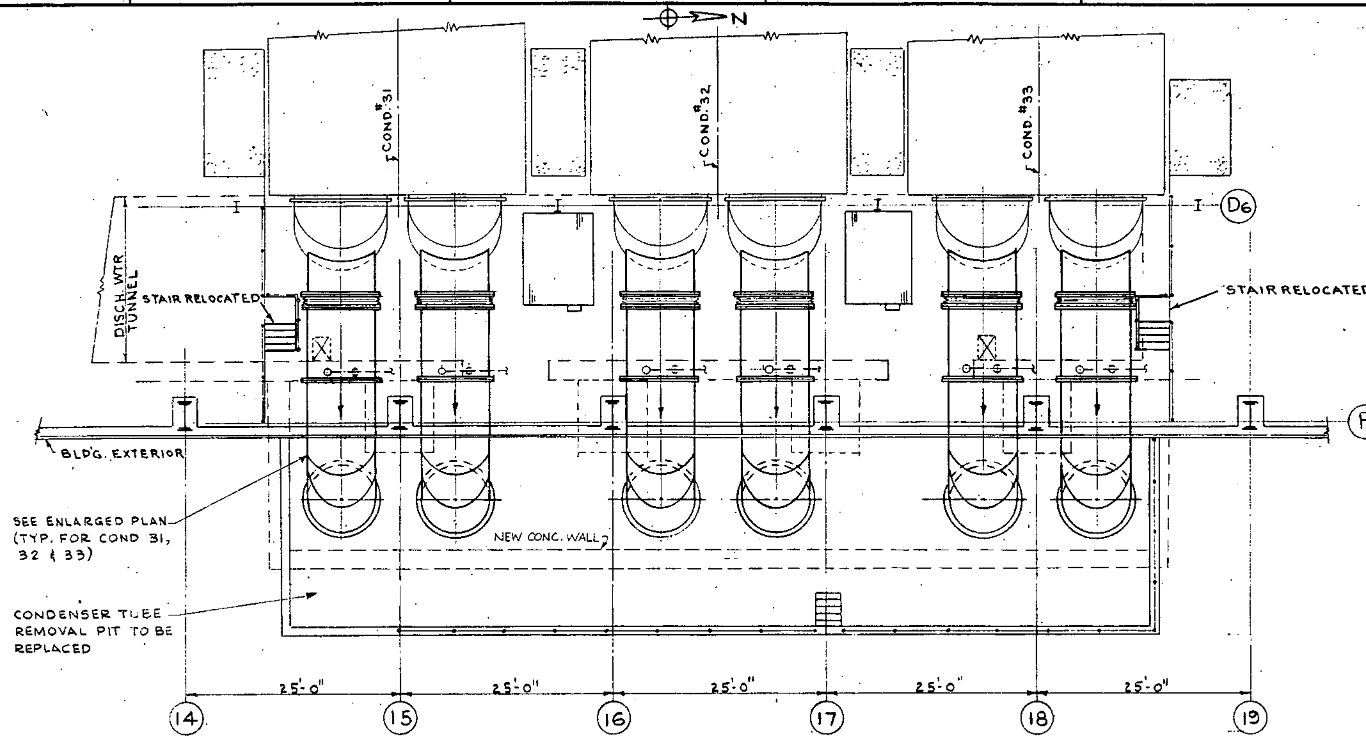
FIG. 3-13



TYPICAL ENLARGED PLAN
1/4" = 1'-0"



SECTION A-A
1/4" = 1'-0"



KEY PLAN
1/8" = 1'-0"

DESIGN CRITERIA

CONDENSER BACKPRESSURE AT DESIGN CONDITIONS IS TO BE MAINTAINED WITHIN .0285 PSI ABSOLUTE OF THE LOWEST CONDENSER BACKPRESSURE OBTAINABLE WITHOUT AN 'AMERTAP' INSTALLATION. MAXIMUM FLOW THROUGH EACH AMERTAP SYSTEM IS ——— GPM. THIS STRAINER SECTION IS BASED ON PRELIMINARY INFORMATION FROM THE 'AMERTAP' CORP' SHOWN ON THEIR DWG. 75-192-03-01.

NOTE:

84" STRAINER SECTION & PIPE FROM CONDENSER OUTLET TO ELBOW TO BE MADE REMOVABLE FOR CONDENSER TUBE CLEANING & REPLACEMENT. MAINTAINENCE AND/OR ACCESS PLATFORMS TO BE DETERMINED IN FINAL DESIGN.

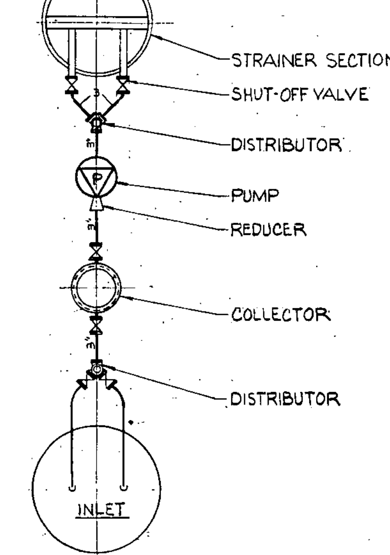


DIAGRAM OF AMERTAP COND. TUBE CLEANING SYS.

FOR REFERENCES SEE CONCEPT DWG 21341

FIG. 3-14

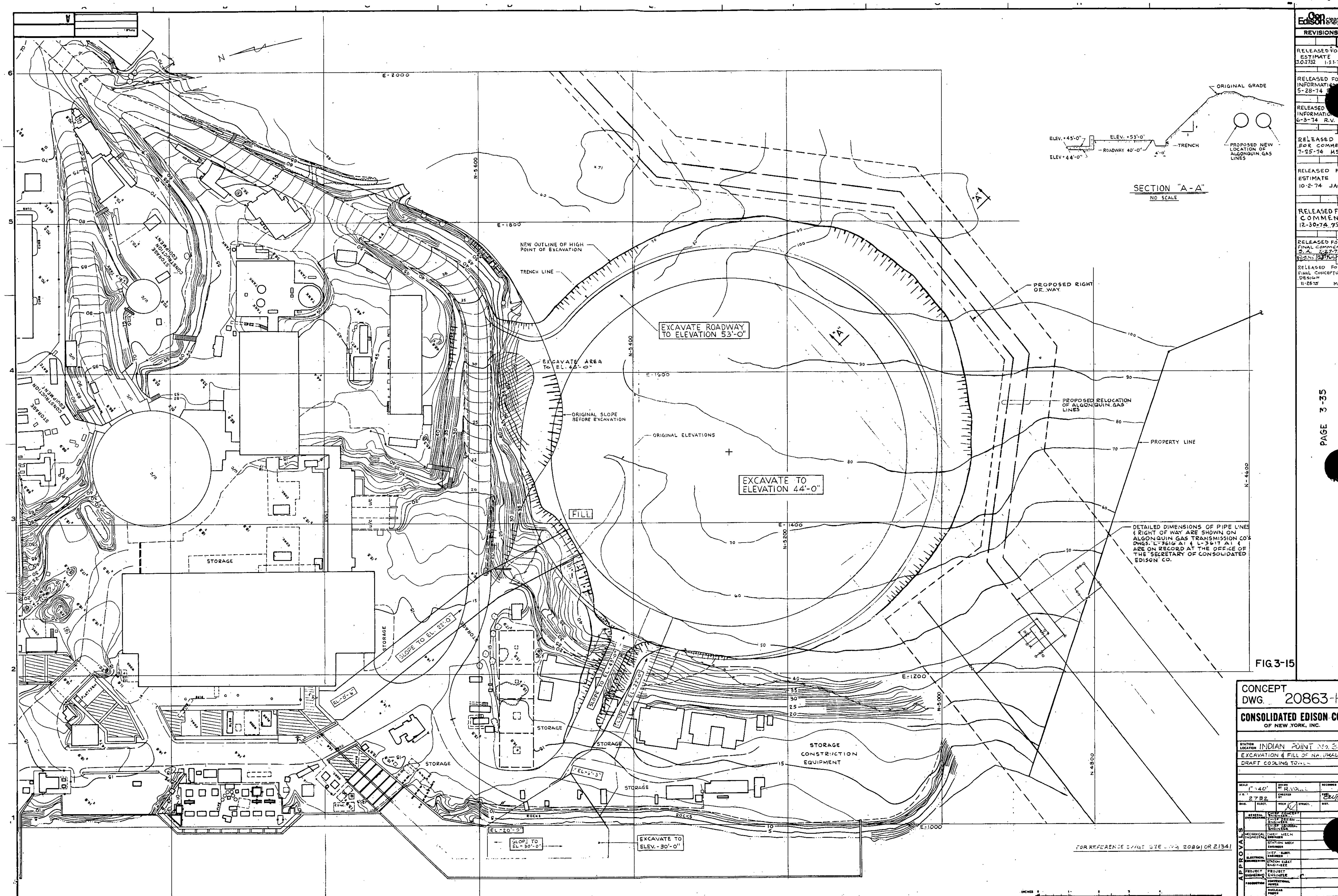
REVISIONS
A RELEASED FOR FINAL COMMENTS
B RELEASED FOR FINAL CONCEPT DESIGN 11-28-75

CONCEPT DWG. 21315-B

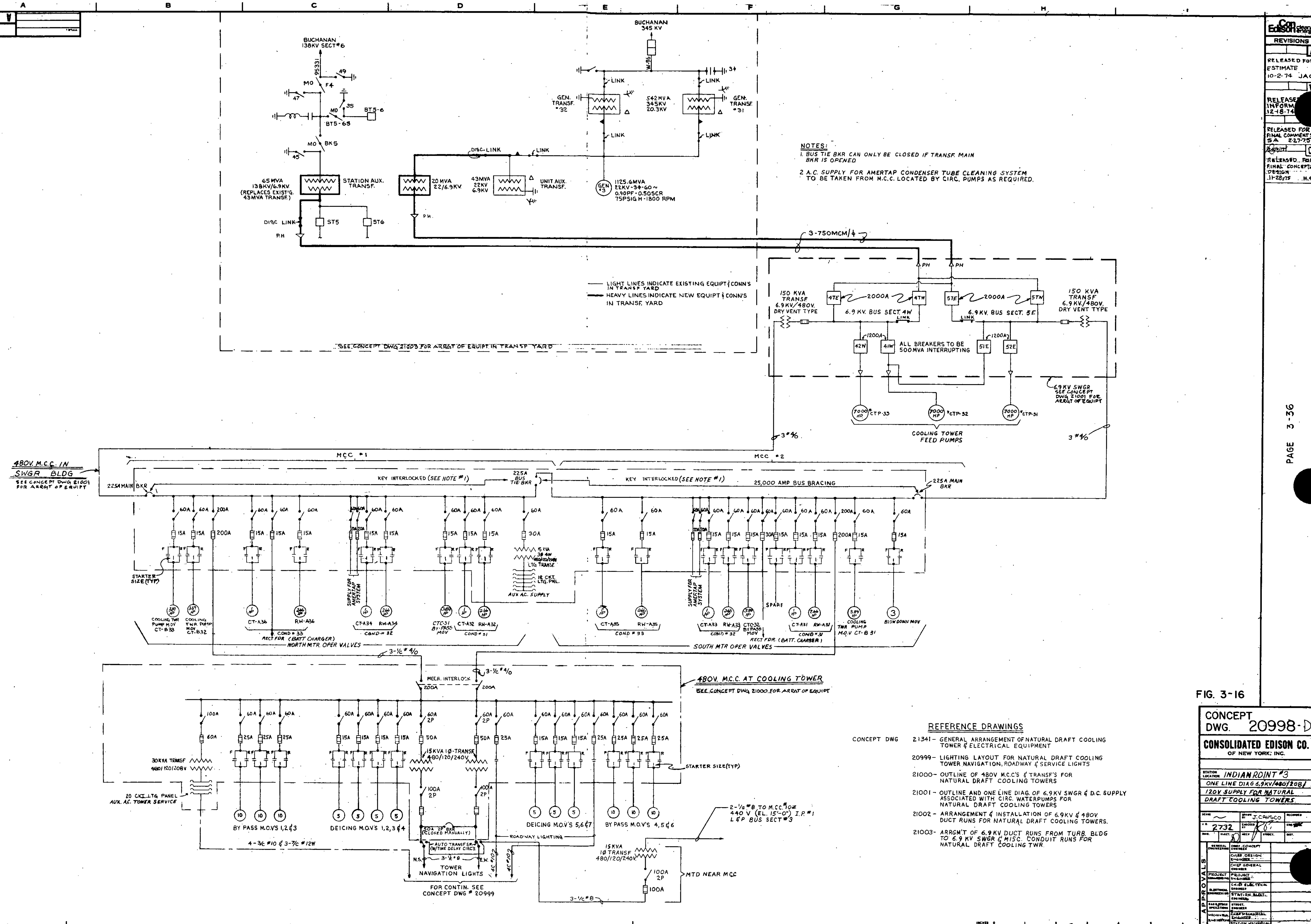
CONSOLIDATED EDISON CO. OF NEW YORK, INC.

IND. POINT #3
PROPOSED INSTALLATION OF AMERTAP STRAINER SECTION IN COND. DISCH. WATER.

SCALE: AS NOTED



ConEdison clean energy
REVISIONS
RELEASED FOR ESTIMATE J.O.2732 1-23-74
RELEASED FOR INFORMATION 5-28-74
RELEASED FOR INFORMATION 6-3-74 R.V.
RELEASED FOR COMMENTS 7-25-74 MS
RELEASED FOR ESTIMATE 10-2-74 JAC
RELEASED FOR COMMENTS 12-30-74
RELEASED FOR FINAL COMMENTS 2-27-75
RELEASED FOR FINAL CONCEPTUAL DESIGN 11-25-75 MS
ORIGINAL GRADE
ELEV. +45'-0"
ELEV. +53'-0"
ELEV. +44'-0"
ROADWAY 40'-0"
TRENCH
PROPOSED NEW LOCATION OF ALGONQUIN GAS LINES
SECTION "A-A"
NO SCALE
NEW OUTLINE OF HIGH POINT OF EXCAVATION
TRENCH LINE
EXCAVATE ROADWAY TO ELEVATION 53'-0"
EXCAVATE AREA TO EL. 45'-0"
ORIGINAL SLOPE BEFORE EXCAVATION
ORIGINAL ELEVATIONS
EXCAVATE TO ELEVATION 44'-0"
FILL
PROPOSED RIGHT OF WAY
PROPOSED RELOCATION OF ALGONQUIN GAS LINES
PROPERTY LINE
DETAILED DIMENSIONS OF PIPE LINES & RIGHT OF WAY ARE SHOWN ON ALGONQUIN GAS TRANSMISSION CO'S DWGS. L-3616 A1 & L-3617 A1 & ARE ON RECORD AT THE OFFICE OF THE SECRETARY OF CONSOLIDATED EDISON CO.
STORAGE CONSTRUCTION EQUIPMENT
STORAGE
SLOPE TO EL. 22'-0"
EL-20'-0"
SLOPE TO EL-30'-0"
EXCAVATE TO ELEV.-30'-0"
ROCKS
FOR REFERENCE DWGS. SEE DWG. 20861 OR 21341
FIG. 3-15
CONCEPT DWG. 20863-H
CONSOLIDATED EDISON CO. OF NEW YORK, INC.
INDIAN POINT No. 3
EXCAVATION & FILL OF NATURAL DRAFT COOLING TOWER
1" = 40'
2732



NOTES:
1. BUS TIE BKR CAN ONLY BE CLOSED IF TRANSF. MAIN BKR IS OPENED
2. A.C. SUPPLY FOR AMERTAP CONDENSER TUBE CLEANING SYSTEM TO BE TAKEN FROM M.C.C. LOCATED BY CIRC. PUMPS AS REQUIRED.

REFERENCE DRAWINGS

CONCEPT DWG
21341 - GENERAL ARRANGEMENT OF NATURAL DRAFT COOLING TOWER & ELECTRICAL EQUIPMENT
20999 - LIGHTING LAYOUT FOR NATURAL DRAFT COOLING TOWER NAVIGATION, ROADWAY & SERVICE LIGHTS
21000 - OUTLINE OF 480V M.C.C'S & TRANSF'S FOR NATURAL DRAFT COOLING TOWERS
21001 - OUTLINE AND ONE LINE DIAG. OF 6.9KV SWGR & D.C. SUPPLY ASSOCIATED WITH CIRC. WATERPUMPS FOR NATURAL DRAFT COOLING TOWERS
21002 - ARRANGEMENT & INSTALLATION OF 6.9KV & 480V DUCT RUNS FOR NATURAL DRAFT COOLING TOWERS.
21003 - ARRGM'T OF 6.9 KV DUCT RUNS FROM TURB. BLDG TO 6.9 KV SWGR & MISC. CONDUIT RUNS FOR NATURAL DRAFT COOLING TWR.

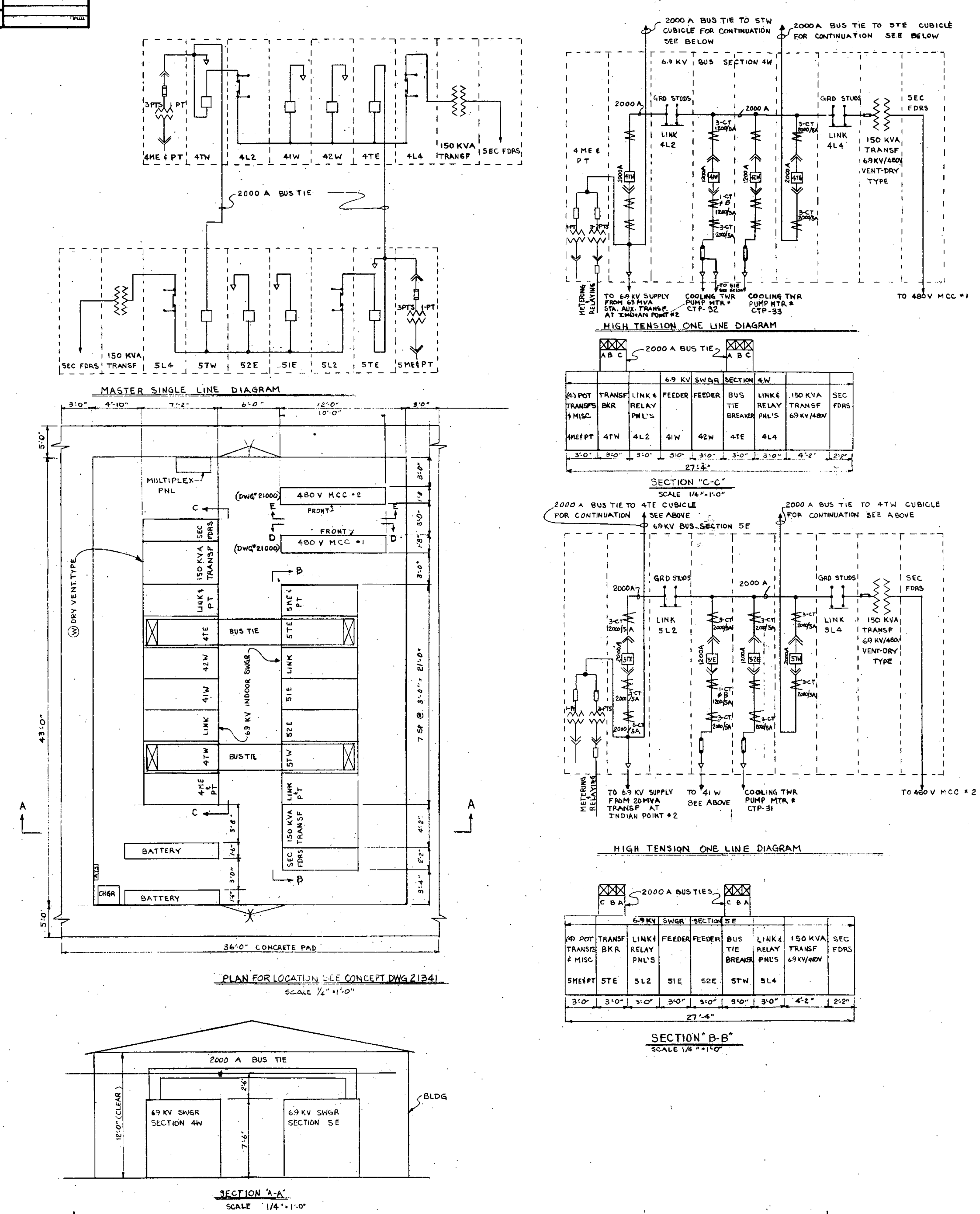
FIG. 3-16

CONCEPT DWG. 20998-D

CONSOLIDATED EDISON CO. OF NEW YORK, INC.

STATION LOCATION: INDIAN POINT #3
ONE LINE DIAG 6.9KV/480/208/120V SUPPLY FOR NATURAL DRAFT COOLING TOWERS

DRAWN BY J. CARUSCO
2732



REFERENCE DWG

CONCEPT DWG 20861 - GENERAL ARRANGEMENT OF NATURAL DRAFT COOLING TOWER & ELECTRICAL EQUIPMENT

20998 - ONE LINE DIAG 6.9 KV/480/208/120V SUPPLIES FOR NATURAL DRAFT COOLING TOWERS

20999 - LIGHTING LAYOUT FOR NATURAL DRAFT COOLING, TOWER NAVIGATION, ROADWAY & SERVICE LIGHTS

21000 - OUTLINE OF 480V MCC'S & TRANSF'S FOR NATURAL DRAFT COOLING TOWERS

21002 - ARRANGEMENT & INSTALLATION OF 6.9KV & 480 V DUCT RUNS FOR NATURAL DRAFT COOLING TOWER

21003 - ARRANGEMENT OF 6.9KV DUCT RUNS FROM TURB BLDG TO 6.9 KV SWGR & MISC CONDUIT RUNS FOR NATURAL DRAFT COOLING TWR

REVISIONS
RELEASED FOR ESTIMATE 10-2-74 JAC
RELEASED FOR INFORMATION 12-18-74
RELEASED FOR FINAL COMMENTS 2-27-75
RELEASED FOR FINAL CONCEPTUAL DESIGN 11-28-75 MS

FIG. 3-17

CONCEPT DWG. 21001-D

CONSOLIDATED EDISON CO. OF NEW YORK, INC.

WESTCHESTER
STATION LOCATION INDIAN POINT #3
OUTLINE AND ONELINE DIAGRAM OF 6.9KV SWGR & D.C. SUPPLY ASSOC. WITH CIRC WATER PUMPS FOR NATURAL DRAFT COOLING TOWER

SCALE AS NOTED | DRAWN BY J CRUSCO
J.O. 2732

APPROVALS

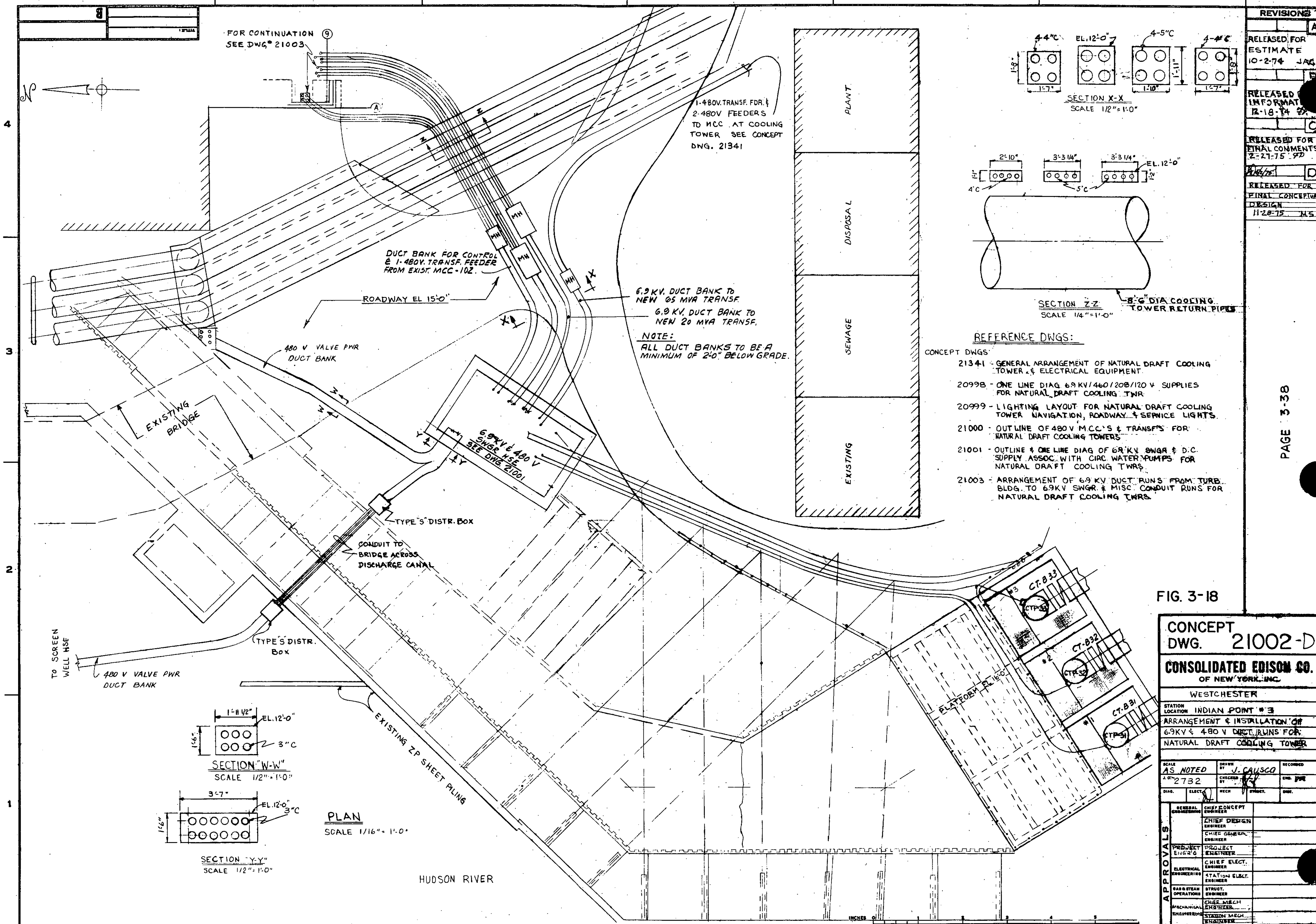
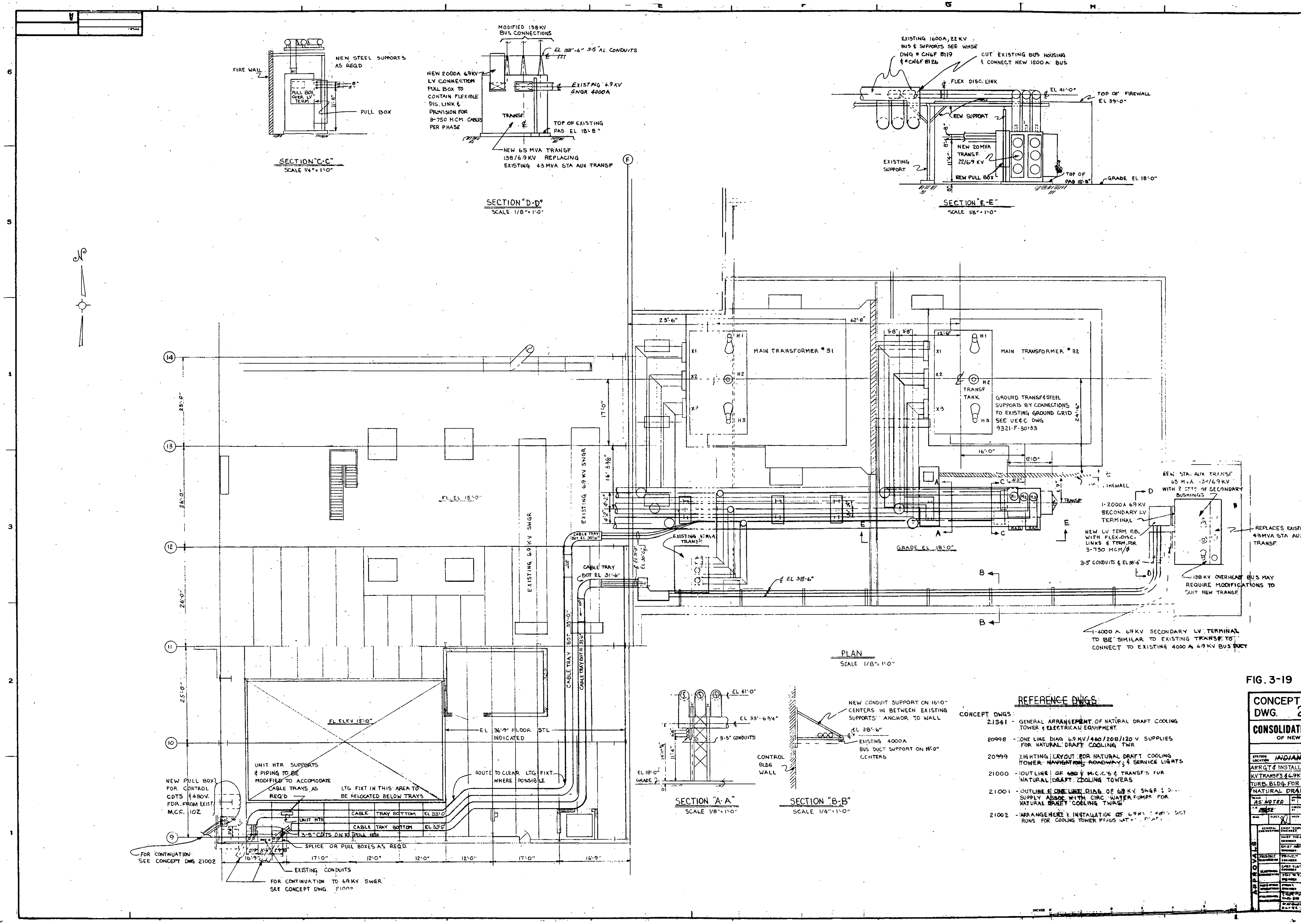


FIG. 3-18

PAGE 3-38



REVISIONS
RELEASED FOR ESTIMATE 10-2-74
RELEASED FOR INFORM 12-18-74
RELEASED FOR FINAL COMMENTS
RELEASED FOR FINAL CONCEPTUAL DESIGN 11-28-75

FIG. 3-19

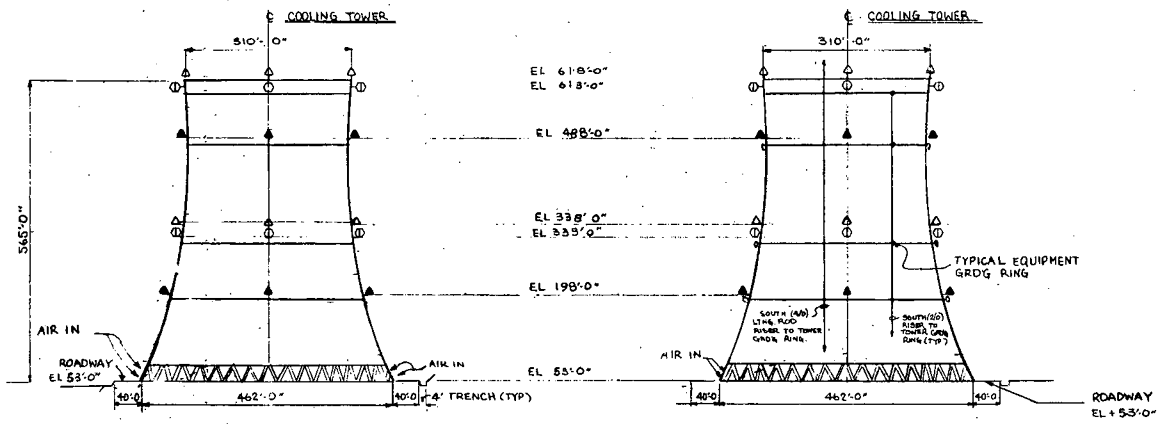
CONCEPT DWG. 21003-D

CONSOLIDATED EDISON CO. OF NEW YORK, INC.

STATION LOCATION: INDIAN POINT #3
ARRGT & INSTALL OF 22/6.9KV & 138/6.9KV TRANSF'S & 6.9KV CABLE TRAY RUNS IN TURB. BLDG. FOR CLG. TWR. FDRS. NATURAL DRAFT COOLING TOWERS

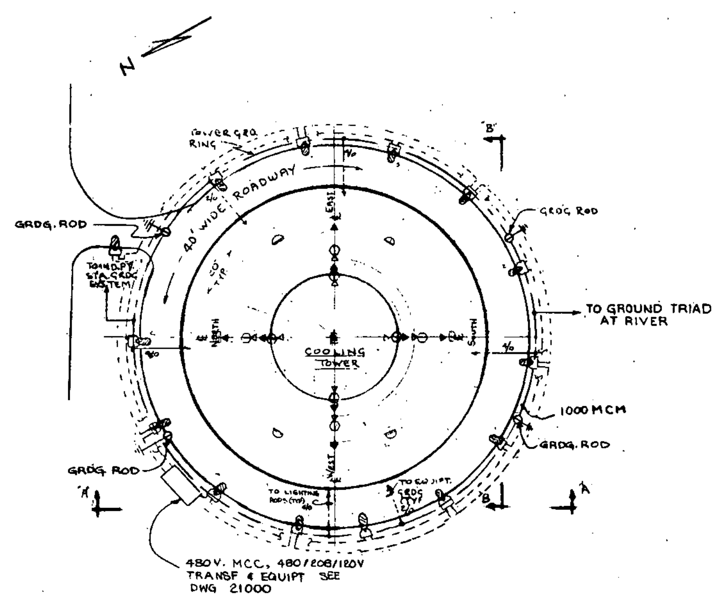
SCALE: AS NOTED

APPROVALS



SECTION A-A
SCALE 13/16 = 100'-0"

SECTION B-B
SCALE 13/16 = 100'-0"



PLAN
COOLING TOWER
SCALE 1" = 100'-0"

LIGHTING LEGEND:

- △ = AVIATION RED FLASHING BEACONS, DUAL BULB (1000W.)
- ⦶ = HIGH INTENSITY WHITE STROBE LIGHTS, DOUBLE INTENSITY (1.2KVA).
- ▲ = AVIATION RED OBSTRUCTION LIGHTS (125W.)

} EQUIPT. TO MEET "FAA" REQUIREMENTS AS PER "FAA" BULLETIN AC70-7460-1A

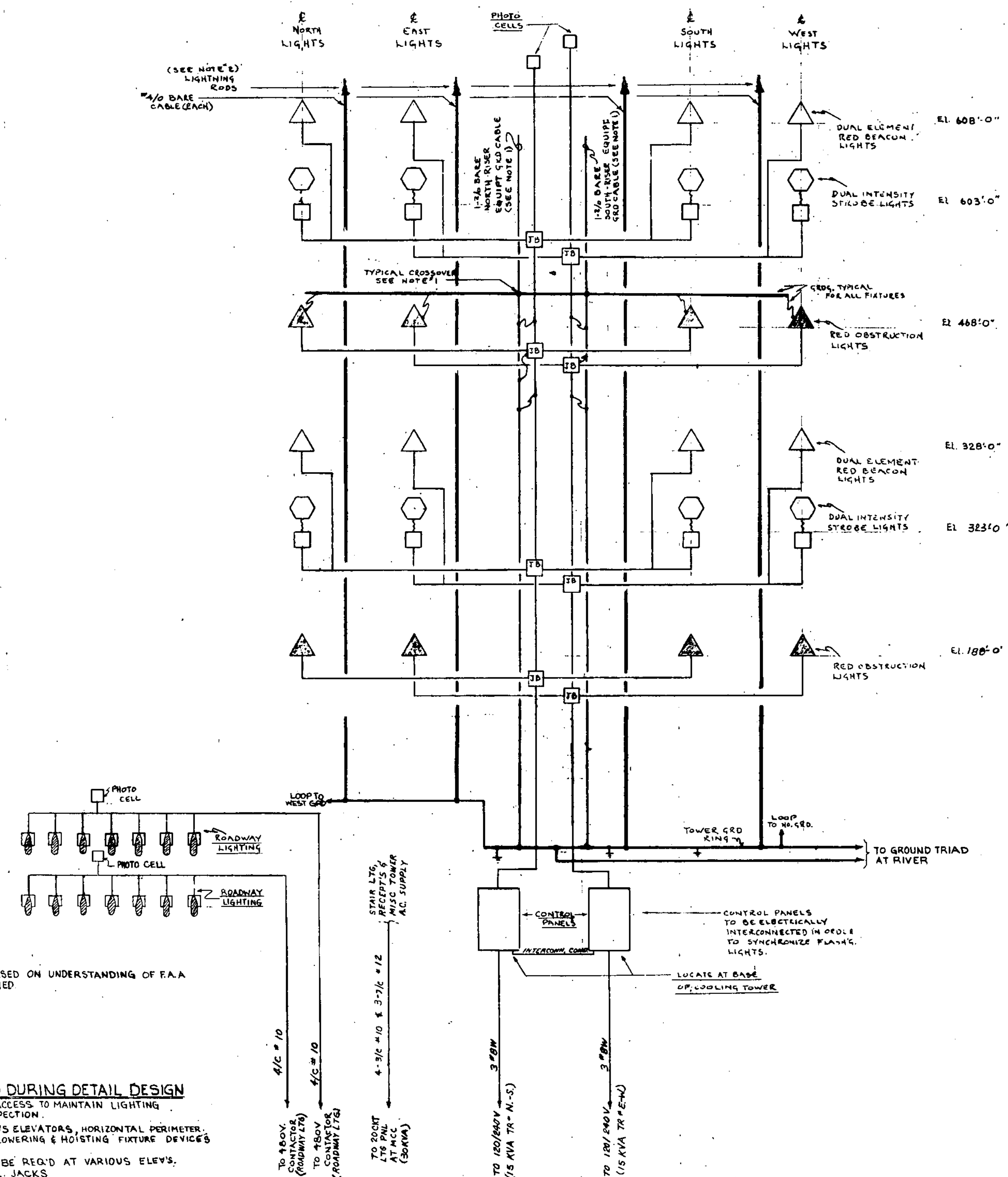
- ROADWAY FIXTURE WITH POLE (400W. MERC. VAPOR)

} SEE UE&C DWG #9321-LL-3042 SH'S 1 & 6 (FIXTURES #11 & 72)

NOTES:

1: ALL LIGHTING FIXTURES & JUNC. BOXES TO BE GROUNDED TO ASSOCIATED GRD CABLE. CROSSOVERS OF ALL GROUNDING CABLES TO BE WELDED AT CROSSOVER POINTS (CALDWELL OR EQUAL).

2: LIGHTNING RODS TO EXTEND OVER TOP OF TOWER.



FOR CONTIN. SEE CONCEPT DWG 20875

ASSUMPTIONS

1- COOLING TOWER LIGHTING BASED ON UNDERSTANDING OF F.A.A REQUIREMENTS. TO BE VERIFIED

ITEMS TO BE DETERMINED DURING DETAIL DESIGN

1- REQUIRE METHOD OF PERSONAL ACCESS TO MAINTAIN LIGHTING SYSTEMS & COOLING TOWER INSPECTION.
ie: VERTICAL LADDERS, STAIRS VS ELEVATORS, HORIZONTAL PERIMETER PLATFORMS AT (X) ELEVATIONS, LOWERING & HOISTING FIXTURE DEVICES (THOMPSON HANGERS)
2- TELEPHONE OUTLETS WILL BE REQ'D AT VARIOUS ELEV'S. SUCH AS SOUND POWERED TEL. JACKS

REFERENCE DWGS:

CONCEPT DWGS

- 21003 - ARRANGEMENT OF 6.9 KV DUCT RUNS FROM TURB. BLDG TO 6.9KV SWGR & MISC CONDUIT RUNS FOR NATURAL DRAFT COOLING TWR
- 21341 - GENERAL ARRANGEMENT OF NATURAL DRAFT COOLING TOWER & ELECTRICAL EQUIPMENT
- 20998 - ONE LINE DIAG 6.9KV/480/208/120V SUPPLIES FOR NATURAL DRAFT COOLING TOWERS.
- 21000 - OUTLINE OF 480V M.CC'S & TRANSF'S FOR NATURAL DRAFT COOLING TOWERS
- 21001 - OUTLINE AND ONE LINE DIAG OF 6.9KV SWGR & D.C SUPPLY ASSOC. WITH CIRC. WATER PUMPS FOR NATURAL DRAFT COOLING TOWERS.
- 21002 - ARRANGEMENT & INSTALLATION OF 6.9KV & 480V DUCT RUNS FOR NATURAL DRAFT COOLING TOWER

REVISIONS
RELEASED FOR ESTIMATE. 10-2-74 JAC
RELEASED FOR FINAL CONCEPTUAL DESIGN

FIG. 3-20

CONCEPT DWG. 20999-D

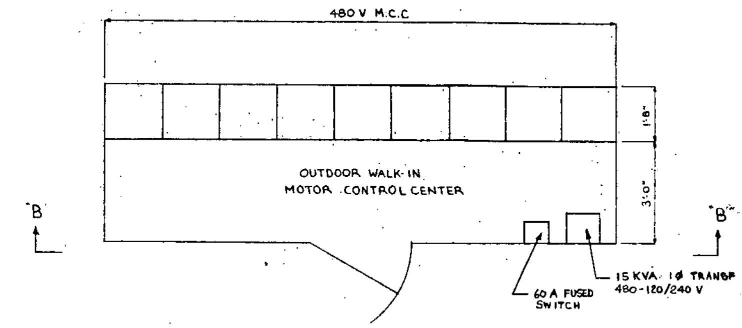
CONSOLIDATED EDISON CO. OF NEW YORK, INC.

STATION LOCATION: INDIAN POINT #3

LIGHTING LAYOUT FOR NATURAL DRAFT COOL'G TOWER NAVIGATION ROADWAY & SERVICE LIGHTS

SCALE: AS NOTED | DRAWN BY: R. PEPE
J.O. 2732

APPROVALS



PLAN

SCALE 1/2" = 1'-0"

10'-0"

1'-8"	1'-8"	1'-8"	1'-8"	1'-8"	1'-8"
BLANK	200 A FUSED DISC. SW TWR MCC FDR	60 A FUSED SW ATS BATT RM	SPACE	SPACE	BLANK
225 A MAIN BREAKER		60 A FUSED SW AMERTAP SYSTEM 60 A FUSED SW AMERTAP SYSTEM	SIZE 1 REV. START CTC-31 BY-PASS MOV	SPACE SPACE	225 A TIE-BKR NON-AUTO
BLANK	BLANK				BLANK
SIZE 1 REV. START COOLING TWR PUMP MOV CT-B33	SIZE 1. REV. START CT-A36 COND # 33 MOV	SIZE 1 REV. START CT-A34 COND # 32 M.O.V	SIZE 1 REV START CT-A32 COND # 31 MOV	SPACE 60 A FUSED SW 15 KVA LTG TRANSF	12 CKT 3 ø 4-W 120/208V LTG PNL
SIZE 1 REV START COOLING TWR PUMP MOV CT-B32	SIZE 1 REV START RW-A36 COND # 33 MOV	SIZE 1 REV. START RW-A34 COND # 32 M.O.V.	SIZE 1 REV. START RW-A32 COND # 31 M.O.V	15 KVA 3 ø 4W LTG TRANSF	BLANK

7'-7 5/8"

480 V MCC #1

SECTION D-D

SCALE 1/2" = 1'-0"

10'-0"

1'-8"	1'-8"	1'-8"	1'-8"	1'-8"	1'-8
SPACE	60 A FUSED SW ATS BATT RM	SPACE	200 A FUSED DISC. SW TWR. MCC FDR	BLANK	BLANK
SPACE	60 A FUSED SW AMERTAP SYSTEM	SPACE		225 A MAIN BREAKER	BLANK
SPACE	60 A FUSED SW AMERTAP SYSTEM	SPACE	BLANK	BLANK	BLANK
SIZE 1 REV START CT-A35 COND # 33 MOV	SIZE 1 REV. START CT-A33 COND # 32 MOV	SIZE 1 REV START CTC-32 BY-PASS MOV	SIZE 1 REV START CT-A31 COND # 31 MOV	SIZE 1 REV. START COOLING TWR PUMP MOV CT-B31	BLANK
SIZE 1 REV START RN-A35 COND # 33 M.OV	SIZE 1 REV START RW-A33 COND # 32 M.OV	SIZE 1 REV START SPARE	SIZE 1 REV START RN-A31 COND # 31 MOV	SIZE 1 REV START BLOW DOWN MOV	BLANK

480 V MCC #2

SECTION E-E

SCALE 1/2" = 1'-0"

480 V MCC'S LOC. IN SWGR BUILDING

FOR PLAN SEE CONCEPT DWG 21001

15'-0"

480 V M.C.C.

1'-8"	1'-8"	1'-8"	1'-8"	1'-8"	1'-8"	1'-8"	1'-8"	1'-8"
		SPACE		200 A MAIN DISC SWITCH	200 A MAIN DISC. SWITCH	60 A FUSED SW. & LTG. CONTACTOR ROADWAY LTG	60 A FUSED SW & LTG. CONTACTOR ROADWAY LTG	SPACE
20 CKT 3 ø-4W 120/208V LTG & MISC PNL	SIZE 1 REV. START BY PASS M.O.V 1	SPACE	SPACE 60 A FUSED SW 15 KVA TRANSF			SPACE 60 A FUSED SW 15 KVA TRANSF	SPACE	SPACE
100 A FUSED SW 30 KVA LTG. TRANSF	SIZE 1 REV. START BY-PASS M.O.V. 2	SIZE 1 REV START DEICING M.O.V 1	SIZE 1 REV. START DEICING M.O.V 3	480-120/240 V 15 KVA TRANSF 1 ø	480-120/240 V 15 KVA TRANSF. 1 ø	SIZE 1 REV. START DEICING M.O.V 5	SIZE 1 REV. START DEICING M.O.V 6	SIZE 1 REV. START BY-PASS M.O.V 4
30 KVA 3 ø 4W LTG & MISC TRANSF	SIZE 1 REV. START BY-PASS M.O.V. 3	SIZE 1 REV. START DEICING M.O.V. 2	SIZE 1 REV. START DEICING M.O.V 4	60 A FUSED SW. NAVIGATION LTGS BLANK	60 A FUSED SW NAVIGATION LTGS 50 A BKR AUTO. LTG. TIE	SIZE 1 REV. START DEICING M.O.V. 7	SIZE 1 REV. START BY-PASS M.O.V. 5	SIZE 1 REV. START BY-PASS M.O.V 6

7'-7 5/8"

480 V MCC AT NATURAL DRAFT COOLING TOWER

(SEE CONCEPT DWG. 21341)

SECTION "B-B"

SCALE 1/2" = 1'-0"

REFERENCE DRAWINGS:

CONCEPT DWG 20998 - ONE LINE DIAG. 6.9 KV/460/208/120 V SUPPLIES FOR NATURAL DRAFT COOLING TOWERS

20999 - LIGHTING LAYOUT FOR NATURAL DRAFT COOL'G TOWER NAVIGATION, ROADWAY, & SERVICE LIGHTS

21001 - OUTLINE & ONE LINE DIAG OF 6.9 KV SWGR & D.C. SUPPLY ASSOC. WITH CIRC WATER PUMPS FOR NATURAL DRAFT COOLING TOWERS

21341 - GENERAL ARRANGEMENT OF NATURAL DRAFT COOLING TOWER & ELECTRICAL EQUIPMENT

21002 - ARRANGEMENT & INSTALLATION OF 6.9 KV & 480 V DUCT RUNS FOR NATURAL DRAFT COOLING TOWERS

21003 - ARRANGEMENT OF 6.9 KV DUCT RUNS FROM T.H.'S BLDG TO 6.9 KV SWGR & MISC. CONDUIT RUNS FOR NATURAL DRAFT COOLING TWR

REVISIONS

A RELEASED FOR ESTIMATE 10-2-74 JAC

B RELEASED FOR INFORMATION 12-18-74

RELEASED FOR FINAL COMMENTS SA 2-27-75

D RELEASED FOR FINAL CONCEPTUAL DESIGN 11-28-75 M.S.

PAGE 3-41

FIG. 3-21

CONCEPT DWG. 21000-D

CONSOLIDATED EDISON CO. OF NEW YORK, INC.

WESTCHESTER

STATION LOCATION INDIAN POINT #3

OUTLINE OF 480V MCC'S & TRANSF'S FOR NATURAL DRAFT COOLING TOWERS

SCALE 1/2" = 1'-0" DRAWN BY J.A. CRUSCO

J.O. 2732 CHECKED BY KP

APPROVALS

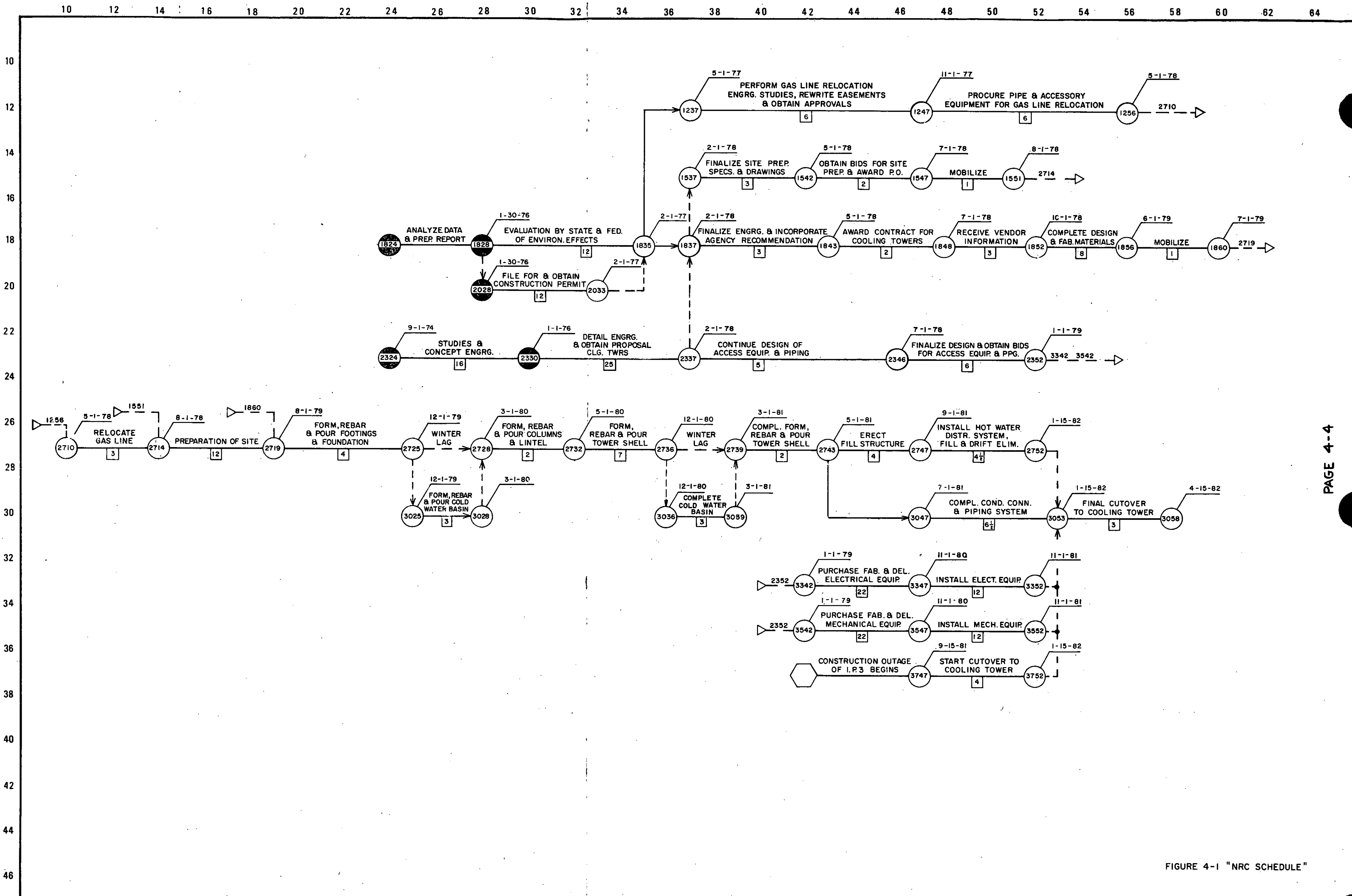


FIGURE 4-1 "NRC SCHEDULE"

NOTE: All Activity Durations Are In Months

REV	DATE	PROJ ENG	PROJ MGR	REV	DATE	PROJ ENG	PROJ MGR

ACT. NOT STARTED or COMPL.
PREDECESSOR ACT. COMPL. SUCCESSOR ACT. NOT STARTED
PREDECESSOR ACT. COMPL. SUCCESSOR ACT. STARTED
PREREQUISITE NOT COMPL.
PREREQUISITE COMPLETE
MILESTONE ACT.

CONSOLIDATED EDISON CO. of NEW YORK

PROJECT ENGRG DEPT — SCHEDULING BUREAU

SCHEDULING ENGINEER	APPROVED BY PROJECT ENGR	APPROVED BY PROJECT MGR

OVERALL SCHEDULE FOR NATURAL DRAFT COOLING TOWER FOR INDIAN POINT 3

REVISION	ISSUE NO.	STATUS DATE	REQD SERV. DATE	PROJ. NO.	B. R. NO.	SHEET NO.
				2732	3EP5	1 OF 1

FORM NO - PSD 1 (rev 4-73)

4.0 SCHEDULE AND PERMITS

4.1 SCHEDULE

The projected schedule for the construction and operation of the preferred alternative closed-cycle cooling system at Indian Point 3 is set forth in Figure 4-1. That schedule, which is based on the construction of a natural draft closed-cycle cooling tower system, requires cessation of operation of Indian Point 3 with once-through cooling by September 15, 1981. Milestone dates include:

1. January 30, 1976: Submittal of economic and environmental evaluation, recommendation for preferred system, and applications for regulatory reviews and approvals and for construction permits;
2. February 1, 1977: Receipt of regulatory reviews and approvals required for the construction of closed-cycle cooling system;
3. May 1, 1978: Commencement of gas line relocation;
4. August 1, 1978: Commencement of excavation;
5. August 1, 1979: Commencement of construction;
6. September 15, 1981: Commencement of cutover to cooling tower;
7. April 15, 1982: Completion of construction of closed-cycle system and commencement of operation of that system.

The schedule depicted in Figure 4-1 does not indicate the times and durations for events related to Con Edison's ongoing Hudson River ecological studies, including performing actual field work, writing reports, submitting appplications to amend licenses and receiving regulatory approval for such license amendments.

4.2 PERMITS AND REGULATORY APPROVALS

The design of the preferred closed-cycle cooling alternative must be reviewed by various federal, state and local agencies. The following is a list of the principal permits and regulatory approvals which would be required for the construction or operation of a natural draft closed-cycle cooling tower system at Indian Point Unit No. 3:

(1) United States Nuclear Regulatory Commission - Review and approval of preferred alternative closed-cycle cooling system for installation, approval of construction pursuant to 10CFR-Sect. 50.59, and amendment of operating license.

(2) United States Environmental Protection Agency - Amendment of discharge permit, if required.

(3) United States Advisory Council on Historic Preservation - Review of environmental impacts.

(4) United States Federal Aviation Agency - Permit for tower.

(5) New York State Department of Environmental Conservation - Permit to construct air contamination source (6 NYCRR Section 201.2(a)).

(6) Division for Historic Preservation, New York State Parks and Recreation - Review of impacts on historical sites.

(7) New York State Agency to be designated pursuant to Coastal Zone Management Act of 1972 (P.L. 92-583) - Approval of certification.

(8) United States Federal Power Commission - Permit to relocate gas pipeline owned by Algonquin Gas Transmission Company.

5.0 ECONOMIC IMPACT OF ALTERNATIVE CLOSED-CYCLE COOLING SYSTEMS

Con Edison has conducted cost analyses of the four alternative closed-cycle cooling systems (natural draft wet, linear and round mechanical draft wet, and mechanical draft wet/dry cooling tower systems) considered to be technically feasible for Indian Point Unit No. 3. Also, Con Edison has conducted cost analysis of the fan-assisted natural draft cooling tower system which is an unproven alternative for Indian Point Unit No. 3. The total capital costs, which include direct and indirect capital costs, and incremental generating costs are described in the following paragraphs.

The preliminary estimates for these cooling tower systems are based on the engineering design completed to date (Section 3.0) and the construction Schedule (Section 4.1). A summary of these cost estimates is given below:

Cost Estimates, $1,000,000

	Total Capital Cost	Incremental Generating Costs (annual levelized Revenue Requirements)
Natural Draft Wet C.T.	107	47.4
Linear Mech. Draft Wet C.T.	155	61.3
Mech. Draft Wet/Dry C.T.	178	66.3
Round Mech. Draft Wet C.T.	103	51.2
Fan-Assisted Natural Draft Wet C.T.	108	48.7

5.1 DIRECT CAPITAL COSTS

Capital costs for the natural draft wet, linear mechanical draft wet, mechanical draft wet/dry, round mechanical draft wet and fan-assisted natural draft wet cooling tower systems for Indian Point Unit No. 3 are given in Tables 5-1, 5-2, 5-3, 5-4 and 5-5, respectively. The major components for the construction of all five alternative closed-cycle cooling systems are set forth in Table 3-4. Site preparation is the largest single direct capital cost. The Indian Point site is composed of exceptionally uneven and rocky terrain. The nature of the Indian Point site requires the construction of long connecting pipe runs. The rock excavation for the alternative cooling systems will be extensive. The cost of the actual cooling tower and the foundation for the tower(s) of the system constitutes only about 25% of the direct capital cost.

Real estate tax during construction is also included in Tables 5-1 through 5-5 in accordance with company procedures for major projects. The tax was estimated by allocating the total estimated direct cost to the various periods of construction activity to develop real estate valuation for each taxing period during construction. Such valuations were based on Con Edison's experience with the ratio of assessed valuation to costs within the taxing districts involved and an estimated tax rate for each period of construction.

5.2 INDIRECT CAPITAL COSTS

The estimated total project cost is made up of the estimated direct costs and those indirect or overhead costs which, under the Federal Power Commission and the New York State Public Service Commission Uniform System of Accounts, are to be capitalized as part of the project capital cost. The indirect or overhead cost includes the following components:

A. Company Engineering and Supervision (13% of total direct costs).

B. Administration and Supervision (3.0% of the sum of total direct cost and (A)).

C. Payroll Taxes and Pensions (29% of the sum of Company labor cost directly charged to the project, and (A)).

D. Allowance for Funds During Construction (9% per year of the sum of total direct cost plus indirect costs set forth in (A), (B) and (C)).

The accounting for each component of indirect cost of the project has been accepted by the Company's auditors, the New York State Public Service Commission and the Federal Power Commission.

These indirect costs plus the total direct costs give the total project cost in terms of current dollars. The total project cost must be escalated to reflect costs at the time when the project is actually implemented and a contingency added to determine the total estimated cost:

E. Escalation (9% per year of total project cost for 1975, 7.0% for the years after 1975).

F. Contingency (20% for the sum of total project cost and (E)).

Computations of these costs are shown in Tables 5-1 through 5-5. Detailed discussion of these items follows:

5.2.1 Company Engineering, Supervision and Construction Management

In order to construct a cooling tower system Con Edison incurs expenses in doing preliminary engineering designs, drafting invitiations to bid, making detailed engineering designs, project supervision and management, etc. These engineering costs are applied to all capital construction projects as an indirect cost (currently 13% of direct cost). This method is accepted by the Company's auditors, the New York State Public Service Commission and the Federal Power Commission.

5.2.2 Administration and Supervision

Proper accounting practice allows the allocation to capital cost of a portion of the general administration expenses of the Company. This reflects the fact that certain administrative functions, including purchasing, personnel, accounting, are, in part, attributable to capital projects.

Con Edison currently uses a factor of 3.0% of the sum of direct cost and company engineering cost for this item.

5.2.3 Payroll Taxes and Pensions

It is proper to include these employee-related expenses (currently 29% of the Company labor cost and Company engineering cost) attributable to the Company labor on the project.

5.2.4 Allowance for Funds During Construction

"Allowance for Funds during Construction" is a factor unique to utility accounting based on the fact that property is not included in the rate base until it goes into service. Accordingly, proper utility accounting requires increasing the direct cost of a project by this factor to take into account the fact that money was invested without obtaining a rate of return for the period of construciton. This factor is computed on the net cost of borrowed funds used for construction purposes plus a reasonable rate of return upon the utility's own funds when so used.

Con Edison currently uses the figure of 9% per annum for interest during construction on all major capital construction projects.

The figures for interest during construction shown on Table 5-1 through 5-5 are derived by multiplying 9% by the number of years of construction activity and dividing the result by 2 on the assumption of an even rate of expenditure over the course of construction.

5.2.5 Escalation

During the past 25 years, construction costs have steadily increased and there is no indication of any change in this trend. Accordingly, it is prudent to increase cost estimates based on current prices by an escalation factor when estimating the cost of a project to be built at a future time, in order to reflect the actual expenditures which will be incurred.

The escalation factor for Company construction projects is estimated on the basis of the New York City Construction Price Index developed by Con Edison. This Index reflects increases in the cost of labor as determined by the Building and Construction Trades Council of Greater New York supplemented by data from actual union contractual agreements, and by increases in the costs of materials shown by the Construction Material Wholesale Price Index of the United States Department of Commerce.

The accuracy of this Index is tested on a semi-annual and an annual basis by comparison with the average rate of change for other industrial agencies. No significant difference has been found.

The average annual rate of change was shown to be: (1) 1964-1971 at 6.3%, (2) 1964-1974 at 6.4%, and (3) 1973 at 7%. The period from 1974 to 1975 was estimated at a 9% average annual rate of change and for years after 1976 at 7%. The computation of the escalation factors used in Tables 5-1, 5-2, 5-3, 5-4 and 5-5 is given in Table 5-6.

5.2.6 Contingency

Contingency is an allowance for costs which cannot be estimated at this time but are certain to occur, as well as an allowance to cover items which because of their nature can vary from the time of the estimate. Three of the main items intended to be covered by the contingency factor are:

(1) Labor productivity being less than anticipated. This item is dependent on the labor market at the time the work is being performed and on the working conditions.

(2) Actual quantities or base prices being greater than anticipated. This item is dependent on the information from which the estimate is being prepared and economic conditions.

(3) The final design being somewhat different than envisioned at the time of the estimate. This item, however, is not intended to cover major changes in scope.

The contingency allowance is based on experience and reflects the extent and certainty of the knowledge of project details. A contingency factor of 20% is appropriate for this project in view of the fact that, among other things, the final detailed design has not been completed or approved.

5.3 INCREMENTAL GENERATING COSTS

The following sections describe the method for computing the incremental generating costs of alternative closed-cycle cooling systems. The economic life of a cooling tower utilized herein is measured from the time it becomes operational to the end of the total economic life of the nuclear plant, taken to be 30 years. Indian Point Unit No. 3's first year of service will be 1976, thus incremental generating costs are considered only for the economic life of the cooling tower, from the beginning of the year 1981 to the end of 2005, inclusive.

The estimated incremental generating costs for the natural draft wet, linear mechanical draft wet, mechanical draft wet/dry, round mechanical draft wet and fan-assisted natural draft wet cooling tower systems are presented in Tables 5-7, 5-8, 5-9, 5-10 and 5-11, respectively, in the following two modes:

(1) The present worth in 1975 of the total revenue requirements (column 1).

(2) The annual levelized revenue requirements from 1981 to 2005 (column 2).

The "Present Worth of the Revenue Requirements" (column 1) is the sum of the annual additional costs due to the cooling tower present-worthed to January 1, 1975. The present worth of a revenue requirement in any given year is the amount of money which, if invested at the specific rate of return in 1975, would meet this revenue requirement in the later year. The "Annual Levelized Revenue Requirements" (column 2) is a constant annual revenue requirement, from 1981 through 2005, which is equivalent to the actual stream of revenue requirements such that the sum of the present worth of these equivalent annual revenue requirements equals the sum of the present worth of the actual annual revenues required from 1981 through 2005. The present worth and the annual levelized revenue requirements are computed using Con Edison's cost of capital, shown in Table 5-12.

These costs reflect the actual increments which would show in our customers' bills. If the transfer payments, which are the Gross Revenue Tax, the Federal Income Tax and the Property Tax were to be deducted, as suggested by the Nuclear Regulatory Commission, the total annual levelized revenue requirements (line F in either Table 5-7, 5-8, 5-9, 5-10 or 5-11) of a natural draft wet cooling tower system would be reduced by $8,085,000. For a linear mechanical draft wet cooling tower system, the annual levelized values would be reduced by $10,774,000. For a mechanical draft wet-dry cooling tower system, the annual levelized values would be reduced by $11,936,000. For a round mechanical draft wet cooling tower system, the annual levelized values would be reduced by $8,256,000. For a fan-assisted natural draft wet cooling tower system, the annual levelized values would be reduced by $8,234,000. If these amounts are deducted from the costs of the towers, the appropriate transfers must also be excluded from consideration as benefits.

5.3.1 MAINTENANCE AND OTHER OPERATING EXPENSES

Cooling tower operating and maintenance costs are estimated based on industry experience. The estimates are escalated by 5% per year compounded to reflect anticipated increasing costs of labor and materials.

5.3.2 CARRYING CHARGES ON ADDITIONAL CAPITAL FOR THE COOLING TOWER SYSTEMS

An annual carrying charge is computed as the sum of the following factors: depreciation, return on invested capital, federal income tax, allowance for replacements, insurance, property taxes and gross revenue tax (see Table 5-13).

The total capital costs of the cooling tower system are depreciated using the straight line depreciation method.

An annual rate of return is computed based on Con Edison's capital structure which consists of approximately 53% debt, 13% preferred stock and 34% common stock. The 15 3/8% cost of capital, reflecting the Company's current incremental cost of capital, (see Table 5-12), results in a levelized rate of return charge of 11.7% over the recovery period for the cooling tower.

In calculating revenue requirements, it is necessary to include a component for federal income tax in the determination of a carrying charge rate. This calculation also takes into consideration the fact that interest on debt is deductible for federal income tax purposes while earnings earmarked for preferred and common stock are not. For Federal Income Tax purposes, equipment is depreciated using the sum-of-years-digits technique. A job-development credit tax write-off, equivalent to 4% of book cost of the installed equipment, is also taken into account. These result in a percentage charge of 2.1%.

Allowance for replacement is an annual average figure, not included in the annual depreciation rate, to cover periodic replacement of components to maintain an asset in good working conditon. Experience indicates that an allowance of 0.5% of capital costs per year would be a reasonable figure for this item.

Provisions must also be made for the increased premium for property insurance which will be paid on the increased value represented by the cooling tower and gas turbines. This has been estimated by dividing the total present insurance charged by the book cost of the plant. The nuclear property insurance rate is 0.3% which can be applied to the cooling tower, while the conventional property insurance rate is 0.1% which can be applied to the gas turbines.

The carrying charges should also include a factor for property taxes allocable to this addition. This has been computed on the basis of the annualized rate of property taxes Con Edison has paid for Indian Point No. 1 to the Town of Cortlandt and the Village of Buchanan in Westchester County, divided by the average book cost of the plant. This results in a factor of 2.2% for facilities located at Indian Point.

The gross revenue tax is a 6.1% tax on the revenues received by Con Edison. It is composed of state and local gross receipts taxes and of a state public utility excise tax. Since the tax is levied on all revenues received by Con Edison, an allocation for the tax is included in all components of the revenue requirement necessitated by installation of a closed-cycle cooling system.

5.3.3 Cost of Replacing Deficient Energy

The computation of incremental annual charges includes the cost of additional energy required because of the derating imposed upon Indian Point Unit No. 3 by the cooling tower. Two types of derating are involved.

One type of derating is an average annual energy derating as a consequence of (a) additional energy required to operate circulating pumps and other auxiliary equipment and (b) high turbine backpressures associated with heat transfer characteristics of the cooling tower as compared to once-through cooling.

The cost of the derating is the cost of obtaining electric energy to compensate for the derating. In this analysis, the alternative source of energy is assumed to be from within the Con Edison system. This cost estimate is based upon the cost of fuel for the energy necessary to replace the energy that was anticipated from Indian Point Unit No. 3. This energy is conservatively assumed to be supplied through additional operation of oil-fired steam generators within the Con Edison system, resulting in an incremental operating cost of approximately 31 mills per kilowatt hour for fuel in 1982, escalating in future years.

5.3.4 Charges on Additional Capital for Replacement Turbine Capacity

A second type of derating is the loss of peak generating capacity which otherwise would have been available to meet Con Edison's peak loads. Peak system demands and the maximum loss of generating capacity due to the cooling tower normally occur during the summer's hottest, most humid weather, making it necessary to install new capacity to cover this derating in order to maintain system reliability. The cheapest source for this replacement generating capacity, from the point of view of overall system cost, would be the installation of gas turbines at an estimated capital cost of approximately $330 per KW, installed in 1981.

The cost of this replacement capacity is the carrying charge on the capital cost of the gas turbines (see Table 5-13). The cost of any operation of the gas turbines is not included within this item because the cost of energy to off-set the derating of Indian Point Unit No. 3 is included above under Cost of Replacing Deficient Energy and is conservatively assumed to be supplied from within the Con Edison system by baseload oil-fired generation.

5.3.5 Replacing Energy for Plant Downtime

Indian Point Unit No. 3 would not operate during the seven month period required for the cut-in of the closed-cycle cooling system. The cooling tower cut-in will affect the refueling schedule for the unit which will induce a change in the maintenance schedules for the other units on the Con Edison system. To account for this, an analysis of system operation for the four year period from 1981 to 1984, inclusive, was performed to estimate the total cost of operating the electric system with and without the cooling tower cut-in outage. The analysis assumed that the energy not generated by Indian Point No. 3, and other units on the system, because of the cut-in and its effects, would be replaced by additional operation of other plants on the Con Edison system together with some increase in the dispatch of capacity already under firm purchase contract from other utilities. The decrease in fuel expenditures resulting at Indian Point Unit No. 3 during this period was also taken into account. After 1984, the residual impact on the operation of the system is insignificant.

5.3.6 Reliability Impact of Indian Point Unit No. 3 Outage

The scheduling of the cut-in outage for the fall/winter period (9/15/81 to 4/15/82) avoids the summer peak load period. Nevertheless, the unavailability of any major plant, even if in an off-peak period, reduces the reliability of service that would otherwise be afforded to electric customers. The duration of the Indian Point Unit No 3 outage (7 months) to cut-in the cooling tower system, consequently, has definite reliability implications, as noted below.

Superimposing this outage on the scheduled maintenance that would normally be performed would present reliability problems for this time period. Thus, the major impact of the Indian Point Unit No. 3 outage will be to require delay and rescheduling in the planned maintenance that would occur in the October 1981 to May 1982 period. Unless purchases can be obtained during this period it may be necessary to defer some of the maintenance program. The economic impact of this rescheduling is included in the costs tabulated in Tables 5-7 through 5-11, as discussed in subsection 5.3.5. Rescheduling of maintenance to accommodate the seven month outage of Indian Point No. 3 to connect the closed cycle cooling system could cause increases in the forced outages and deratings to be experienced in the Summer of 1982, thus resulting in some deterioration in system reliability that summer.

TABLE 5-1

CAPITAL COST ESTIMATE SUMMARY OF CLOSED CYCLE
NATURAL DRAFT WET COOLING TOWER

DESCRIPTION	INSTALLATION COMPANY	INSTALLATION CONTRACTOR	MATERIAL	TOTAL
Furnish and Erect Cooling Tower		$10,600,000		$10,600,000
Amertrap Clean System		3,300,000		3,300,000
Furnish and Install Piping and Mechanical System	$41,400	2,196,000	$4,149,200	6,387,400
Structural - Civil Work	7,400	17,630,700		17,638,100
Electrical Work		1,169,300	1,480,200	2,649,500
Real Estate Tax During Construction			4,677,200	4,677,200
PROJECT MANAGEMENT & INSPECTION	1,346,400			1,346,400
OTHER DIRECT COST	188,200		35,700	223,900
TOTAL DIRECT COST	1,583,400	34,896,800	10,342,300	46,822,500 (TDC)
ENGINEERING & SUPERVISION: 13% of (TDC)				5,478,900 (A)
ADMINISTRATION & SUPERVISION: 3% of (TDC)(A)				1,428,700 (B)
PAYROLL TAXES & PENSIONS: 29% of (L)+(A)				2,048,100 (C)
INTEREST DURING CONSTRUCTION: 18.89% of (TDC) +(A)+(B)+(C)				10,525,300
TOTAL PROJECT COST				66,303,500 (TPC)
ESCALATION: 39.49% of (TPC)				23,987,700 (E)
CONTINGENCY: 20% of (TPC) + (E)				16,707,800
TOTAL ESTIMATED COST				$107,000,000

TABLE 5-2

CAPITAL COST ESTIMATE SUMMARY OF
CLOSED CYCLE LINEAR MECHANICAL DRAFT
WET COOLING TOWERS

DESCRIPTION	INSTALLATION COMPANY	INSTALLATION CONTRACTOR	MATERIAL	TOTAL	
Furnish and Erect Cooling Tower		$ 7,100,000		$ 7,100,000	
Amertrap Clean System		3,300,000		3,300,000	
Furnish and Install Piping and Mechanical System	$ 52,300	3,663,500	$ 4,966,900	8,682,700	
Structural - Civil Work	8,400	32,040,000		32,048,400	
Electrical Work		4,040,800	3,657,500	7,698,300	
Real Estate Tax During Construction			6,762,000	6,762,000	
PROJECT MANAGEMENT & INSPECTION	1,949,700			1,949,700	
OTHER DIRECT COST	171,000		81,400	252,400	
TOTAL DIRECT COST	2,181,400	50,144,300	15,467,800	67,793,500	(TDC)
ENGINEERING & SUPERVISION: 13% of (TDC)				7,934,100	(A)
ADMINISTRATION & SUPERVISION: 3% of (TDC)(A)				2,069,000	(B)
PAYROLL TAXES & PENSIONS: 29% of (L)+(A)				2,933,500	(C)
INTEREST DURING CONSTRUCTION: 18.89% of (TDC)+(A)+(B)+(C)				15,233,400	
TOTAL PROJECT COST				95,963,500	(TPC)
ESCALATION: 39.49% of (TPC)				34,721,900	(E)
CONTINGENCY: 20% of (TPC) + (E)				23,314,600	
TOTAL ESTIMATED COST				$155,000,000	

TABLE 5-3

CAPITAL COST ESTIMATE SUMMARY OF CLOSED CYCLE MECHANICAL DRAFT WET/DRY COOLING TOWERS

DESCRIPTION	INSTALLATION COMPANY	INSTALLATION CONTRACTOR	MATERIAL	TOTAL
Furnish and Erect Cooling Tower		$10,200,000		$10,200,000
Amertrap Clean System		3,300,000		3,300,000
Furnish and Install Piping and Mechanical System	$52,300	3,748,500	$4,966,900	8,767,700
Structural - Civil Work	8,400	37,350,000		37,358,400
Electrical Work		4,043,800	3,699,200	7,743,000
Real Estate Tax During Construction			7,746,400	7,746,400
PROJECT MANAGEMENT & INSPECTION	2,231,600			2,231,600
OTHER DIRECT COST	171,000		82,700	253,700
TOTAL DIRECT COST	2,463,300	58,642,300	16,495,200	77,600,800 (TDC)
ENGINEERING & SUPERVISION: 13% of (TDC)				9,081,100 (A)
ADMINISTRATION & SUPERVISION: 3% of (TDC)(A)				2,368,100 (B)
PAYROLL TAXES & PENSIONS: 29% of (L)+(A)				3,347,900 (C)
INTEREST DURING CONSTRUCTION: 18.89% of (TDC) +(A)+(B)+(C)				16,435,400
TOTAL PROJECT COST				109,833,300 (TPC)
ESCALATION: 39.49% of (TPC)				39,736,900 (E)
CONTINGENCY: 20% of (TPC) + (E)				28,429,800
TOTAL ESTIMATED COST				$178,000,000

TABLE 5-4

CAPITAL COST ESTIMATE SUMMARY OF CLOSED CYCLE
ROUND MECHANICAL DRAFT WET COOLING TOWERS

DESCRIPTION	INSTALLATION COMPANY	INSTALLATION CONTRACTOR	MATERIAL	TOTAL
Furnish and Erect Cooling Tower		$7,000,000		$7,000,000
Amertrap Clean System		3,300,000		3,300,000
Furnish and Install Piping and Mechanical System	$61,000	4,023,900	$4,982,800	9,067,700
Structural - Civil Work	8,400	15,174,000		15,182,400
Electrical Work		2,155,600	2,361,800	4,517,400
Real Estate Tax During Construction			4,505,200	4,505,200
PROJECT MANAGEMENT & INSPECTION	1,296,800			1,296,800
OTHER DIRECT COST	171,000		58,000	229,000
TOTAL DIRECT COST	1,537,200	31,653,500	11,907,800	45,098,500 (TDC)
ENGINEERING & SUPERVISION: 13% of (TDC)				5,277,100 (A)
ADMINISTRATION & SUPERVISION: 3% of (TDC)(A)				1,376,100 (B)
PAYROLL TAXES & PENSIONS: 29% of (L)+(A)				1,976,100 (C)
INTEREST DURING CONSTRUCTION: 18.89% of (TDC) +(A)+(B)+(C)				10,138,400
TOTAL PROJECT COST				63,866,200 (TPC)
ESCALATION: 39.49% of (TPC)				23,106,000 (E)
CONTINGENCY: 20% of (TPC) + (E)				16,027,800
TOTAL ESTIMATED COST				$103,000,000

TABLE 5-5

CAPITAL COST ESTIMATE SUMMARY OF CLOSED CYCLE FAN ASSISTED NATURAL DRAFT COOLING TOWERS

DESCRIPTION	INSTALLATION COMPANY	INSTALLATION CONTRACTOR	MATERIAL	TOTAL
Furnish and Erect Cooling Tower		$8,900,000		$8,900,000
Amertrap Clean System		3,300,000		3,300,000
Furnish and Install Piping and Mechanical System	$61,000	4,143,400	$4,982,800	9,187,200
Structural - Civil Work	8,400	15,211,600		15,220,000
Electrical Work		1,884,100	2,277,800	4,161,900
Real Estate Tax During Construction			4,701,300	4,701,300
PROJECT MANAGEMENT & INSPECTION	1,353,300 (L)			1,353,300
OTHER DIRECT COST	171,000		68,900	239,900
TOTAL DIRECT COST	1,593700	33,439,100	12,030,800	47,063,600 (TDC)
ENGINEERING & SUPERVISION: 13% of (TDC)				5,507,100
ADMINISTRATION & SUPERVISION: 3% of (TDC) (A)				1,436,100 (B)
PAYROLL TAXES & PENSIONS: 29% of (L)+(A)				2,059,200 (C)
INTEREST DURING CONSTRUCTION: 18.89% of (TDC) +(A)+(B)+(C)				10,579,600
TOTAL PROJECT COST				66,645,600 (TPC)
ESCALATION: 39.49% of (TPC)				24,111,500 (E)
CONTINGENCY: 20% of (TPC) + (E)				17,242,900
TOTAL ESTIMATED COST				$108,000,000

TABLE 5-6

COMPUTATION OF ESCALATION FACTORS OF

COOLING TOWERS BASED ON EQUAL ANNUAL EXPENDITURES

Period of Construction: 6/1/78 to 4/15/82

Year of Expenditure	Escalation Period	ESCALATION*	Allocable Portion
1978	1/1/75-12/31/78	27.96%	4.21%
1979	1/1/75-12/31/79	33.50	8.65
1980	1/1/75-12/31/80	40.50	10.45
1981	1/1/75-12/31/81	47.50	12.26
1982	1/1/75-4/15/82	52.02	3.92
		Total	39.49%

* 9% for 1975
7% for 1976 thru 1982

TABLE 5-7

INCREMENTAL REVENUE REQUIREMENTS ABOVE BASE PLANT FOR A NATURAL DRAFT WET COOLING TOWER AT INDIAN POINT UNIT NO. 3

DESCRIPTION OF EXPENSE	PRESENT WORTH REVENUE REQUIREMENTS 1981-2005*	ANNUAL LEVELIZED REVENUE REQUIREMENTS 1981-2005
A) Maintenance and Other Operating Expenses	713,000	266,000
B) Carrying Cost of Capital for Cooling Tower	55,187,000	20,590,000
C) Cost of Replacing Deficient Energy (Average Derating)	22,801,000	8,507,000
D) Carrying Cost of Capital for Replacement Capacity (Peak Derating)	15,629,000	5,831,000
E) Replacement Energy for Plant Downtime to Cut-in Cooling Tower	32,595,000	12,161,000
F) Total	126,925,000	47,355,000

*Base Year = 1975

Annual Average Derating 33.5 MW

Maximum Derating at Peak Temperature 77.5 MW

TABLE 5-8

INCREMENTAL REVENUE REQUIREMENTS ABOVE BASE PLANT
FOR LINEAR MECHANICAL DRAFT WET COOLING TOWERS
AT INDIAN POINT NO. 3

DESCRIPTION OF EXPENSE	PRESENT WORTH REVENUE REQUIREMENTS 1981-2005*	ANNUAL LEVELIZED REVENUE REQUIREMENTS 1981-2005
A) Maintenance and Other Operating Expenses	2,149,000	802,000
B) Carrying Cost of Capital for Cooling Tower	79,945,000	29,827,000
C) Cost of Replacing Deficient Energy (Average Derating)	33,011,000	12,316,000
D) Carrying Cost of Capital for Replacement Capacity (Peak Derating)	16,637,000	6,207,000
E) Replacement Energy for Plant Downtime to Cut-in Cooling Tower	32,595,000	12,161,000
F) Total	164,337,000	61,313,000

* Base Year = 1975

Annual Average Derating 48.5 MW

Maximum Derating at Peak Temperature 82.5 MW

TABLE 5-9

INCREMENTAL REVENUE REQUIREMENTS ABOVE BASE PLANT FOR MECHANICAL DRAFT WET/DRY (LINEAR) COOLING TOWERS AT INDIAN POINT UNIT NO. 3

DESCRIPTION OF EXPENSE	PRESENT WORTH REVENUE REQUIREMENTS 1981-2005*	ANNUAL LEVELIZED REVENUE REQUIREMENTS 1981-2005
A) Maintenance and Other Operating Expenses	2,709,000	1,011,000
B) Carrying Cost of Capital for Cooling Tower	91,808,000	34,253,000
C) Cost of Replacing Deficient Energy (Average Derating)	33,691,000	12,570,000
D) Carrying Cost of Capital for Replacement Capacity (Peak Derating)	16,838,000	6,282,000
E) Replacement Energy for Plant Downtime to Cut-in Cooling Tower	32,595,000	12,161,000
F) Total	177,641,000	66,277,000

* Base Year = 1975

Annual Average Derating	49.5 MW
Maximum Derating at Peak Temperature	83.5 MW

TABLE 5-10

INCREMENTAL REVENUE REQUIREMENTS ABOVE BASE PLANT FOR ROUND MECHANICAL WET COOLING TOWERS AT INDIAN POINT UNIT NO. 3

DESCRIPTION OF EXPENSE	PRESENT WORTH REVENUE REQUIREMENTS 1981-2005*	ANNUAL LEVALIZED REVENUE REQUIREMENTS 1981-2005
(A) Maintenance and Other Operating Expenses	1,949,000	727,000
(B) Carrying Cost of Capital for Cooling Tower	53,124,000	19,820,000
(C) Cost of Replacing Deficient Energy (Average Derating)	33,011,000	12,316,000
(D) Carrying Cost of Capital for Replacement Capacity (Peak Derating)	16,637,000	6,207,000
(E) Replacement Energy for Plant Downtime to Cut-in Cooling Tower	32,595,000	12,161,000
(F) Total	137,316,000	51,231,000

* Base Year = 1975

Annual Average Derating 48.5 MW
Maximum Derating 82.5 MW

TABLE 5-11

INCREMENTAL REVENUE REQUIREMENTS ABOVE BASE PLANT
FOR FAN-ASSISTED NATURAL DRAFT COOLING TOWERS
AT INDIAN POINT UNIT NO. 3

DESCRIPTION OF EXPENSE	PRESENT WORTH REVENUE REQUIREMENTS 1981-2005*	ANNUAL LEVELIZED REVENUE REQUIREMENTS 1981-2005
(A) Maintenance and Other Operating Expenses	1,949,000	727,000
(B) Carrying Cost for Capital for Cooling Tower	55,702,000	20,782,000
(C) Cost of Replacing Deficient Energy (Average Derating)	24,163,000	9,015,000
(D) Carrying Cost of Capital for Replacement Capacity (Peak Derating)	16,031,000	5,981,000
(E) Replacement Energy for Plant Downtime to Cut-in Cooling Tower	32,595,000	12,161,000
(F) Total	130,440,000	48,666,000

* Base Year = 1975

Annual Average Derating	35.5 MW
Maximum Derating	79.5 MW

TABLE 5-12

CONSOLIDATED EDISON COMPANY OF NEW YORK

ESTIMATED COST OF CAPITAL

	CAPITALIZATION RATIO %	NOMINAL COST %	EFFECTIVE COST %
Debt	53	14.000	7.42
Preferred Stock	13	14.000	1.82
Common Stock	34	18.000	6.12
	100		15.36 rounded of to 15.375

TABLE 5-13

ANNUAL LEVELIZED CARRYING CHARGES

(As a percent of capital cost)

	Cooling Tower (At Indian Point No. 3)	Gas Turbine (At Indian Point)
Return	11.7	11.8
Depreciation	4.2	4.0
Federal Income Tax	2.1	2.8
Allowance for Replacements	.5	.5
Insurance	.3	.1
Property Taxes	2.2	2.2
Sub-total	21.0	21.4
Gross Revenue Taxes	1.3	1.4
Total Fixed Charges	22.3	22.8

6.0 ENVIRONMENTAL IMPACT OF ALTERNATIVE CLOSED-CYCLE COOLING SYSTEMS

Detailed analysis of the environmental effects of the natural draft wet cooling tower designed for Indian Point Unit No. 2 operating in conjunction with either a natural draft wet, linear mechanical draft wet, mechanical draft wet/dry, round mechanical draft wet, or fan-assisted natural draft wet cooling tower system for Indian Point Unit No. 3 have been conducted. These analyses included a comprehensive study of the effects of cooling tower system operations on air quality, an evaluation of the effect of drift on botany, toxicity anlaysis of tower blowdown, an analysis of noise emissions, an evaluation of radioactive releases, an assessment of effects on fish impingement and entrainment, and an investigation with regard to aesthetics and land use impacts.

Environmental impacts of a closed-cycle cooling tower system for Indian Point Unit No. 3, in conjunction with the previously selected natural draft wet tower for Indian Point Unit No. 2, were evaluated considering the following combinations of systems.

Case	Unit No. 2		Unit No. 3
(I)	Natural Draft Wet	&	Natural Draft Wet
(II)	Natural Draft Wet	&	Linear Mechanical Draft Wet
(III)	Natural Draft Wet	&	Mechanical Draft Wet/Dry
(IV)	Natural Draft Wet	&	Round Mechanical Draft Wet

(V) Natural Draft Wet & Fan-Assisted Natural Draft Wet

6.1 Air Quality Study Program

The cooling tower air quality study program was separated into distinct phases as shown on Figure 6-1. One phase consisted of ambient condition data acquisition including meteorology, salt concentration and deposition measurements and a botanical survey. Mathematical models were developed concurrently to predict the environmental impact of cooling tower airborne effluents. At the completion of the data acquisition phase, data were incorporated into the mathematical models to predict salt deposition and atmospheric concentration, fogging and icing potential and length of the visible plumes created by the cooling tower effluent. Results from the saline drift deposition study were in turn used to evaluate the botanical effects of drift.

6.1.1 Onsite Meteorological Program

The unique valley induced micrometeorological characteristics of the Indian Point site dictated the need for an extensive meteorological measurement program to describe the vertical structure of the atmosphere in which the cooling tower plume would be dispersed. An objective of this program was to determine the height at which prevailing winds predominate over valley induced winds. A 400 foot meteorological tower was erected 2650 feet south of the Indian Point nuclear generating units at an elevation of approximately 117 feet above MSL. Figures 6-2 and 6-3 illustrate the location of the meteorological tower with respect to the Indian Point nuclear facilities. Meteorological instrumentation on the tower enabled a climatology to be developed for the ambient air inlet and exhaust levels for the various natural draft and mechanical draft cooling tower designs. Higher level meteorological measurements consisting of tetroon, rocket and balloon soundings, were conducted at the site to further identify the vertical profiles of wind, temperature and humidity. Precipitation, visibility and solar radiation were also measured.

Specific instrumentation on or near the 400 foot tower, schematically shown on Figure 6-4, consisted of the following:

(a) Wind sensor: 33, 125, 280 and 400 foot AGL (above grade level).

(b) Ambient dry bulb temperature: 33 feet AGL.

(c) Dew point temperature: 33, 200 and 400 feet AGL.

(d) Temperature difference: 400-33 feet AGL; 200-33 feet AGL.

(e) Visibility: 33 feet AGL.

(f) Net radiometer: 33 feet AGL.

(g) Precipitation: Ground Level.

Parameters were recorded on continuous analog charts and reduced to mean hourly values. All instrumentation met sensitivity criteria established in NRC Regulatory Guide 1.23, and calibration procedures were consistent with NRC specifications.

The comprehensive field data acquisition program documented the characteristic meteorological parameters prevailing at the exit of the various cooling towers, thus permitting appropriate plume rise and diffusion calculation input parameters to be used in the modeling studies. These parameters also established ambient levels of moisture and visibility. Data collected on the tower indicate a valley wind regime, under light geostrophic conditions, extending from river level to approximately five hundred feet above river level. Prevailing wind characteristics dominate above the valley flow.

Onsite fog conditions were determined from simultaneous visibility measurements (made with a forward scatter meter) and relative humidity measurements (calculated from ambient air temperature and dew point temperature).

Fog is defined as a cloud based on or near the ground and observed subjectively. For the purpose of this evaluation, fog was defined as a coincidence of surface visibility less than 1500 feet and relative humidity in excess of 80 percent. The necessity of the instrumented fog measuring program was due to a lack of fog observations by weather observers in the vicinity of Indian Point. Use of the instrument correlation program eliminated the requirement of stationing an observer on site, on a round-the-clock basis, to report fog subjectively as is performed in the observation program of the National Weather Service. Measurements at Indian Point indicate less than 2 percent of the hours annually documented have conditions meeting the aforementioned classification for fog.

Data analysis of the meteorological program is presented in Reference 6-1.

6.1.2 Visible Plume Impact

Operation of closed cycle evaporative cooling systems result in continuous discharges of water vapor and saline droplets to the atmosphere. As a result of these effluents, a visible plume can develop.

A theoretical analysis is required to determine the magnitude and extent of the visible plume impact. Input parameters of pertinent meteorological parameters at ground level and the respective heights of the cooling tower were determined from the meteorological measurement program previously described.

At high wind speeds, coincident with high ambient relative humidity and low temperatures, a plume will generally appear as a white coherent elongated cloud and extend downwind several miles. During calm wind conditions plumes will rise vertically and condense into a cumulus type cloud above the cooling tower. For periods of large saturation deficit and moderate winds a plume will generally dissipate within several tower heights creating a short, wispy, fragmented appearance.

6.1.2.1 Physical Concepts of Moist Plume Dispersion Modeling

A warm plume will rise primarily due to the density differential of the plume with respect to the ambient air. Initial momentum will propel the plume upward; however, it is rapidly dissipated by turbulent mixing.

The rise of the moist plumes from cooling towers is similar to warm plumes in general. In addition to being at higher temperatures than the ambient air, cooling tower plumes contain large amounts of water vapor. Since water vapor is less dense compared to air at the same temperature, cooling tower plumes are buoyant.

The buoyancy of a cooling tower plume is quantitatively represented by a buoyancy factor F, including both sensible and latent heat. By definition (Briggs), the buoyancy factor F of a hot source is

$$F = Q_H g / (\pi C_p \rho T)$$

where T is the average ambient temperature. The quantity Q_H, which is defined as heat emission due to efflux stack gases is considered to be the sum of both sensible and latent heats:

$$Q_H = \pi R^2 W \rho_e [C_p (T_e - T) + \lambda (M_e - M_a)]$$

where R is the stack exit radius, W is the exit velocity, Te and T are exit and average ambient temperatures, ρ is the ambient air density, and, ρ_e and C are the gas density and specific heat at the exit temperature. The quantity λ is the heat of condensation, M_e and M_a are the mixing ratios of the plume at exit and that of ambient air respectively (in units of grams H_2O per gram of dry air).

Combining the above two equations and replacing ρ = MTo/VT and ρ_e=MTo/VoT (To = 273°k), the buoyancy factor F is simplified as

$$F = R^2 W g [(T_e - T)/T_e + \lambda (M_e - M_a)/(C_p T_e)]$$

This final formulation was included in the plume model.

Compared to mechanical draft cooling towers, the buoyancy factor of a natural draft cooling tower, having the same heat load, is significantly larger. This is because mechanical draft cooling towers consist of a large number of small separate cooling cells, arranged in either a linear or round formation, while a natural draft cooling tower combines all the effluent into a single exhaust stack. The plume from each of the mechanical draft cooling cells designed for Indian Point Unit No. 3 would carry approximately 3.5 percent of the total heat load rejected to the atmosphere.

Plume rise, based on Briggs' formula, is jointly proportional to F1/3, and Hs 2/3 and inversely proportional to the wind speed u, where F and Hs are, respectively, the buoyancy factor and the stack height. Based upon the design conditions, the buoyancy factors for each of the five types of cooling towers are determined hourly as a function of the ambient conditions. In the extreme case the plume rise from the natural draft cooling is approximately 5-6 times of that from a mechanical draft cooling tower for a constant wind speed.

As the cooling tower plume rises, the plume temperature is reduced due to entrainment and the excess water vapor begins to condense. The latent heat thus released causes the plume temperature to decrease at a slower rate than would a plume containing only non-condensibles. The plume moisture condenses into droplets, which tend to fall, thus depressing the upward motion of the plume. Gravity eventually neutralizes the buoyancy force as the plume reaches the ultimate height (the "effective stack height").

The downwind distance from the tower at which the plume rises to the ultimate height is found to be approximately ten stack heights . For a natural draft cooling tower, the ultimate plume height occurs approximately one mile downwind from the point of emission. In the case of the mechanical draft cooling towers, this distance is approximately 680 feet. For the fan-assisted natural draft and round mechanical draft cooling towers, this distance falls within that of the natural draft and linear mechanical draft cooling towers.

Because a natural draft cooling tower plume emanates from an orifice 310 feet in diameter, a point source assumption is not valid. The model therefore uses a virtual source approximation to characterize the existing plume. In the vicinity of the exit, the plume can be represented by a transverse jet model. In strong winds, when the wind speed exceeds 25 mph, the profile of the natural draft cooling tower tends to create aerodynamic downwash conditions which induce the effluent into the tower wake. The downwash effects are based on wind tunnel test data and are incorporated into the mathematical model. Details of the natural draft cooling tower model are included in Appendix A.

For a linear mechanical draft wet, mechanical draft wet/dry, or round mechanical draft wet cooling tower, the stack diameter is approximately 28-40 feet. A point source approximation is reasonably valid for each stack; however, in order to insure consistent results for every downwind distance including those which fall very close to the stack exit, a virtual source approximation is used.

At the tower exit, the distance between the edge of the adjoining plumes is nominally 12 feet. A short distance downwind from the point of discharge the plumes from all the cooling cells of either the mechanical wet or mechanical wet/dry towers will merge into a continuous plume with a base in excess of 1000 feet wide, for winds perpendicular to the cooling towers. Both round mechanical draft and fan-assisted natural draft cooling towers will probably produce plumes with a base width of approximately 600 feet. Narrow and dense plumes will be observed for winds parallel to the longitudinal line of the cells. (See Section 3.0 for arrangements of cooling towers).

A complete description of the linear mechanical draft wet and wet/dry, round mechanical draft wet and fan-assisted natural draft wet cooling tower models is included in Appendix B.

Variation of the terrain in the vicinity of Indian Point changes the relative ultimate height of the plume and thus increases the probability of tower induced fog. When the tower plume approaches a promontory higher than the plume itself, the path is governed by the aerodynamic processes and local micrometeorology. Because of the hilly terrain surrounding Indian Point, the mathematical models for the two types of natural draft and the three types of mechanical draft cooling towers have incorporated local topographic features (by reductions in local effective plume height).

6.1.3 Induced Fog and Icing

Excess moisture in the plume, whether as entrained droplets or vapor, can coalesce or condense, and, consequently, come into contact with the ground causing fog, or ice when deposited on the surface under freezing temperature conditions. Reduced visibility and/or icing would make highways, bridges, and railroads hazardous to travel. Navigation on the Hudson River would be hampered because of the resulting reduced visibility. Refer to Figure 6-10 for identifications of highways, bridges and railroads in the vicinity of Indian Point.

The probability of fogging and/or icing depends on the atmospheric dilution factor, rates of excess moisture and enthalpy emissions, the ambient temperature and relative humidity near the ground. Fog potential exists for a much larger area for a hyperbolic natural draft cooling tower than for mechanical draft towers; however, the probability of dense fog is greater from mechanical towers due to the lower effective stack height.

The cumulative effects of moist plumes, that is the induced fogging and icing, are presented below. Both are evaluated by mathematical modeling based on simultaneous operations of cooling towers at Unit No. 2 and Unit No. 3. For all cases a natural draft cooling tower is assumed to be operational for Unit No. 2. The effects of the cooling tower plume of the Unit No. 2 tower is combined with plumes from each of the five cooling towers postulated for Unit No. 3. The model calculations were based on the hourly on-site meteorological data for the full year period October 1973 through September, 1974 recorded by means of the 400 foot meteorological tower.

Generally, fogging and icing potentials are considered to exist when the moisture content in the plume-ambient air mixture near ground level is in a two-phase equilibrium (either vapor--liquid or vapor solid). The two-phase state is further distinguished by whether the predicted temperature of the plume ambient air mixture is above or below the freezing temperature. Above the freezing temperature the condensed moisture will exist as droplets which give rise to fogging potential. When the temperature is below freezing the condensed moisture can exist as ice particles or subcooled liquid depending upon a number of factors such as the number of neuclei in the air and the salinity of the liquid. The unstable subcooled condition will cease as soon as the condensed moisture precipitates on the ground or comes into contact with a solid surface, resulting in an ice formation.

Fogging and icing results for each case are briefly discussed in the following paragraphs. Detailed presentation is shown in Appendices A and B.

<u>CASE I: NATURAL DRAFT WET TOWERS OPERATING ON UNIT No. 2 AND UNIT No. 3</u>

This combination is calculated to produce only 3 hours of fogging per year. The induced fogging frequency from the proposed cooling towers would be small compared to natural fog occurrences which is less than 2 percent annually. Therefore, no significant ground level visibility hazard is expected to occur from the operation of two natural draft wet cooling towers.

Subfreezing temperature conditions which may potentially produce icing from cooling tower operations generally occur during the November through April period. No occurrences of icing are predicted to occur as a result of operation of the natural draft wet cooling towers. Analytical details and results are documented in Appendix A.

CASE II: NATURAL DRAFT WET TOWER ON UNIT No. 2 AND LINEAR MECHANICAL DRAFT WET TOWERS ON UNIT No. 3

The analysis for this case indicates that linear mechanical draft wet towers would produce a significant potential for fogging in the Indian Point vicinity. A total of 98 hours per year of fog would be induced by both towers in this case, with the mechanical wet towers on Unit No. 3 contributing 97 of the hours. The seasonal distribution due to the mechanical wet tower contribution is as follows:

Spring	--	39 hours
Summer	--	20 hours

Autumn	--	21 hours
Winter	--	17 hours
Annual	--	97 hours

Fogging may persist for several hours at a time.

Icing conditions are totally due to the wet linear mechanical draft cooling tower operation. Predictions indicate that icing will not occur in November; however, 20 hours of icing were predicted for December, 20 hours for January, 30 hours for February, 10 hours for March, and 3 hours for April. The annual icing occurrence is 83 hours.

CASE III: NATURAL DRAFT WET TOWER ON UNIT No. 2 AND MECHANICAL WET/DRY TOWERS ON UNIT No. 3

This case is calculated to produce only 1 hour of fogging per year and no icing occurrence. This environmental impact would be attributable solely to the operation of the natural draft wet cooling tower on Indian Point Unit No. 2. Operation of the mechanical-draft wet/dry cooling towers on Indian Point Unit No. 3 would practically eliminate any plume induced fogging and icing conditions.

CASE IV: NATURAL DRAFT WET TOWER ON UNIT No. 2 AND ROUND MECHANICAL WET TOWERS ON UNIT No. 3

In addition to the one hour of fog per year, induced by the natural draft cooling tower at Unit No. 2, the wet plume from the two round mechanical draft wet cooling towers for Unit No. 3 can induce additional hours of fog in each month of the year.

	Total Number Hours of Fog (Hours/Season)
Spring	15
Summer	2
Autumn	15
Winter	12
Annual	44

Icing is found to occur frequently in winter by the mathematical model analysis used in this study. There are a total of 22 hours of icing occurring in December, 22 hours in January, 30 hours in February, 10 hours in March, and 2 hours in April. The annual icing occurrence is 86 hours.

CASE V: NATURAL DRAFT WET TOWERS ON UNIT No. 2 AND FAN-ASSISTED NATURAL DRAFT WET TOWERS ON UNIT No. 3

Simultaneously operating the natural draft cooling tower on Unit No. 2 and the fan-assisted natural draft cooling towers on Unit No. 3 would cause considerable fogging and minimal icing. The plume from the natural draft wet tower on Unit No. 2 adds only one additional hour of fog per year, and no contributions in icing.

The seasonal occurrence of fog is given below:

	Total Occurrences Of Fog (Hour/Season)
Spring	10
Summer	5
Autumn	4
Winter	4
Annual	23

The plume induced icing is relatively insignificant. A total of 3 hours of icing produced in December, 3 hours in January, and 2 hours in February. The annual icing occurrence is 8 hours.

6.1.4 Drift and Salt Deposition

Drift is entrained water, in the form of small droplets, exiting from the top of a wet or a wet/dry cooling tower. When brackish water is used in evaporative cooling towers, sodium chloride and other dissolved salts in the drift may produce adverse effects on vegetation, structures, electrical insulators and associated equipment.

Until recently, manufacturers typically guaranteed drift rates from mechanical draft cooling towers to be less than 0.005 percent of the circulating water. During the past several years, however, manufacturer drift guarantees have ranged to as low as 0.002 percent. Limited tests made on a natural draft hyperbolic cooling tower at B. L. England Station indicate an average drift rate of less than 0.002 percent. In this study, a drift of 0.005 percent is used for all mechanical draft cooling towers, and 0.002 percent for conventional and fan-assisted natural draft cooling towers.

CASE I: Salt Deposition-Natural Draft Wet Cooling Towers For Unit No. 2 and Unit No. 3

A mathematical cooling tower diffusion model was developed to describe the history of representative drift droplets from the cooling tower exit to the area of impaction on the ground. Physical processes such as accretion, evaporation, settling and turbulent dispersion were incorporated in the model. Aerodynamic and topographic effects were also considered. The model utilized field data obtained in a cooperative program with the Tennessee Valley Authority from the natural draft cooling tower at the Paradise Plant, in Kentucky. A complete description of the drift model is included in Appendix A.

Calculations of monthly saline drift deposition from the natural draft cooling towers were based on a "two-cycles of concentration" operation using monthly average ambient (make-up water) salinities for each calculation. A drift rate of 0.002 percent of circulating water was used in the calculations. The salt drift effects of the cooling towers are computed utilizing historical data for Hudson River salinity. Based on a 45-year average of freshwater flow, the salinity in the river varies from below 100 ppm from March to May to a maximum of 3500 ppm in August. It remains approximately at 3500 ppm in September and October, declining to 1050 ppm in December. For the purpose of the prediction model, it was assumed that salinity in the basin will be controlled at twice the river salinity. The average monthly salinity selected for the various cooling tower analyses provides a more realistic assessment of expected drift droplet salinites.

The average monthly salinities and the maximum salinity discussed do not necessarily represent river conditions during which a potential for botanical injury is most likely to exist. The potential for botanical injury from saline drift is probably greatest during an extended period of zero or trace rainfall. Because no data is available on the joint probability of zero rainfall and river salinity, saline deposition was also calculated for a 30 day drought period coincident with a 90 percent probability river flow rate. River freshwater flow rate is equal to or less than 7,300 cfs at Indian Point during 90 percent of all years (Ref. 6-2). This river flow rate corresponds to a salinity of 3,500 ppm (Ref. 6-3) . Thus, 3,500 ppm represents a highly probable and realistic one-month average make-up water salinity for the study of botanical injury which is presented later in the text.

Salinity variations created by drought or excess freshwater run off would directly increase or decrease the salt deposition.

Based on the aforementioned salinities, the analytical results indicate that the maximum monthly values of salt deposition in winter are 510 $Kg/Km^2/mo$, spring 15 $Kg/Km^2/mo$, summer 250 $Kg/Km^2/mo$ and autumn 420 $Kg/Km^2/mo$. A maximum one hour salt deposition rate is calculated to be approximately 36 Kg/Km^2.

CASE II: Salt Deposition-Natural Draft Wet Cooling Tower For Unit No. 2 and Linear Mechanical Draft Wet Cooling Tower for Unit No. 3 Cooling

Monthly averages of cumulative saline deposit caused by entrained salt drift in the wet mechanical draft cooling tower plumes were calculated by a mathematical model. The model utilized on site data collected during the meteorological observation program of October 1973 to September 1974. Details of the model are shown in Appendix B. Results obtained from the operation of the natural draft wet tower for Unit No. 2 were superimposed on results from the mechanical wet tower for Unit No. 3. The combined effect due to operation of these two types of towers was obtained. Operation of mechanical draft wet towers, in conjunction with the natural draft wet cooling tower for the data analysis period, would produce maximum monthly salt deposition rates in winter of approximately 1200 $Kg/Km^2/Mo$, spring 50 $Kg/Km^2/Mo$, summer 2600 $Kg/Km^2/Mo$ and autumn 2700 $Kg/Km^2/Mo$. Maximum hourly values can range from 100 $Kg/Km^2/hr$ to 1000 $Kg/Km^2/hr$.

CASE III: Salt Deposition-Natural Draft Wet Cooling Tower for Unit No. 2 and Mechanical Draft Wet/Dry Cooling Tower for Unit No. 3

Salt deposition rates resulting from a natural draft wet tower operating on Unit No. 2 and the mechanical draft wet/dry for Unit No. 3 were analyzed using the respective model outputs described in Appendicies A and B. During the twelve month period of analysis, maximum monthly values of the predicted salt deposition rate in winter are approximately 840 $Kg/Km^2/Mo$, spring 50 $Kg/Km^2/Mo$, summer 1500 $Kg/Km^2/Mo$ and autumn 2700 $Kg/Km^2/Mo$. Maximum hourly values can range from 100 $kg/km^2/hr$ to 1000 $Kg/Km^2/hr$.

CASE IV: Salt Deposition Natural Draft Wet Cooling Tower for Unit No. 2 and Round Mechanical Draft Wet Cooling Towers For Unit No. 3

Salt deposition rates resulting from a natural draft wet tower at Unit No. 2 operating simultaneously with two round mechanical draft wet cooling towers at Unit No. 3 were analyzed. During the twelve month period of analysis, maximum monthly values of the predicted salt deposition rate in winter are approximately 1000 $Kg/Km^2/Mo.$, spring 200 $Kg/Km^2/Mo.$, summer 5,000 $Kg/Km^2/Mo.$, and autumn 5,000 $Kg/Km^2/Mo$. Maximum hourly values can range from 70 $Kg/Km^2/hr$ to 2000 $Kg/Km^2/hr$ depending on the average river salinity of the month and the ambient relative humidity.

CASE V: Salt Deposition-Natural Draft Wet Cooling Tower For Unit No. 2 and Fan Assisted Natural Draft Wet Cooling Towers For Unit No. 3

Salt deposition resulting from a natural draft wet cooling tower at Unit No. 2 operating simultaneously with two fan assisted natural draft cooling towers at Unit No. 3 were analyzed with the respective models described in Appendices A and B.

For this case the predicted maximum monthly values of salt deposition rate in winter are approximately 630 $Kg/Km^2/Mo$, spring 30 $Kg/Km^2/Mo.$, summer 1,000 $Kg/Km^2/Mo.$, and autumn 1,500 $Kg/Km^2/Mo.$ Maximum hourly values range from 16 $Kg/Km^2/hr$ to 620 $Kg/Km^2/hr$.

Figures 6-5 and 6-6 represent estimated monthly rates of salt depositions for (1) the two natural draft wet cooling towers (CASE I), and (2) the natural draft wet (Unit No. 2) and mechanical draft wet (Unit No. 3) towers (CASE II) for the month of August, respectively.

Similarly, Figures 6-7 and 6-8 illustrate the predicted monthly rate of salt depositions in August for natural draft wet cooling tower (Unit No. 2) in combination with mechanical draft wet/dry on Unit No. 3 (CASE III), and round wet mechanical tower on Unit 7 (CASE IV) respectively. Figure 6-9 represents the predicted monthly rate of salt deposits in August for a natural draft cooling tower on Unit No. 2 and two fan assisted natural draft wet cooling towers on Unit No. 3. All predictions were made based on the assumption that no precipitation occurred during the month. Discussions of the predictive models are given in Appendices A and B.

6.1.5 Ambient Salt Monitoring

To quantify the natural salt background in the Indian Point environs, field sampling devices were installed to measure the deposition and air concentration of ambient salt particles. High volume air samplers were used to collect airborne particulates on filter paper for subsequent sodium and chloride analysis. Deposition measurements were made with standard dustfall buckets. The field sampling network, consisting of five sampling sites for ambient salt(sodium chloride) in the vicintiy of Indian Point is shown in Figure 6-10. The measured values of sodium and chloride ions were not equivalent to the exact stoichiometric analysis of pure sodium chloride. This finding together with wind correlation analyses indicates the effects of the local industrial emissions. However, a conservative approach to establish an ambient salt base was selected so a comparative analysis to the predicted cooling tower contribution could be assessed. It was assumed that all the sodium measurements were attributable to salt particles. During the one-year sampling period, ambient salt concentrations (as sodium chloride) range from 0 to 6.15 ug/m^3 and averaged approximately 1.0 ug/m^3.

Total monthly ambient salt deposition during the period ranged from 38 to 366 $Kg/Km^2/Mo$, with a mean value of 160 $Kg/Km^2/Mo$. The sampling data are presented in Reference 6-1.

6.1.6 Effects of Cooling Tower Drift on Plants

Studies described herein were conducted to estimate the botanical impact of saline drift from simultaneous operation of a natural draft wet cooling tower at Unit No. 2 in combination with the following various cooling tower options for Unit No. 3:

- Case I - natural draft wet cooling tower for Unit No. 3
- Case II- mechanical draft wet cooling tower for Unit No. 3
- Case III- mechanical draft wet/dry cooling tower for Unit No. 3
- Case IV - round mechanical draft cooling tower for Unit No. 3
- Case V - Fan-Assisted Natural Draft Cooling Tower For Unit No. 3

The analysis for each option is based upon a botanical survey of the Indian Point vicinity, greenhouse studies which determined the toxicity of salt on the local plant species, and analytical models of drift deposition in the absence of rainfall. Meteorological conditions for the months of August and October have been used in the predictions of potential botanical injury for all cases. August and October are considered representative of the other summer and autumn months, respectively, during which a two week rainless period may occur.

(a) BOTANICAL SURVEY OF THE INDIAN POINT VICINITY -

A survey of the principal naturally occurring plants in the Indian Point vicinity was conducted during the summer of 1972 (Reference 6-4). The report describes the Indian Point vicinity as being characterized primarily by species of eastern deciduous hardwood. The regional vegetation is quite thick; canopies are dense. The understory vegetation is moderately dense. Both shade tolerant and intolerant species are well established in their respective niches. The vegetational cover of the area has attained the codominant climax stand maturity characteristic of eastern hardwood forest.

The dominant and codominant tree species found were Canadian hemlock (*Tsuga canadensis*), red oak (*Quercus rubra*), white oak (*Quercus alba*), chestnut oak (*Quercus prinus*), and shagbark hickory (*Carya ovata*). (Dominant species are defined as species of plant or plants which give the community its characteristic appearance or physiognomy and which may also control its structure. Codominant species are defined as species of plant or plants which, in combination, give the community its characteristic appearance or physiognomy and which may control its structure.) Associations of oak-hemlock and hickory-flowering dogwood are common. The understory relationships include second canopies of Canadian hemlock (*Tsuga canadensis*) and a ground canopy of witch hazel (*Hamamelis virginiana*).

(b) BOTANICAL TOXICITY OF COOLING TOWER DRIFT -

Laboratory experiments to determine botanical toxicity of salt deposit on vegetation typically found in the Indian Point area are described in Reference 6-5. These experiments were conducted under controlled climatic conditions in a greenhouse in which plants were exposed to controlled concentrations of saline aerosol similar to that expected in cooling tower drift. In these experiments, aerosols which were generated in liquid droplet form would deposit onto the test plants and onto an adjacent horizontal surface as either saline drops or cystals, depending on the relative humidity within the exposure chambers during each particular experiment. After exposure, the plants were periodically inspected for foliar lesions, occurrence of foliar lesions being considered symptomatic of plant injury.

The indigenous plants on which these saline toxicity experiments were conducted include red maple (*Acer rubrum*), witch hazel (*Hamamelis virginiana*), chestnut oak (*Quercus prinus*), black locust (*Robinia pseudoacacia*), white ash (*Fraxinus americana*), flowering dogwood (*Cornus florida*) eastern white pine (*Pinus strobus*) and Canadian hemlock (*Tsuga canadensis*). Ornamental trees, including mimosa (*Albizzia julibrissin rosea*), golden rain tree (*Koelreuteria paniculata*), and forsythia (*Forsythia *intermedia spectabilis*) were also exposed. The two most susceptible deciduous species among those tested were found to be the flowering dogwood (*Cornus florida*) and the white ash (*Fraxinus americana*), and the most susceptible coniferous species was Canadian hemlock (*Tsuga canadensis*).

At the lowest exposure rate tested (0.01 ug Cl / cm^2/min for 4 to 6 hour exposures as measured on the adjacent horizontal collecting plate), injury was reported on three species, hemlock, flowering dogwood, and white ash. This exposure rate is equivalent to net saline deposits of 4.0 ug/cm^2 to 5.9 ug/cm^2 expressed as NaCl. The lowest exposures were conducted at the relative humidity level which had been found to maximize the injury from saline aerosol. All hemlocks exhibited total loss of mature foliage, but dogwood and white ash exhibited a wide variation of tissue injury, primarily to immature foliage. The ED50 (level where 50% of exposed plants are expected to develop some leaf spotting or marginal necrosis) exposure for dogwood and ash, calculated from data in Reference 6-5, was found to be 12 ug NaCl/cm^2 and 17 ug NaCl/cm^2, respectively. Although a threshold dose was not absolutely determined, it can be assumed to be approximately equivalent to the level of the lowest dose experiments considering the conservative definition for "injury" in these experiments.

(c) PREDICTED BOTANICAL INJURY IN THE INDIAN POINT ENVIRONS -

Laboratory determined toxicity data in Reference 6-5 has been interpreted, as shown in Table 6-1, to present potential botanical injury for several saline deposit levels. In order to interpret the many greenhouse experiments, each of which was unique with respect to exposure rate, duration of exposure, or both, it was assumed that the observed effects were not dependent upon exposure rate, but were the result of total accumulated salt deposit. Table 15 of Appendix E, of the environmental analysis for Indian Point Unit No. 2, which represents the relationship between total salt deposit and the risk of injury on woody plant species, was prepared using this assumption. Table 15 lists, for each level of salt accumulation, the percentage of plants of each species that were observed to exhibit injury. The 95% confidence limit on the probability of injury, based upon the number of plants tested and the number responding, is also presented. By examining the data in Table 15, it was found that the percentage data could be grouped into four ranges of salt accumulation. These groupings were used to prepare Table 6.1.

The units of salt deposition in Table 6.1 have been expressed both as Cl^-, the unit of Table 15, Appendix E, and as NaCl, in order to show the relationship between the two units. The discription of potential injury are all based upon the statistical data presented in Table 15.

To avoid overstatement of injury, no injury was stated in Table 6.1 for salt deposit accumulations less than the lowest deposit tested during the greenhouse experiments (40 Kg/Km^2). Because the threshold for injury to hemlock has not been defined, it is possible that the area of potential injury to hemlock will be actually greater than estimated in this report.

Predictions of injury to foliage have not taken into account the assumed 160 $Kg/Km^2/mo$ natural salt deposition values which were based on data measured at Indian Point. An undetermined but probably significant portion of the natural saline deposit is associated with rainfall. Because the proportion of the natural saline deposit which is dry has not been fully quantified, the estimates of botanical injury have been based only on the dry saline deposit from settling of cooling tower drift particles.

Climate is an important variable which has been considered in developing predictions of possible botanical injury produced by saline drift from Indian Point cooling towers. Injury is more probable during late summer or autumn drought conditions because of the increased salinity of the river water which constitutes the cooling tower make-up. Also, during rainless periods, salt previously deposited on foliage is not washed off leaf surfaces. It is believed that toxic effects are associated with total salt accumulations on the leaves.

Climatological data for the New York area indicates the longest rainless period on record was 27 consecutive days, in September 1897. Precipitation data recorded at Dobbs Ferry, New York (approximately 19.0 miles south of Indian Point) indicates that there have been rainless periods as long as 24 days. Based on this data, it was determined that the respective probabilities of either 30 consecutive rainless days or 14 consecutive rainless days are .013 and .42 per year. It therefore appears that a 14 day rainless period is highly probable, and calculations of botanical injury are presented in this report for such 14 day rainless periods. During such periods, salt deposited would be approximately half that predicted in Figures 6-5 through 6-9 for August.

(d) BOTANICAL INJURY FOR CASE I: NATURAL DRAFT WET COOLING TOWER FOR UNIT No. 2; NATURAL DRAFT WET COOLING TOWER FOR UNIT No. 3

Figure 6-11 presents the approximate area of potential botanical injury predicted to result from cooling tower operation during a 2 week summer drought. Potential injury to all hemlock and 20% - 100% of the flowering dogwood and white ash is predicted in two regions of the eastern bank of the Hudson River, encompassing a total area of approximately 1.2 Km^2. The largest of these impact areas is approximately 1.0 Km^2 in size and is located in the community of Peekskill. The smaller impact area of approximately 0.2 Km^2 is located in Verplanck. An area of about 22 Km^2 of potential injury to all hemlock and to approximately 5% - 20% of the flowering dogwood and white ash extends approximately 2.0 Km south and 4.0 Km north of the Indian Point facility. The communities of Montrose, Buchanan, Verplanck and Peekskill, as well as Depew Park, Blue Mountain Reservation, Camp Smith and other sections of the New York State Military Reservation are wholly or partially within the impact area.

Similar analysis for a 2 week autumn drought indicated that a total area of about 1 Km^2 would be susceptible to potential injury to all hemlock and 20%-100% of the flowering dogwood and white ash, and a total area of about 9 Km^2 would be susceptible to potential injury to all hemlock and 5% - 20% of the flowering dogwood and white ash.

(e) BOTANICAL INJURY PREDICTED FOR CASE II - NATURAL DRAFT WET COOLING TOWER FOR UNIT No. 2; LINEAR MECHANICAL DRAFT WET COOLING TAOWER FOR UNIT No. 3

Figure 6-12 presents the approximate area of potential botanical injury predicted to result from cooling tower operation during a two-week summer drought. Potential injury to all hemlocks, and 20% - 100% of the flowering dogwood and white ash is predicted in an irregularly shaped area of about 14.4 Km^2 extending on both banks of the Hudson River to at least 4 Km northeast and southwest from Indian Point Unit No. 2. The communities of Montrose, Verplanck, Peekskill, Tompkins Cove, and Stony Point, aS well as Jones Point, Stony Point State Park, Georges Island Park, Palisades Interstate Park, and Fort Hill Park are located partially or completely within this impact area. Potential injury to all hemlock and 5%-20% of the flowering dogwood and white ash is predicted for areas of about 37 Km^2 of Montrose, Buchanan, Verplanck, Peekskill, Depew Park, Blue Mountain Reservation, and Palisades Interstate Park.

Analysis for a 2 week autumn drought showed that a region about 8.6 Km^2 would be vulnerable to potential injury to all hemlock and 20%-100% of the flowering dogwood and white ash, and a region about 28 Km^2 would be vulnerable to potential injury to all hemlock and 5% - 20% of the flowering dogwood and white ash.

(f) BOTANICAL INJURY PREDICTED FOR CASE III - NATURAL DRAFT WET COOLING TOWER FOR UNIT No. 2; MECHANICAL DRAFT WET/DRY TOWER FOR UNIT No. 3

Figure 6-13 presents the approximate area of potential botanical injury predicted to result from cooling tower operation during a two-week summer drought. Potential injury to all hemlock, and 20%-100% of the flowering dogwood and white ash is predicted in an irregularly shaped area of about 16.1 Km^2 (versus an area of about 10 Km^2 from an analysis for a two week autumn drought), extending on both banks of the Hudson River to at least 4 Km northeast and southwest from Indian Point Unit No. 2. The communities of Montrose, Verplanck, Buchanan, Peekskill, Tompkins Cove, and Stony Point, as well as Stony Point State Park, Palisades Interstate Park, Depew Park and Fort Hill Park are located partially or completely within this impact area. Potential injury to hemlock and 5%-20% of the flowering dogwood and white ash is predicted for regions with a total area of about 45 Km^2 (versus an area of about 28 Km^2 from an analysis for a two week autumn drought) of Montrose, Buchanan, Blue Mountain Reservation, Beecher Park, Camp Smith and the New York State Military Reservation, Jones Point and the Palisades Interstate Park.

(g) BOTANICAL INJURY PREDICTED FOR CASE IV: NATURAL DRAFT WET COOLING TOWER FOR UNIT No. 2; ROUND MECHANICAL DRAFT WET COOLING TOWER FOR UNIT No. 3

Figure 6-14 presents the approximate areas of potential botanical injury predicted to result from cooling tower operation and a two week summer drought. Potential injury to all hemlock, and 20%-100% of the flowering dogwood, and white ash is predicted in an irregularly shaped area of about 11 Km^2 extending on both banks of the Hudson river to at least 4.5 Km northeast and 3.5 Km southwest from Indian Point Unit No. 2. This maximum impact area includes Verplanck, Tomkins Cove, and parts of Buchanan, and Peekskill. Potential injury to all hemlock and 5%-100% of the white ash and flowering dogwood is predicted for parts of about 31 Km^2 of Montrose, Buchanan, Peekskill and Stony Point as well as parts of Georges Island Park, Blue Mountain Reservation, Depew Park, Fort Hill Park, Beecher Park, Camp Smith, Jones Point and Palisades Interstate Park.

For a two week autumn drought condition, potential injury to all hemlock and 20%-100% of the flowering dogwood and white ash is predicted in a region of about 5.6 Km^2, and potential injury to all hemlock and 5%-20% of the flowering dogwood and white ash is predicted in a region of about 12 Km^2.

(h) BOTANICAL INJURY PREDICTED FOR CASE V: NATURAL DRAFT WET COOLING TOWER FOR UNIT No. 2; FAN-ASSISTED NATURAL DRAFT TOWER FOR UNIT No. 3

Figure 6-15 presents the approximate areas of potential botanical injury predicted to result from cooling tower operation during a two-week summer drought. Potential injury to all hemlock, and 20-100% of the flowering dogwood, and white ash is predicted in an irregularly shaped area of about 1.7 Km^2 (versus an area of about 1.3 Km^2 from an analysis for a two week autumn drought), extending on both banks of the Hudson River to at least 3 Km northeast and 1.5 km southwest of the Indian Point Unit No. 2. This area of maximum impact extends inland less than 1 Km from the bank of the Hudson River, but include parts of Stony Point, Verplanck, and Peekskill. Potential injury to hemlock and 5%-20% of the flowering dogwood and white ash is predicted for parts of Verplanck, Peekskill, Tompkins Cove, Fort Hill and Depew Park. An area of about 24 Km^2 is predicted for a two week summer drought and an area of about 10 Km^2 is predicted for a two week autumn drought.

(i) CONCLUSIONS

Drift from a natural draft wet cooling tower or mechanical draft (wet or wet/dry) cooling tower or a fan assisted cooling tower at Unit No. 3 operating in the proposed configurations is not likely to injure most indigenous or cultivated plants found in the Indian Point area. A potential for some degree of botanical injury does exist for hemlock, white ash, and flowering dogwood.

It is evident that the extent of potential botanical injury will be dependent upon what cooling tower configuration is chosen for Unit No. 3. The degree and location of botanical injury will also be dependent upon the specific wind conditions during a drought period, the salinity of the Hudson River make-up water, and the number of successive days without rainfall. Climatological and hydrological data indicate that the conditions producing the greatest potential for injury are more likely to occur during July through October than in other months. Although the actual injury during each specific drought would vary, models based upon climatological data have estimated the most probable injury.

The area in which potentially significant injury to hemlock, flowering dogwood, and white ash is predicted generally extends northeast and southwest from the plant site regardless of cooling tower configuration. The following communities and parks are expected to be partially or completely affected by one or several of the alternative cooling tower configurations because of saline drift deposited during a 14 day late summer or autumn drought.

<u>Communities</u>:

Montrose

Verplanck

Buchanan

Peekskill

Tompkins Cove

Stony Point

<u>Parks/Reservations</u>:

Georges Island Park

Blue Mountain Reservation

Depew Park

Fort Hill Park

Beecher Park

New York State Military Reservation

Palisades Interstate Park

Hemlock appears to have a high potential for significant injury regardless of tower configuration. Not only is the foliage highly susceptible, but the most susceptible foliage is the mature growth. Because foliage maturation occurs simultaneously with increasing river salinity levels, the potential for hemlock injury during the late summer and autumn may be especially great.

Injury to hemlock may include crown defoliation within stands, or complete defoliation of free-standing trees within the areas where high saline deposition rates are predicted. Potential injury to flowering dogwood and white ash is expected to be less severe, but aesthetically displeasing. Injury to these two species will probably be limited to a varying of leaf spotting and marginal necrosis, resulting in some loss of fall coloration.

Potential injury to either hemlock or flowering dogwood is especially important because of the extrinsic value of these species. Fine specimens of hemlock representing an unquantifiable but undeniable aesthetic value are found in the Indian Point area. This aesthetic value will probably become more valuable as residential development increases within the surrounding areas. Flowering dogwood is universally recognized as an especially beautiful tree species. It is protected as an endangered and threatened native plant under Section 9-1503 of the New York State Environmental Conservation Law.

The two natural draft cooling tower configurations presented in Case I and V, result in the minimum areas of possible botanical injury. Operation of natural draft wet cooling towers at both units No. 2 and No. 3 (Case I) during a two week late summer or autumn drought has the potential to cause injury to all hemlock; and 20%-100% of the flowering dogwood and white ash within two residential areas on the east bank of the Hudson River: Verplanck and southern Peekskill. Injury to all hemlock and 5%-100% of the flowering dogwood and white ash, however, would extend from Montrose Point into the New York State Military Reservation and Depew Park.

Operation of a natural draft wet cooling tower at Unit No. 2 and a fan-assisted natural draft wet cooling tower at Unit No. 3 (Case V) during a two week late summer or autumn drought has the potential to cause injury to all hemlock and 20%-100% of the flowering dogwood and white ash within an area of less than 1 Km in width that extends along the east bank of the Hudson between Peekskill Bay and the Verplanck quarry. Small areas in Verplanck and Tompkins Cove (on the west bank of the Hudson River) are similarly affected. Injury to all hemlock and 5-20% of the flowering dogwood and white ash would be largely confined to the Peekskill area, including Fort Hill and Depew Parks.

In the improbable event of a 31 day drought, the general configuration of significant botanical impact delineated on the proceding pages remains the same: an area extending on both banks of the Hudson River generally northeast and southwest from the Indian Point plant site. The total area impacted, however, is predicted to increase. Botanical injury in areas such as the New York State Military Reservation (north of the plant site), Blue Mountain Reservation (east of the plant site) and the Palisades Interstate Park near Dunderburg Mountain (west of the plant site) would be more pronounced then during the 14 day drought conditions, previously described.

6.1.7 IMPACT OF COOLING TOWER DRIFT ON EXPOSED SURFACES

Saline drift from cooling tower operation may potentially cause detrimental effects to onsite electrical equipment and structures by increasing corrosion activity on exposed surfaces. Metal, concrete, wood, painted and asphalt surfaces in the vicinity of the cooling tower may all present a potential for saline damage. Analytical results previously stated indicate saline effects from an additional natural draft tower operating on Unit No. 3 would be relatively lower in magnitude compared to additive effects of either the mechanical draft wet, wet/dry, or fan-assisted natural draft wet cooling towers.

6.1.8 PLUME INTERACTION

The fossil fired superheater for Indian Point Unit No. 1 emits sulfur dioxide (0.3 percent sulfur fuel) through the 390 foot MSL stack. If a cooling tower plume were to interact with the sulfur dioxide plume, a slightly acidic sulfate mist might be produced. The potential for this interaction was evaluated by calculating the effective plume heights from the stack and the various cooling tower designs.

The ambient effect of plume interactions may be differentiated into two aspects: the ground level effect, and the interaction when the fossil plume is intercepted by cooling tower plumes at higher elevations.

Plume interactions at high elevations as well as on the ground level, depend upon the relative heights of the cooling towers and the fossil stack, the atmospheric stability, and the downwind distance from the source. The sum of the plume rise and the height of the structure is designated as the effective height. Utilizing a bent over plume model, based upon the plume rise equation of Briggs, the plume rise is calculated as

$$\Delta H = 1.6 F^{1/3} (10 H_s)^{2/3} / U$$

where F is the buoyancy factor and x is the downwind distance, and u is the wind speed. After the plume has travelled a distance x=10 Hs, where Hs is the structural height, the plume rise ΔH becomes constant. Any interactions or overlapping between the fossil and the cooling tower plumes can then be assessed by examining the separations of the vertical distances between the center lines of the plumes, and the vertical spread (σ_z)of the plumes.

The various parameters discussed above are summarized below. A wind speed of 9 mph (4.0 m/s) at ground level was used in the calculations. Atmospheric stability Pasquil class D (neutral) was used to obtain the results.

Based on the aforementioned parameters, a 426 meter MSL effective plume height is estimated for the superheater stack, 1320 meter MSL for natural draft towers, 203 meter MSL for linear mechanical draft wet and wet/dry towers, 210 meter MSL for round mechanical draft towers, and 596 meter MSL for fan-assisted natural draft towers.

Since the center lines of the plumes from the natural draft cooling towers (on Unit No. 2 and Unit No. 3) and that of the superheater stack are separated by a vertical distance of approximately 900 meters the possibility for these plumes to intercept or overlap is very remote under prevailing atmospheric conditions. For the three types of mechanical draft cooling towers, the vertical separations are in the order of 200 meters and plume overlapping would occur at a downwind distance of approximately 1 mile from the source.

6.1.9 CLIMATIC IMPACT

Additions of water vapor could potentially increase the local cloud cover thus reducing incoming solar radiation (sunlight) and the outgoing terrestrial radiation, thereby unbalancing the local thermal equilibrium of the valley.

In the Indian Point environs, conditions favorable for extensive plumes generally occur under an overcast cloud cover or nocturnal inversion. Therefore, microclimatic effects due to the operation of wet cooling towers are expected to be minimal.

6.2 BLOWDOWN

6.2.1 General Description

In closed-cycle operation, it is necessary to add makeup water to the circulating water to replace that lost by evaporation and drift. In addition, an amount of water must be continuously withdrawn from the cycle to limit the concentration levels of dissolved solids to prevent scale formation, corrosion, and general deterioration of cooling system structures. The withdrawn water is defined as "blowdown".

The relationship between blowdown, drift, evaporation, and salt concentration is:

(1) $B + D = E \times Cm/(Cb-Cm)$

Where:

B = Blowdown
D = Drift
E = Evaporation
Cm = Dissolved solids concentration; makeup
Cb = Dissolved solids concentration; blowdown

The relationship between makeup, blowdown, drift and evaporation is:

(2) $M = B + D + E$

Where

M = Makeup

The ratio Cb/Cm is termed "multiples of concentration", or "cycles of concentrations", and is equal to:

(3) $C = Cb/Cm = M/(B+D)$

Where:

C = multiples (or cycles) of concentration

The amount of blowdown is determined by the cycles of concentration selected for operation, as well as the drift and evaporation rates. The cycles of concentration maintained during operation are determined by the dissolved solids content of the makeup water. The dissolved solids content of Hudson River water available for Indian Point Unit No. 3 makeup is shown in Tables 6-2 and 6-3.

A two cycle concentration has been tentatively selected for the Indian Point Unit No. 3 closed cycle cooling system, when maximum river salinity is present, to prevent the circulating cooling water from acquiring scale forming tendencies. For the two cycle concentration operation (C = 2) the amount of blowdown approximately equals the evaporation, and is about half the total makeup rate. Estimated makeup and blowdown requirements are tabulated below.

	Linear & Round Mechanical Draft Cooling Towers	Conventional & Fan-Assisted Natural Draft Cooling Towers
Total Cooling water, (gpm)	600,000	600,000
Evaporation loss, (gpm)	15,000	15,000
Drift, gpm	30	12
Blowdown, gpm	14,970	14,988
Makeup, gpm	30,000	30,000

Drift loss assumptions expressed in terms of percent of circulating water for natural draft cooling tower is 0.002 and mechanical draft cooling tower is 0.005.

6.2 Chemical Analysis

Chemicals must be added to a closed cooling system to limit corrosion, scaling, microbiological fouling, and silting. Blowdown is released from the system to control solids buildup, and river water must be added to replace this loss. Necessary water treatment at Indian Point would include chlorination of the circulating water and possibly the addition of sulfuric acid to the circulating water on an intermittent basis. The addition of sulfuric acid to the circulating water increases the sulfate content while decreasing the alkalinity content. However, the total dissolved solids in the circulating water system remain approximately constant when sulfuric acid addition takes place. The acid addition would be regulated to maintain the circulating water within a pH range necessary to limit scale formation. To supplement chemical treatment, an Amertap condenser tube cleaning system is being considered.

A chlorine residual analyzer would continuously sample cooling tower blowdown to prevent "free available chlorine" in the blowdown from exceeding the limits mandated by the EPA Effluent Guidelines and Standards, Part 428. The EPA regulations provide for a maximum concentration of free available chlorine in the blowdown of 0.5 mg/1, and an average concentration of 0.2 mg/1.

The average concentration of free available chlorine in the blowdown is determined by calculating the total daily allowable quantity of free available chlorine discharged (based on an average concentration of 0.2 mg/1) and averaging this quantity over a 30 consecutive day period.

In addition to free available chlorine, the quantities of zinc, chromium, and phosphorous discharged from cooling tower blowdown will be in accordance with the following maximum and average limits mandated by the EPA Effluent Guidelines and Standards, Part 428.

	Maximum for any one day	Average of daily values for 30 consecutive days shall not exceed
Zinc	1.0 mg/l	1.0 mg/l
Chromium	0.2 mg/l	0.2 mg/l
Phosphorous	5.0 mg/l	5.0 mg/l

Chemical analyses of the blowdown are quantitatively presented in Tables 6.2 and 6.3: assuming maximum and average chemical concentrations of the Hudson River respectively. Under average concentrations, which are assumed to be representative of about nine months of the year, the necessary chemical treatment would include intermittent chlorination and a sulfuric acid feed in the order of 1.6 ppm (of 66° Baume concentration) to prevent scale formation. (see Table 6.4). Under maximum concentrations, which are assumed to occur during the three summer months, the necessary chemical treatment would include intermittent chlorination.

The blowdown could be diluted and discharged to the river through the discharge canal. The service water discharge from Indian Point Unit No. 2 plus the service water discharge from Indian Point Unit No. 3 (with or without the circulating water from Indian Point Unit No. 1) could be used for dilution. The resultant chemical concentrations at the point of discharge, as compared to ambient river water concentrations, are presented in Table 6-2, Table 6-3 and Table 6-4.

6.2.3 Bioassay

Bioassays have been conducted to determine the effects of cooling tower blowdown and chemical discharges from the plant on aquatic organisms endemic to the Hudson River. The tests assessed acute (short-term) and chronic (long-term) toxicities of these chemicals on striped bass and white perch under winter and summer conditions. Detailed descriptions of this program are reported in Reference 6-4.

The bioassays were performed in accordance with acceptable standard procedures. The continuous-flow bioassay technique was utilized to determine chemical concentrations that will kill 50 percent of the fish being tested in a given exposure time; in this case, 96 hours (LC50). The studies were extended to a period of 4 weeks for chronic mortality. The results (winter and summer) indicate that the projected chemical concentrations to be discharged into the Hudson River from Indian Point cooling tower (Units No. 2 & 3), and plant operation (Units No. 1, 2 and 3) are below the acute and chronic LC50 values and therefore are assumed to be environmentally safe.

Because of the complexity of the cooling tower blowdown and power plant chemical discharge combination, and the ambiguous complex mode of action of this slurry on striped bass and white perch, it was only possible to determine LC50 concentration ranges in most cases. However, some replicate testing in the summer did provide LC50's with 95 percent confidence limits.

Some interaction between the cooling tower blowdown and the plant chemical discharges was observed during the testing of the effects of combinations of the discharges. It appeared as a stress on the osmoregulatory (ionic balance mechanism) ability of the fish rather than in inherent biochemical or physiological toxicity.

Winter and summer acute and chronic bioassay results indicate that the 96-hour LC50 for striped bass was greater than 4 times the predicted maximum concentration for the Indian Point cooling tower blowdown and plant chemical discharge. For white perch the winter 96-hour LC50 was between 2.8 and 3.6 times, and the summer 96-hour LC50 was between 3.6 and 4.0 times the maximum discharge concentrations.

For both species the incipient LC50, the concentration at which lethal toxicity to the average fish ceases on chronic exposure, was also in the 2.8 - 3.6 times maximum discharge concentration range. Summer testing showed results similar to winter testing.

6.2.4 Thermal Discharge

The heat carried by blowdown from the cooling tower to the river can be found by taking the product of the flow rate of the blowdown and the enthalpy difference between blowdown and river water.

Since the flow rates of the blowdown of all cooling towers are practically identical, the thermal discharges from these cooling alternatives are assumed to be the same.

Temperature conditions assumed for the thermal calculations are listed below:

	Summer Conditions, °F	Remainder of Year Conditions, °F
Average Wet Bulb Temperature	65	35
Approach	20	30
Tower Effluent Temperature	85	65
Condenser Water Inlet Temperature	85	65
Average Rise Across Condenser	25	25
Condenser Water Outlet Temperature	110	90
Blowdown Temperature (same as tower effluent temperature)	85	65
Average River Temperature	74	49
Temperature Differences	11	16

On a yearly average basis, the temperature of the blowdown water exceeds the temperature of the river water by:

$$\frac{11 + (3 \times 16)}{4} = 14.8^{\circ}F$$

This 14.8°F temperature difference multiplied by a blowdown flow of about 7.5 million lb/hr (15,000 gpm) results in 111 million BTU/hr. This amount of heat, plus the service heat load of 140 million BTU/hr, is the total waste heat (251 million BTU/hr) dissipated to the river.

6.3 RADIOACTIVE RELEASE EVALUATION

Disposal of liquid radioactive wastes from the Indian Point site will be governed by the requirements of the Commission's regulations and the facility's Technical Specifications. The radioactive release evaluation given in Case 1 below is applicable with either Indian Point Unit No. 2 or 3 on closed-cycle cooling and Indian Point Unit No. 1 not operating. Case 2 presents release estimates with both Unit No. 2 and 3 on closed-cycle cooling and Unit No. 1 on once-through cooling. Case 3 presents release estimates with both Unit No. 2 and 3 on closed-cycle cooling and Unit No. 1 not operating. The estimated concentrations reported for the above three cases are conservative because the amount of radioactive generated was calculated assuming the maximum power available (3216 MWt).

CASE 1: Indian Point Unit No. 2 or 3 Operating And Indian Point Unit No. 1 Not Operating

As shown in Table 6-5, the estimated release of radionuclides from Indian Point Unit No. 2 or 3 is 608 curies per year of tritium and 9.58 curies per year of all other radionuclides; Table 6-6 shows the percentages of the 10 CFR 20 concentration limits of radionuclides that are estimated to be released to the Hudson River from Indian Point Unit No. 2 or 3. With closed-cycle cooling operation, the blowdown from the cooling system would be available for diluting the liquid radioactive effluents.

All radionuclide concentrations are within the requirements of 10 CFR 20.

CASE 2: Indian Point Units Nos. 1, 2, And 3 Operating

Simultaneous operation of Indian Point Units No. 1, 2 and 3 will alter the concentration of radionuclides that could be released to the river. The total radionuclide release as liquid radioactive effluents from the three units is the sum of the contribution from each unit, as shown in Table 6-5 for Unit No. 2 or 3 and in Table 6-7 for Unit No. 1. The estimated release of radionuclides from Indian Point Unit No. 1 is 752 curies per year of tritium and 1.19 curies per year of all other radionuclides. Unit No. 1 is assumed to continue using its once-through cooling system. Assuming an 80 percent capacity factor, Unit No. 1 cooling water volume is equivalent to approximately 5 X 10^{14} cubic centimerers per year. This volume of water plus the service water flow and the blowdown discharge from Units No. 2 and 3 will be available to dilute the total liquid radioactive effluents.

Table 6-8 presents the percentages of the allowable concentrations limits for Units No. 1, 2, and 3 according to 10 CFR 20 with Indian Point Unit No. 1 using once-through cooling and Indian Point Units No. 2 and 3 on closed-cycle cooling. All radionuclide concentrations are within the requirements of 10 CFR 20.

CASE 3: Indian Point Units No. 2 and 3 Operating On Closed-Cycle Cooling and Indian Point Unit No. 1 Not Operating

In this instance the total possible radionuclide release as liquid radioactive effluents from the Units No. 2 and 3 is the sum of the contribution from each unit. Estimated annual radioactive liquid releases from Indian Point Units No. 2 or 3 are listed in Table 6-5. The dilution flow will consist of Units No. 2 and 3 service water and cooling tower blowdown flow.

Table 6-9 lists the percentages of the allowable concentration limits according to 10 CFR 20 with Indian Point Units No. 1 not operating and Indian Point Unit No. 2 and 3 on closed-cycle cooling. All radionuclide concentrations are within the requirements of 10 CFR 20.

It is possible that a higher dilution flow will be available (greater than 100,000 gpm) instead of the 42,000 gpm and 84,000 gpm assumed for Cases 1 and 3 respectively). In this case, the calculated percentages of 10 CFR Part 20 limits would be correspondingly lower.

6.4 NOISE STUDY

Cooling tower environmental noise impact was assessed by estimating incremental community noise increase and resulting reaction caused by cooling tower construction and operation. Cooling tower operational noise emissions were compared to site boundary noise regulation limits to further assess noise impact.

The average day-night A-weighted sound level (Ldn) was selected as the parameter to evaluate changes in residential zone community noise caused by cooling tower construction and operation. Ldn is the energy equivalent A-weighted sound level which considers the time of day when the noise occurs, its temporal pattern and frequency spectrum. The United States Environmental Protection Agency (USEPA Report No. 550/9-74-004, March, 1974) suggested its use for evaluating community noise impact.

6.4.1 NOISE ASSESSMENT METHODOLOGY

Major elements of the cooling tower noise impact study include:

- Sample ambient community noise
- Develop ambient community average day-night A-weighted sound level (Ldn) contours

- Estimate cooling tower noise emissions for operation and construction

- Develop community Ldn noise contours of ambient noise that include cooling tower noise emissions

- Compute change in community area exposed to average day-night A-weighted sound levels above Ldn = 55 dB.

- Compare cooling tower noise emissions with site boundary regulation limits

- Estimate incremental change in community reaction to cooling tower noise emissions

6.4.2 AMBIENT COMMUNITY NOISE

A-weighted sound level measurements were made at thirteen locations in communities surrounding the proposed cooling tower site (Appendix C). Measurement locations were chosen to provide representative samples of daily community ambient noise in quiet residential and noisier commercial/industrial areas. Figure 6-16 shows ambient community Ldn noise contours which include estimated cooling tower noise emissions resulting from a natural draft cross-flow cooling tower operating at Indian Point Unit No. 2. Community noise is estimated to increase about the same amount due to noise of either natural draft counter-flow or cross-flow cooling towers installed at Unit No. 2. Noise contours shown on Figure 6-16 are used as the base case against which noise emissions resulting from operation of Indian Point Unit No. 3 cooling towers are compared.

6.4.3 COOLING TOWER OPERATIONAL NOISE EMISSIONS

Natural draft cooling tower noise emission prediction schemes were developed from measurements made around operating towers (Appendix C). Figures 6-17 and 6-18 show estimated A-weighted sound emission contours for cross-flow and counter-flow type natural draft cooling towers at Unit No. 3. Sound emission differences between cross-flow and counter-flow type natural draft towers are small and are not considered significant at the site studied.

Linear mechanical draft wet tower noise emissions were estimated using a scheme similar to those previously published, and verified by field measurements (Appendix C). Estimated linear mechanical draft wet cooling tower noise emission contours are shown in Figure 6-19.

Linear mechanical draft wet/dry cooling tower noise emissions were estimated to be similar to and about 3 db(A) higher than linear mehcanical draft wet cooling towers (Appendix C). Estimated A-weighted sound emission contours from linear mechanical draft wet/dry cooling towers are shown in Figure 6-20.

Sound attenuation due to acoustic shielding by local topography and existing plant structures, and excess atmospheric sound absorption have been included in the noise emission estimates for the natural draft and linear mechanical draft cooling towers.

Because cooling tower noise is continuous, A-weighted noise contours shown in Figures 6-17, 6-18, 6-19 and 6-20 can be converted to Ldn noise contours by adding 6 dB to A-weighted values (Appendix C). Figures 6-21, 6-22, 6-23 and 6-24 show, respectively, estimated natural draft cross-flow and counter-flow, and linear mechanical draft wet and wet/dry cooling tower Ldn noise emission contours at Indian Point No. 3.

Because round mechanical draft wet cooling towers are expected to use fans that are similar to those used on linear mechanical draft cooling towers, the noise emissions are expected to be similar in level and character to the noise emissions from linear mechanical draft wet cooling towers.

Fan-assisted natural draft wet towers use fans which are positioned around the tower base, therefore, noise emissions are expected to be directed outward from the base as opposed to mechanical draft cooling towers which direct noise upward. In the absence of substantive published or vendor far-field sound level data, fan-assisted natural draft wet tower noise emissions could be expected to be at least as loud as, or 5-10 dB(A) higher than those from linear mechanical draft cooling towers.

Measurements of noise from this type of tower have not been made because none are operational in this country.

6.4.4 COOLING TOWER CONSTRUCTION NOISE EMISSIONS

Cooling tower construction activity noise emissions were estimated using published construction equipment noise emission data for the type and number of vehicles and devices used on-site for site preparation and tower construction (Appendix C). Analysis showed that on-site construction noise is not significant; however, construction vehicle traffic occuring off -site is significant. Natural draft cooling tower off-site construction vehicle activity is estimated to be at its maximum for about one year; whereas linear mechanical draft cooling tower off-site construction vehicle activity is estimated to be at its maximum for about 1/2 year.

Round mechanical draft wet cooling tower construction noise is expected to be similar to the level and duration of linear mechanical draft cooling tower construction noise. Fan-assisted natural draft cooling tower construction noise is expected to be most similar to, and perhaps slightly less than, natural draft cooling tower construction noise.

6.4.5 COMMUNITY NOISE WITH UNIT No. 3 COOLING TOWER NOISE OPERATING

Community noise contours were developed to show estimated community noise with the added noise emissions estimated to be caused by Unit No. 3 cooling tower operation and construction (Appendix C).

Cross-flow and counter-flow natural draft, linear mechanical draft wet and mechanical draft wet/dry cooling tower operational noise emission contours shown on Figures 6-21, 6-22, 6-23, and 6-24 were added to the ambient community Ldn noise contours (which include a natural draft cooling tower operating at Unit No. 2) shown on Figure 6-16. Figures 6-25,6-26, 6-27, and 6-28 show Ldn community noise contours combining the operation of these Unit No. 3 cooling towers with the Unit No. 2 cooling towers.

Figure 6-29 shows Ldn community noise contours for off-site construction vehicle activity, that would be expected to occur for about 1/2 or 1 year, depending upon the type of cooling tower built.

Operation and construction of round mechanical wet and fan assisted natural draft cooling towers are expected to increase community noise to levels similar to those estimated in subsections 6.4.3 and 6.4.4, where comparisons were made to natural draft and linear mechanical type cooling towers.

6.4.6 COMMUNITY AREA EXPOSED TO NOISE LEVELS OF Ldn GREATER THAN 55 dBA

Estimates of the amount of residentially zoned land area surrounding the plant exposed to different average day-night sound levels, with and without Unit No. 3 cooling towers, were made (Appendix C investigated natural draft, linear mechanical draft wet and mechanical draft wet/dry towers). Summarized on Table 6-10 are residential land areas exposed to average day-night sound levels greater than Ldn = 55 dB and the increase estimated to be caused by Unit No. 3 cooling tower operation and construction.

Since it is unlikely that the Unit No. 2 cooling tower will be operating during the Unit No. 3 excavation period, evaluation of increased community noise was limited to comparison with present community noise levels.

6.4.7 COMPARISON OF COOLING TOWER NOISE EMISSIONS WITH SITE BOUNDARY REGULATION LIMITS

The Village of Buchanan Zoning Code has established property line sound level limits which are equivalent to 48 dB(A) at residential and non-residential zones. Figures 6-17, 6-18, 6-19 and 6-20 show A-weighted cooling tower operational noise emissions (Appendix C, for natural draft, linear mechanical draft wet and mechanical draft wet/dry cooling towers).

Unit No. 3 natural draft or linear mechanical cooling tower operational noise emissions in combination with those from the Unit No. 2 cooling tower are not expected to exceed the regulation limits at residential zones. In non/residential commercial/industrial zones along Broadway and the parkland north of the facility, noise emitted by the combination by natural draft or linear mechanical cooling towers and the Unit No. 2 natural draft cooling tower is estimated to exceed code limits by as much as 7 dB in certain octave bands.

At the southern property line which is adjacient to an industrial zone used as a quarry, the maximum sound levels due to Unit No. 3 cooling towers are; 66 dB(A) for cross-flow or counter-flow natural draft, 72 dB(A) for linear mechanical/wet and 76 dB(A) for linear mechanical wet/dry.

Operation of round mechanical draft wet cooling towers is expected to produce property line sound levels comparable to linear mechanical draft wet cooling towers. Property line sound levels emitted by fan assisted natural draft cooling towers could be expected to be at least as loud as, or 5 to 10 dB(A) noisier than linear mechanical draft cooling towers thereby exceeding property line noise limits in some non-residential zones and possibly in the residential zones near the intersection of Broadway and Bleakley Avenue.

6.4.8 EXPECTED COMMUNITY REACTION TO NOISE

Residential community reaction to a new noise intrusion was gaged by estimating the expected group response to change in average day-night A-weighted sound levels as suggested by the USEPA. Increasing the residential area noise levels above Ldn = 55 dB to 60 dB may result in increased community dissatisfaction as shown in Figure 6-30. Residential community noise intrusions above Ldn = 60 dB may be expected to cause group "complaints or threats of legal action" (refer to USEPA Report No. 550/8-73-002, July 1973).

Unit No. 3 natural draft cooling tower are estimated to cause no additional increase in community group reaction to sound levels greater than Ldn = 60 dB. Noise emitted by Unit No. 3 mechanical draft cooling towers during operation would be expected to cause an additional 2.8 to 4.0 acres of residential land to be exposed to sound levels greater than Ldn = 60 dB whereby "complaints or threats of legal action might be expected". Fan assisted natural draft cooling towers are expected to cause an additional area, greater than 4 acres, to be exposed to sound levels greater than Ldn = 60 dB.

Vehicle traffic on Bleakley Avenue and Route 9 due to the excavation stage of construction of Unit No. 3 cooling towers will result in an additional 89 acres of residential land to be exposed to sound levels exceeding Ldn = 60 for about 1/2 to one year.

6.5 INDIAN POINT SITE PLANNING AND REGIONAL LAND USE

6.5.1 Conclusions

Construction of the Indian Point Unit No. 3 natural draft hyperbolic cooling tower will produce significant site planning and regional land use impacts. These impacts, which will magnify and reinforce those predicted to result from construction of the Unit No. 2 hyperbolic tower, are summarized below:

1. Tower Size: The hyperbolic tower structure's great bulk and towering height will impact negatively on areas surrounding Indian Point.
2. Tower Plume: Depending on atmospheric conditions, the cooling tower's plume will be visible from many areas outside the tower structure's viewshed. Because of its great height, the tower's plume gives the cooling tower a dynamic, industrial aspect.
3. Site Planning Goals: Cooling towers soaring above the highest nearby hills would void site planning goals to blend the generating station with its surroundings. Removing about 1,000 feet of forested shoreline background, in order to construct the Unit No. 3 tower, would reinforce this condition.
4. Impact on Land Uses and Real Estate Values: It is probable the negative visual/aesthetic impacts of large hyberbolic cooling towers at Indian Point, together with a potential damage to vegetation from

salt drift, would reduce the values of surrounding non-industrial/commercial land uses.

6.5.2 The Indian Point Site

Indian Point is located on the east bank of the Hudson River about 30 miles north of New York City in the Village of Buchanan. The site is 239 acres in area, and is zoned medium density(M-D) industrial use. About 35 acres have been permanently modified for generating station and auxiliary facilities. Auxiliary facilities present on the site include a meteorological tower, a nuclear training simulator, a visitors center, tankage, a service/storage area, overhead and underground transmission lines and transmission towers. Across Broadway is the Buchanan Substation and a gas turbine facility. Access to the site is from the east via a plant entrance road leading from the intersection of Broadway and Bleakley Avenue.

Presently, with Indian Point Unit No. 2 complete, and Indian Point Unit No. 3 recently completed,the site is still largely utilized for temporary construction facilities such as trailers, material laydown areas, construction parking and temporary roadways. Such activities have passed their peak now that major construction activities are declining.

Major elements of the three unit station include domed containments, rectilinear turbine buildings and miscellaneous structures and tanks. Immediately bordering the generating station to the north, south and east is rising ground covered by second generation woodland. The west boundary is defined by the Hudson River, and approximately 4,000 feet of the Indian Point site fronts on the river.

6.5.3 The Areas Surrounding Indian Point

Bordering Indian Point immediately to the north is a yeast processing plant (zoned M-Z in Peekskill), and to the south a gypsum wallboard factory and Con Edisons Verplanck property (zoned M-D in Cortland). The residential communities of Buchanan, Montrose, Peekskill, Stony Point, Tompkins Cove and Peekskill surround the Indian Point Site. Peekskill is the largest with a population of 19,800. Across the Hudson River are the Lovett and Bowline fossil-fuel power plants, located about 0.5 and 5 miles south of Indian Point, respectively. Within a 10 mile radius of Indian Point land uses are predominantly residential (single family dwellings). There are also significant recreational uses and open space areas including:

Blue Mountain Reservation

Depew Park

Fort Hill Park

New York State Military Reservation

Palisades Interstate Park

Georges Island Park

Beecher Park

Other uses of land in the surrounding area are stone quarries and water reservoirs.

6.5.4 Unit No. 3 Cooling Tower Construction: Effects on Comprehensive Site Planning and Development

Con Edison has sold Indian Point Unit No. 3 and a large parcel of the Indian Point site to the Power Authority of the State of New York (PASNY). This transaction will require revision of prior site planning. A new comprehensive site plan has been started, and this plan retains many of the basic design parameters that guided development of the previous plan. These include:

a. Preservation, restoration, and reinforcement of the rural wooded character that once predominated at Indian Point.

b. Recreational development of forested areas north and east of the visitors center as a natural resource to be used and enjoyed by both the visiting public and station personnel.

c. Development of a phased landscaping plan to restore areas of the Indian Point site spoiled by contractors during the various construction phases.

d. Reinforcement of wooded areas at site boundaries, including the shoreline, to act as acoustical and visual buffer zones.

Each of the two cooling tower systems consists of three major elements: (1) a tower/basin, (2) pumps and (3) connecting piping. Auxiliary cooling tower facilities include underground power supply lines and access roads.

Addition of the Unit No. 3 natural draft cooling tower system would expand the total area now utilized for the three-unit generating station (including auxiliary facilities and the Unit No. 2 cooling tower) from 51 to 67 acres -- or to about 28% of the total 239 acre Indian Point site.

During the tower construction phase there will be a great deal of additional traffic at the site. This traffic will be routed so as to reduce possible vehicular clogging on and off the site.

Construction activities will also require appropriate and careful consideration of the following:

a. Modifications to the security arrangements now in effect at Indian Point;

b. Precautions to prevent river silting;

c. Reforestation to replace wooded areas that must be removed in order to construction the Unit No. 3 tower.

6.5.5 Visual/Aesthetic Impacts of the Unit No. 3 Cooling Tower on the Hudson River Valley Region

Construction of the Unit No. 3 cooling tower at Indian Point will produce three general visual/aesthetic impacts.

The first results from altering the existing topography and eliminating 1,000 feet of forested shoreline background in order to construct the Unit No. 3 tower. These alterations essentially complete a continuing transformation of the natural shoreline along the Indian Point promontory. Verplanck quarry activities, previous Hudson River Day Line operations and the construction of three nuclear generating units have each successively altered the natural shoreline. Additional adverse visual effects, predicted to result from construction of the Unit No. 3 cooling tower, will probably be most pronounced in the areas immediately west of Indian Point.

The second visual impact predicted as a result of constructing hyperbolic natural draft cooling towers is that due to their great bulk and height. Such towers would be the highest structures along the Hudson River from New York City to the Albany Mall. Each tower would be as high as a 45 story office building and would be 200 feet higher than the Unit No. 1 stack. A football field could be placed atop each of the towers.

The third visual impact is that of the tower's plume. The geometry of a hyperbolic tower is essentially aesthetically pleasing, However, when atmospheric conditions are conducive, a large, billowing plume occurs, the visual impact of which would be out of character with the rural/suburban character of the Hudson River environs. Because of its great rise, under certain conditions, a tower plume would visually impact on much more of the surrounding region than would the tower structure itself.

6.5.6 Quantifying Regional Visual/Aesthetic Impacts

In order to quantify how visible the Unit No. 3 hyperbolic natural draft cooling tower will be from the surrounding region, Con Edison has made a sight-line/population analysis of the areas within a 10 mile radius of Indian Point. Results are graphically indicated on Figure 6-31 titled "Viewshed Map."

To construct the viewshed map, a closely spaced series of radial, vertical sections emanating from the cooling tower were drawn. Each section includes the terrain profile within ten miles of the cooling tower and a reference elevation which is the elevation of the top of the Unit No. 3 tower. Sightlines were drawn on each vertical section from the reference elevation to ridges of land forms that would block visibility of the cooling tower beyond, and the lines of intersection of sight-lines and ridges were then plotted on a base map. If the sight-lines from the top of the cooling tower are thought of as light rays, the surfaces of land and water forms illuminated would be the viewshed area (light areas on Figure 6-32), while the areas from which the tower cannot be seen would be in "shadow" (shaded areas on Figure 6-32).

Estimated resident viewer populations, within a 10 mile radius of Indian Point, were added to the light areas (Unit No. 3 viewshed of Figure 6-31). Population estimates were based on the population projections for 1980, reported in the Final Safety Analysis Report (FSAR) for Indian Point Unit No. 3 (IP3 FSAR). The "Specified Population Pojected for the Year 1980" is in Table 5, page 2.4.P-15 of Supplement 7 to the IP3 FSAR prepared in July 1972.

Tabulated results of the line-of-sight/population study indicate the Unit No. 3 cooling tower would be visible to 27% of the estimated 1980 population living within a 10 mile radius of Indian Point - or to 22,000 of a total of 81,700 residents. Determination of the Unit No. 3 tower's visual impact on transient populations traveling through the Indian Point region - via automobile, rail, boat or air - was not included in the Con

Edison analysis. Also, modifications for seasonal deciduous foliage variations were not made.

To further study regional visual/aesthetic tower effects, Con Edison has made a photographic study of how two natural draft cooling tower structures would visually impact on surrounding viewshed areas. Five photographs were taken from different vantage points within the viewshed, and tower structures (without plumes) then simulated on them. Towers used in this photographic study may be slightly smaller than the final designs for Units No. 2 and 3 cooling towers. However, the results would be valid for larger towers as well, and these are summarized in Table 6-9. No other evaluation of the photographs taken has been made. However, Table 6-9 does indicate the many visual variables affecting how large cooling tower structures would be perceived in the surrounding viewshed. Depending on the vantage point, and recognizing the subjective quality of aesthetic judgments, one's perception of large cooling tower structures is seen to vary considerably depending on how, when and where the tower structures are viewed; on atmospheric conditions; and on distances to viewing points.

6.6 Fish Impingement or Entrapment at the Intake Structure

The closed cycle cooling system for Indian Point Unit No. 3 will have a make-up water flow of 30,000 gpm which will be withdrawn from the existing intake structure as described in subsection 3.6.

The flow rate and intake velocities of the service water and make-up water system at Indian Point Unit No. 3 is very low compared to the existing circulating water flow rates and velocities. Based on experiments and operating experience with reduced flow and reduced intake velocities, and on observations of the service water and make-up water system at Unit No. 2, the fish impingement rate at the service water and make-up water system of Unit No. 3 is expected to be negligible.

6.7 Entrainment of Aquatic Life in the Cooling System

The service water and make-up water system will entrain organisms that pass through the 3/8 in. square mesh screens at the intakes. Bacteria, phytoplankton, zooplankton and the larval and juvenile stages of fishes are the kinds of organisms which will be commonly entrained.

The entrainment of these forms is dependent upon their seasonal occurrence in the vicinity of the plant, which is in turn dependent upon the physical and chemical conditions of the estuary. Through field sampling and laboratory tests at Indian Point, Con Edison has investigated the effect of entrainment in the once-through cooling system on these forms and the effect on their populations in the estuary. Those individuals which are pumped through the service water system (30,000 gpm) will be returned to the estuary via the discharge canal system. The entrainment studies to date have not attempted to differentiate between the effect of service water passage and condenser passage on these forms; however, for the purpose of this analysis the effects are assumed to be the same. The service water requirements are a fraction of the water requirements of the once through cooling system (840,000 gpm). Therefore, based on the assumption of comparable mortality between the two systems, entrainment impacts on the river populations of primary producers and consumers with just the service water system operating will be significantly reduced below the impacts which might occur with the once through cooling system also in operation.

The primary producers and consumers entrained in the closed-cycle cooling system will be exposed to severe stresses of elevated temperature, turbulence and chemicals. Although there is very little information on the survival of aquatic life in a closed-cycle cooling system, it is assumed that all organisms entrained will be killed, due to the harshness of this environment.

Field sampling in the estuary to assess the effect of once-through cooling indicates that because of the wide distribution of these forms and their rapid reproductive rate, the loss of organisms occurring in the service water system and the condenser cooling system will probably not have a significant adverse effect on their populations.

Striped bass eggs and larvae will be entrained into the service water system and the make-up water system during and following the spawning season. Due to the severe stresses in the condenser cooling system (closed cycle mode), 100% mortality of the eggs and larvae passing through this system is expected; however, due to the greatly reduced flow rate compared to the open cycle mode, the effect of the closed cycle cooling system at Unit No. 3 is expected to be considerably less than that of the open cycle system. In addition, the low flow rate and low intake velocity of the closed cycle mode will permit a greater percentage of the late larvae and early juveniles to avoid the intakes than in the open cycle mode, and result in greater reductions of impacts. Based on the above discussion, Con Edison feels that the impact of entrainment due to closed-cycle operation of Units No. 2 and 3, on the striped bass population will be negligible.

6.8 Additional Oil Consumption for Make-Up Generation

Operation of a cooling tower for Unit No. 3 would necessitate substitute power generation for two reasons. The first power generation substitution would be during the downtime required to tie the cooling tower into the existing cooling system. The second substitution would be on account of derating of the net electrical output because of a thermodynamic penalty to the steam turbine due to higher turbine backpressure associated with closed-cycle operation, and additional plant auxiliary power use required for operation of a closed-cycle cooling system. Therefore, operation of a cooling tower for Unit No. 3 will have a detrimental effect on the conservation of oil.

The downtime to tie-in the cooling tower is estimated at seven months. Since two months are required annually for maintenance and refueling, only a five-month downtime has been used for this evaluation. An estimated 3 million megawatthours of nuclear generation from Unit No. 3 would then be lost as a result of the five-month forced outage. Based on an economic dispatch model of the Consolidated Edison system, the make-up generation would be made up mainly by fossil fuel-fired units and gas turbines. This replacement generation would consume about 4,400,000 barrels of residual oil and 809,000 barrels of distillate oil.

Moreover, the annual average derating of Unit No. 3 would result in an annual increase in residual oil consumption for make-up generation units. Assuming that this replacement energy is supplied by the base load fossil fuel-fired units, it is estimated that annual residual oil consumption would be increased by about 381,000 barrels for natural draft cooling tower, 552,000 barrels for linear mechanical draft wet, 564,000 barrels for mechanical draft wet/dry, 552,000 barrels for round mechanical draft wet, and 403,000 barrels for fan-assisted natural draft cooling towers.

The above additional oil consumption could be almost doubled if Unit No. 2 is also operated with a closed-cycle cooling system.

REFERENCES

6.1 York Research Corporation, "Meteorological Ambient Salt Studies and Upper Air Studies at Indian Point Station, Buchanan, New York," October, 1974.

6.2 Con Edison Indian Point Unit No. 2 Environmental Report. Appendix K (Quirk, Lawler & Matusky Report, "Effect of Indian Point Cooling Water Discharge on Hudson River Temperature Distribution," January 1968).

6.3 Testimony of John P. Lawler, "The Effect of Indian Point Units 1 & 2 Cooling Tower Discharge on Hudson River Temperature Distribution," April 5, 1972 (AEC Docket No. 50-247)

6.4 Dames and Moore, "Vegetation Survey of the Indian Point Environs," March, 1973.

6.5 Boyce Thompson Institute, "Effects of Aerosol Drift Produced by a Cooling Tower at Indian Ooint Generating Station on Native and Cultivated Flora in the rea," October, 1974.

TABLE 6-1

POTENTIAL BOTANICAL INJURY AS A
FUNCTION OF TOTAL SALINE DEPOSIT ON FOLIAGE

Salt Accumulation *		Potential Injury
Kg(NaCl)Km^{-2}	ug(Cl^{-})cm^{-2}	
0-40	0-2.4	No injury
40-100	2.4-6.0	All hemlocks injured; 5%-20% of dogwood and white ash experience slight leaf spotting and some loss of fall color.
100-600	6.0-36.0	All hemlocks injured; 20%-100% of dogwood and white ash injured.
>600	>36.0	All hemlocks, white ash, and dogwood injured; 20%-80% of silk trees, forsythia, chestnut oak, black locust, white pine, red pine, red maple injured

* Saline deposit on foliage refers to that deposit measured on a level surface.

TABLE 6-2

DISSOLVED SOLIDS CONTENT OF BLOWDOWN
BASED ON MAXIMUM VALUES OF HUDSON RIVER CHEMICAL COMPOSITION
(BLOWDOWN RATE = 15,000 gpm)

Chemical Constituent	Hudson River	Blowdown - Two Concentrations (No Dilution)	Blowdown - 2 concentrations (diluted in 30,000 gpm service water flow from IP#3 and 30,000 gpm service water flow from IP#2)	Blowdown - 2 concentrations (Diluted in 30,000 gpm service water flow from IP#3, 30,000 gpm service water flow from IP#2 and 318,000 gpm circulating water from IP#1)
Calcium	82	164	109	89
Magnesium	184	368	245	198
Sodium	1700	3400	2267	1825
Potassium	60	120	80	64
Bicarbonate	82	164	109	88
Chloride	3020	6040	4027	3242
Sulfate	420	840	560	451
Silica	4	8	5	4

TABLE 6-3

DISSOLVED SOLIDS CONTENT OF BLOWDOWN
BASED ON AVERAGE VALUES OF HUDSON RIVER CHEMICAL COMPOSITION
(BLOWDOWN RATE = 15,000 gpm)

Chemical Constituent	Hudson River	Blowdown - Two Concentrations (No dilution)	Blowdown - 2 concentrations (diluted in 30,000 gpm service water flow from IP #3 and 30,000 gpm service water flow from IP#2)	Blowdown - 2 concentrations (Diluted in 30,000 gpm service water flow from IP#3, 30,000 gpm service water flow from IP#2 and 318,000 gpm circulating water from IP#1)
Calcium	36	72	48	39
Magnesium	46	92	61	49
Sodium	40	80	53	43
Potassium	17	34	23	18
Bicarbonate	67	134	89	72
Chloride	74	148	99	79
Sulfate	127	254	169	136
Silica	-	-	-	-

TABLE 6-4

DISSOLVED SOLIDS CONTENT OF BLOWDOWN
BASED ON AVERAGE VALUES OF HUDSON RIVER CHEMICAL COMPOSITION
(BLOWDOWN RATE = 15,000 pgm - ANTICIPATED SULFURIC ACID FEED = 1.6 gpm)

Chemical Constituent	Hudson River	Blowdown - Two Concentrations (No dilution)	Blowdown - 2 concentrations (diluted in 30,000 gpm service water flow from IP#3 and 30,000 gpm service water flow from IP#2)	Blowdown - 2 concentrations (Diluted in 30,000 gpm service water flow from IP#3, 30,000 gpm service water flow from IP#2 and 318,000 gpm circulating water from IP#1)
Calcium	36	72	48	39
Magnesium	46	92	61	49
Sodium	40	80	53	43
Potassium	17	34	23	18
Bicarbonate	67	39	57	65
Chloride	74	148	99	79
Sulfate	127	349	201	143
Silica	-	-	-	-

TABLE 6-5

ESTIMATED ANNUAL RADIOACTIVE LIQUID RELEASE FROM INDIAN POINT NO. 2 or NO. 3 (CURIES)

	Waste Processing System	Boiler Blowdown	Turbine Hall Leaks	Total
Mn-54	2.6×10^{-4}	2.5×10^{-3}		2.8×10^{-3}
Mn-56	9.0×10^{-5}	1.7×10^{-2}		1.71×10^{-2}
Fe-55	3.8×10^{-4}			3.8×10^{-2}
Fe-59	1.46×10^{-3}			1.46×10^{-3}
Co-58	1.22×10^{-2}	7.5×10^{-2}		8.72×10^{-2}
Co-60	4.5×10^{-4}	2.3×10^{-3}		2.75×10^{-3}
Sr-89	1.74×10^{-3}	2.2×10^{-3}		3.94×10^{-3}
Sr-90	8.00×10^{-5}	8.1×10^{-5}		1.61×10^{-4}
Sr-91	1.00×10^{-5}	6.1×10^{-4}		6.2×10^{-4}
Y-90	2.00×10^{-5}	8.6×10^{-5}		1.06×10^{-4}
Y-91	2.88×10^{-3}	3.0×10^{-3}		5.88×10^{-3}
Y-92	1.00×10^{-5}	1.1×10^{-4}		1.2×10^{-4}
Mo-99	4.11×10^{-1}	2.7	1.4×10^{-2}	3.125
I-131	5.01×10^{-1}	1.35	2.9×10^{-2}	1.88
I-132	2.55×10^{-2}	9.9×10^{-2}	2.3×10^{-3}	1.27×10^{-1}
I-133	9.75×10^{-2}	1.55	3.3×10^{-2}	1.68
I-134	6.1×10^{-4}	2.6×10^{-2}	6.0×10^{-4}	2.72×10^{-2}
I-135	1.67×10^{-2}	5.0×10^{-1}	1.1×10^{-2}	5.28×10^{-1}
Te-132	2.31×10^{-2}	1.4×10^{-1}		1.63×10^{-1}
Cs-134	1.47×10^{-1}	1.5×10^{-1}	8.9×10^{-4}	2.98×10^{-1}
Cs-136	4.65×10^{-2}	1.0×10^{-1}		1.46×10^{-1}
Cs-137	7.3×10^{-1}	7.5×10^{-1}	4.3×10^{-3}	1.48
Ba-140	1.19×10^{-3}	2.5×10^{-3}		3.69×10^{-3}
La-140	6.0×10^{-5}	6.3×10^{-4}		6.9×10^{-4}
Ce-141	2.8×10^{-4}			2.8×10^{-4}
Ce-144	1.3×10^{-4}	1.9×10^{-4}		3.2×10^{-4}
Total (excluding H-3)	2.02	7.47	9.5×10^{-2}	9.58
H-3	448	160		608

TABLE 6-6

PERCENTAGES OF RADIONUCLIDES FOR CLOSED-CYCLE COOLING OPERATION OF INDIAN POINT UNIT NOS. 2 or 3 and INDIAN POINT UNIT NO. 1 NOT OPERATING

Dilution	Percentage of 10CFR20 Limits	
	H-3	Highest Other (I-131)
Cooling tower blowdown of 15,000 gpm plus service water flow of 30,000 gpm; 0.8 load factor	0.303	9.38

TABLE 6-7

ESTIMATED ANNUAL RADIOACTIVE LIQUID RELEASES
FROM INDIAN POINT NO. 1
(CURIES)

	Waste	Boiler Blowdown	Total
Mn-54	7.6×10^{-2}	6.2×10^{-2}	1.38×10^{-1}
Co-58	4.2×10^{-2}	1.6×10^{-2}	5.8×10^{-2}
Co-60	4.5×10^{-2}	4.1×10^{-3}	4.91×10^{-2}
Cs-134	1.9×10^{-3}	3.0×10^{-3}	4.9×10^{-3}
Cs-137	2.9×10^{-2}	2.6×10^{-2}	5.5×10^{-2}
I-131	1.5×10^{-2}	3.5×10^{-1}	3.65×10^{-1}
I-132	0	1.4×10^{-2}	1.4×10^{-2}
I-133	0	2.3×10^{-1}	2.3×10^{-1}
I-135	0	5.7×10^{-2}	5.7×10^{-2}
Sr-89	2.6×10^{-4}	1.7×10^{-3}	1.96×10^{-3}
Sr-90	4.6×10^{-5}	4.3×10^{-5}	8.9×10^{-5}
F-18	0	5.0×10^{-2}	5.0×10^{-2}
Na-24	0	1.2×10^{-1}	1.2×10^{-1}
Cu-64	0	5.0×10^{-2}	5.0×10^{-2}
Total (excluding H-3)	2.09×10^{-1}	9.84×10^{-1}	1.19
H-3	7.11×10^{2}	4.1×10^{1}	7.52×10^{2}

TABLE 6-8

INDIAN POINT UNIT NOS. 1, 2 and 3
PERCENTAGES OF RADIONUCLIDES FOR CLOSED-CYCLE
COOLING OPERATION

(INDIAN POINT UNIT NO. 1 ON ONCE-THROUGH OPERATION)
(INDIAN POINT UNIT NOS. 2 and 3 ON CLOSED-CYCLE COOLING)

Dilution	Percentage of 10CFR20 Limits	
	H_3	Highest Other (I-131)
Indian Point Unit No. 1 circulating water flow and service water flow of 318,000 gpm plus Indian Point Unit No. 2 service water flow of 30,000 gpm and cooling tower blowdown of 15,000 gpm plus Indian Point Unit No. 3 service water flow of 30,000 gpm and cooling tower blowdown of 15,000 gpm; 0.8 load factor for each unit	0.103	2.15

TABLE 6-9

PERCENTAGES OF RADIONUCLIDES FOR CLOSED-CYCLE COOLING OPERATION OF BOTH INDIAN POINT UNIT NOS. 2 and 3 and INDIAN POINT UNIT NO. 1 NOT OPERATING

Dilution	Percentage of 10CFR20 Limits	
	H_3	Highest Other (I-131)
Indian Point Unit No. 2 service water flow of 30,000 gpm and cooling tower blowdown flow of 15,000 gpm, and Indian Point Unit No. 3 service water flow of 30,000 gpm and cooling tower blowdown flow of 15,000 gpm; 0.8 load factor for each unit	0.303	9.38

TABLE 6-10

ENVIRONMENTAL NOISE/RESIDENTIAL ZONES STUDIED
(974 Acres) *

L_{dn}	Area Exposed to Average Day-Night Sound Level, Acres 55-60	60-65 (1)	Increase in Area Exposed to Average Day-Night Sound Level, Acres > 55 (2)	> 60 (2)
Ambient Community with Unit No. 2 cooling tower	460.4	0.6	0	0
Natural draft cross-flow	462.5	0.6	2.1	0
Natural draft counter-flow	464.0	0.6	3.6	0
Linear mechanical wet	467.7	3.4	10.7	2.8
Round mechanical wet	-	-	~ 10.7 (4)	~ 2.8 (4)
Linear mechanical wet/dry	482.2	4.6	26.4	4.0
Fan-assisted natural draft	-	-	~ 10.7-26.4 (4)	~ 2.8-4.0 (4)
Off-Site Construction traffic	-	-	54 (3)	89 (3)

1 Area within 2000 meters of Unit Nos. 2 and 3 Cooling Towers
2 Estimated range; upper limit = 65 dB
3 Within 2000 meters of Unit 2 Cooling Tower
4 Expected

TABLE 6-11

REGIONAL VISUAL IMPACT FACTORS OF NATURAL

DRAFT COOLING TOWERS

LOCATION OF VANTAGE POINT	APPROXIMATE DISTANCE FROM GENERATING STATION	OBSERVATION
South of Haverstraw, looking north across the Hudson River, Montrose Point and Verplanck.	6 miles	Towers lose definition because of distance, and blend with background mountains. Base of towers are hidden by high ground at Verplanck.
North of Tomkins Cove, looking across the Hudson River.	1.5 miles	Tower details are clearly visible, and tower structures are silhouetted against the sky. Huge tower sizes dwarf their surroundings. Modifications made to the natural shoreline are clearly visible.
New York State Military Reservation, looking across the Hudson River.	2.5 miles	View of generating station is partially blocked by Dunderberg Mountain, but tower structures are totally visible. Much of the structures are silhouetted against the sky. The size of towers is dwarfed by the bulk of Dunderberg Mountain, and by contrast do not appear as prominent on the landscape as they might otherwise.

TABLE 6-11(continued)

LOCATION OF VANTAGE POINT	APPROXIMATE DISTANCE FROM GENERATING STATION	OBSERVATION
North of Peekskill, looking across the Hudson River.	2 miles	Towers are clearly visible, with most of their height silhouetted against the sky. Size of towers are accentuated, since their verticality is contrasted with a strong horizontal in the landscape.
Southeast of Indian Point Generating Station, looking over Buchanan.	1.25 miles	Bottoms of towers are hidden by intervening land forms. However, the tower structures loom large, and out of scale, over the tree tops and against the sky.

TABLE 6-12

REGIONAL VISITORS ATTRACTIONS AND RECREATION AREAS

IN THE INDIAN POINT REGION

Name & Location of Attraction	Description	Annual Attendance (1973)
1. Vanderbilt Mansion National Historical Site, Route 9, Hyde Park, N. Y.	Preserved portion of former Vanderbilt estate. Mansion and 212 acres of landscaped grounds.	Mansion - 167,000 Grounds - 298,000
2. Hyde Park National Historic Site, Franklin Delano Roosevelt Home, Franklin Delano Roosevelt Library U.S. 9 - Hyde Park, N.Y.	Home and library contain furnishings and exhibits of life of FDR - 187 acres of landscaped grounds.	Home - 197,000 Library - 168,000 Grounds - 270,000
3. West Point Military Reservation, Old Storm King Highway, West Point, N.Y.	Military academy, historic sites, museum, stadium-available for sporting events of outside groups.	Estimated at 2,500,000
4. Boscobel, Route 9D, Garrison, N.Y.	Historic restoration of 18th century home, tours, summer evening sound and light show	30,000
5. Sleepy Hollow Restoration, Van Cortlandt Manor, U. S. 9, Croton-on-Hudson, N.Y.	Restored 18th century Dutch-English manor house on 20 acres.	44,000
6. Philipsburg Manor, North Tarrytown, N.Y.	Early 18th century Dutch trading center with manor house, water-powered grist mill.	71,000

TABLE 6-12 (continued)

Name & Location of Attraction		Annual Attendance (1973)
7. Lyndhurst, Tarrytown, N.Y.	Restored Gothic style mansion of Jay Gould, 67 acres of landscaped grounds, lawns and woodlands	30,000
8. Palisades Interstate Park, West bank of Hudson River. Bear Mountain State Park, New York	14 State Parks covering 62,400 acres, Bear Mountain State Park, 5,100 acres-includes museums, winter sports. Harriman State Park, 46,000 acres -including beaches, lakes, ski slopes.	Bear Mt. - 2,700,000 Harriman - 2,800,000 (cars counted)

TABLE 6-13

HISTORICAL PLACES IN THE VICINITY OF INDIAN POINT GENERATING STATION**

County		Site and Location
I. Westchester	1.	Bedford Village Historic District Bedford
	* 2.	Van Cortlandt Manor U. S. 9, north of intersection with U. S. 9A, Croton-on-Hudson
	3.	Hyatt - Livingston House 152 Broadway, Dobbs Ferry
	4.	Odell House 425 Ridge Road, Greenburgh
	5.	Jasper F. Cropsey House and Studio 49 Washington Avenue, Hastings-on-Hudson
	6.	John Jay Homestead Jay Street, Katonah
	7.	St. Paul's Church National Historic Site Eastchester, Mount Vernon
	8.	John Stevens House 29 West Fourth Street, Mount Vernon
	* 9.	Thomas Paine Cottage 20 Sicard Avenue, New Rochelle
	*10.	Dutch Reformed (Sleepy Hollow) Church North Edge of Tarrytown on U.S. 9, North Tarrytown
	11.	First Baptist Church of Ossining South Highland Avenue and Main Street, Ossining
	12.	Site of Old Croton Dam Ossining Vicinity
	13.	Joseph Purdy Homestead Intersection of (Old) N.Y. 22 and N. Y. 129, Purdys
	14.	Caleb Hyatt House (Cudner - Hyatt House) 937 White Plains Post Road, Scarsdale
	15.	Jay Gould Estate (Lyndhurst) 635 South Broadway, Tarrytown
	*16.	Washington Irving House (Sunnyside) Sunnyside Lane, Tarrytown

TABLE 6-13 (continued)

	County		Site and Location
I.	Westchester (cont'd)	*17.	Philipsburg Manor 381 Bellwood Avenue, Upper Mills
		18.	Old St. Peter's Church Oregon Road and Locust Avenue, Van Courtlandtville
		*19.	Philipse Manor Warburton Avenue and Dock Street, Yonkers
		20.	John Bond Trevor House 511 Warburton Avenue, Yonkers
II.	Rockland	* 1.	Palisades Interstate Park West Bank of Hudson River (also in Orange Co., N.Y. and Bergen Co., N.J.)
		2.	Henry Garner Mansion 18 Railroad Avenue, Garnerville
		* 3.	Stony Point Battlefield North of Stony Point on U. S. 9W and U. S. 202
		* 4.	DeWint House Livingston Avenue and Oak Tree Road, Tappan
		5.	Terneur - Hutton House 160 Sickelton Road, West Nyack
III.	Orange	* 1.	Delaware and Hudson Canal (Also in Sullivan and Ulster Counties, N.Y., and Pike and Wayne Counties, Pa.)
		* 2.	Fort Montgomery North of Bear Mountain Bridge on the Hudson River, Bear Mountain
		3.	Fort Montgomery Site South of Fort Montgomery
		* 4.	Historic Track Main Street, Goshen
		* 5.	Harriman (E.H.) Estate (Arden) New York 17, Harriman
		6.	Southfield Furnace Ruin South of Monroe off N.Y. 17
		7.	New Windsor Cantonment Temple Hill Road, New Windsor
		8.	Haskell House West of New Windsor off N.Y. 32

TABLE 6-13 (continued)

County		Site and Location
III. Orange (cont'd)	9.	David Crawford House 189 Montgomery Street, Newburgh
	10.	Dutch Reformed Church Northeast corner of Grand and Third Streets, Newburgh
	11.	Mill House (Gomez the Jew House) Mill House Road, Newburgh
	12.	Montgomery - Grand - Liberty Streets Historic District Newburgh
	*13.	Washington's Headquarters Liberty and Washington Streets, Newburgh
	14.	Knox Headquarters Quassaick Avenue and Forge Hill Road, Vails Gate
	*15.	U. S. Military Academy New York 218, West Point

* Designated National Historic Landmark by the U. S. Secretary of the Interior.

** List prepared from the National Register of Historic Places, Federal Register, Volume 39, No. 34, February 19, 1974.

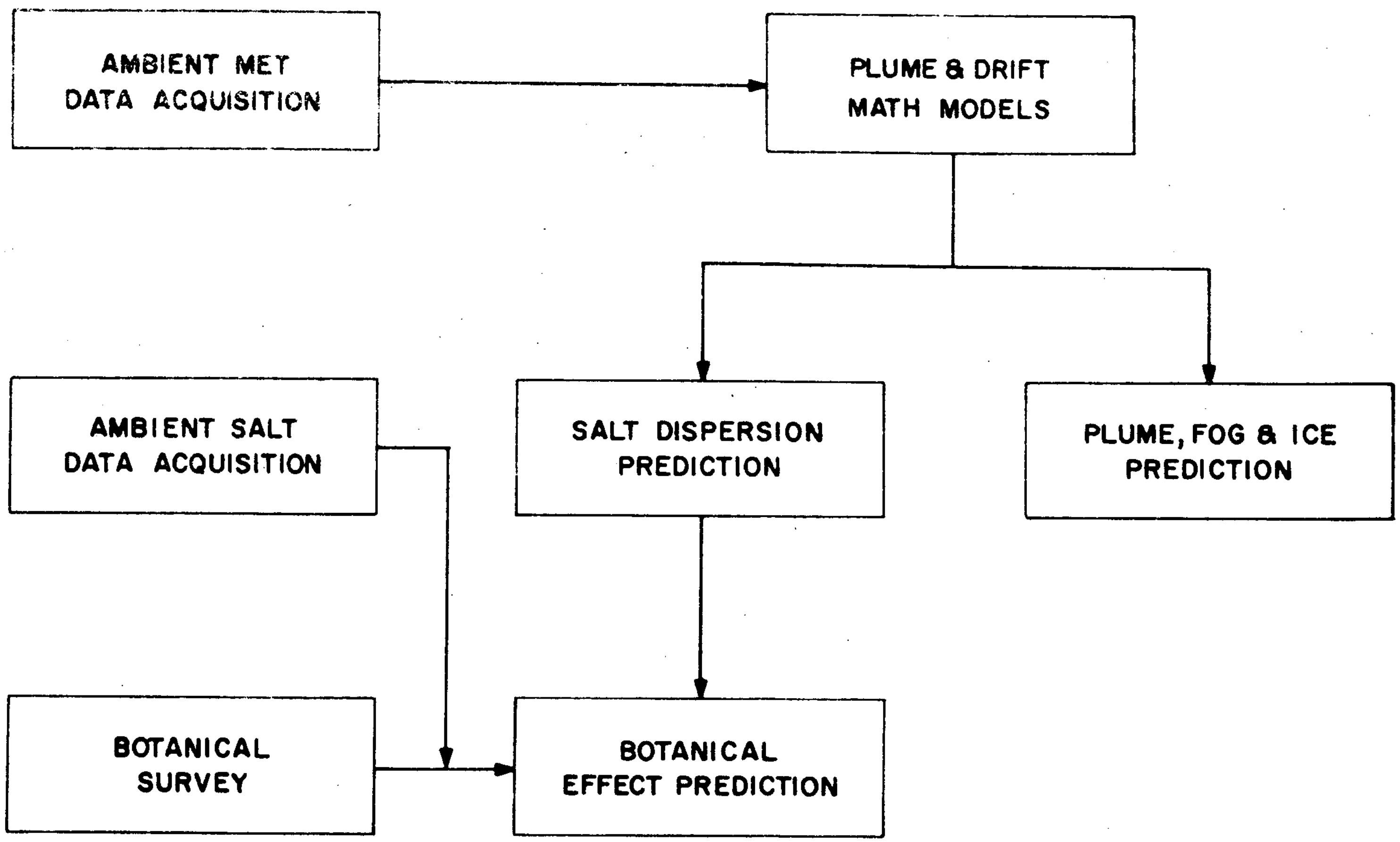


FIGURE 6-1
COOLING TOWER AIR QUALITY STUDY PROGRAM

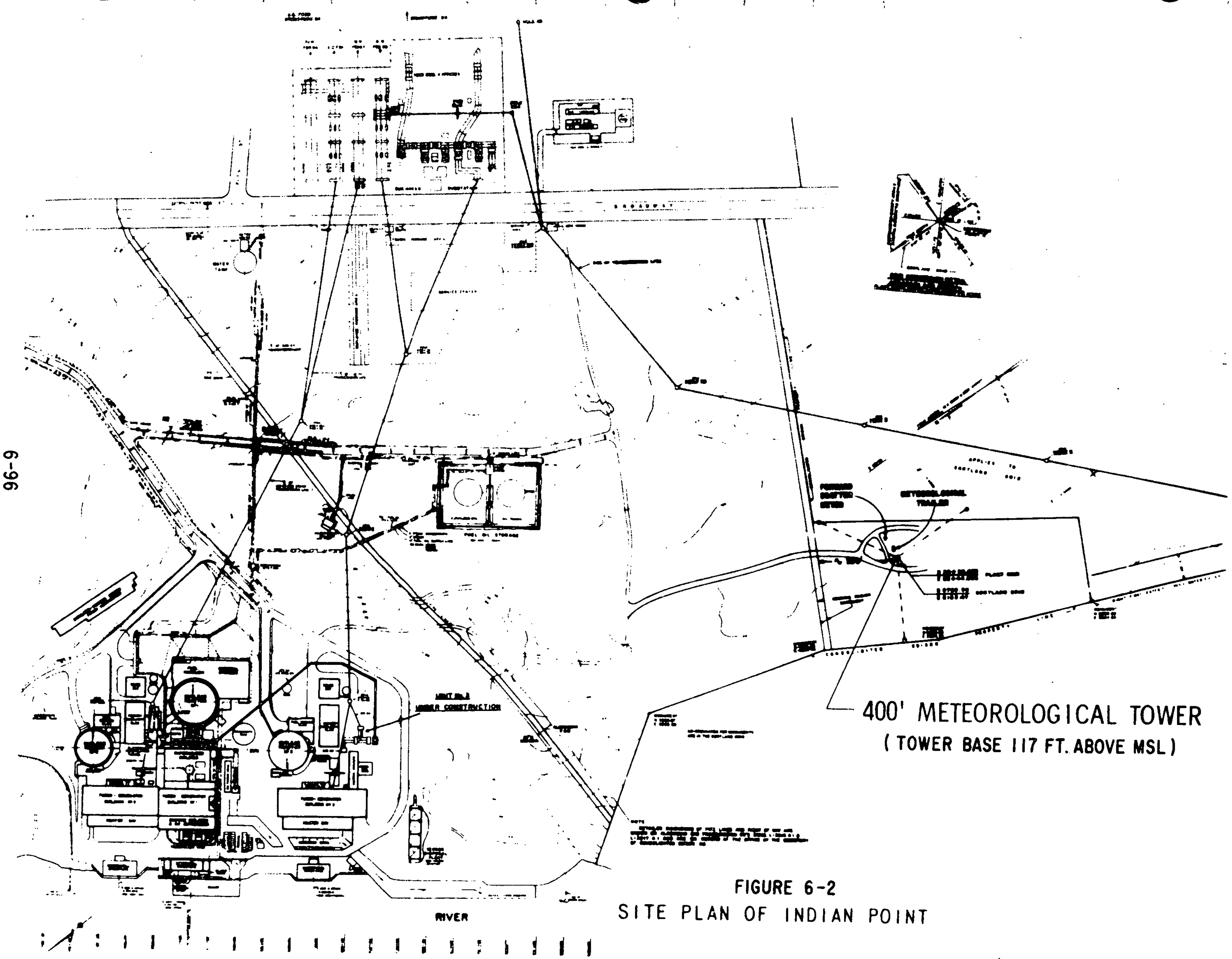


FIGURE 6-2
SITE PLAN OF INDIAN POINT

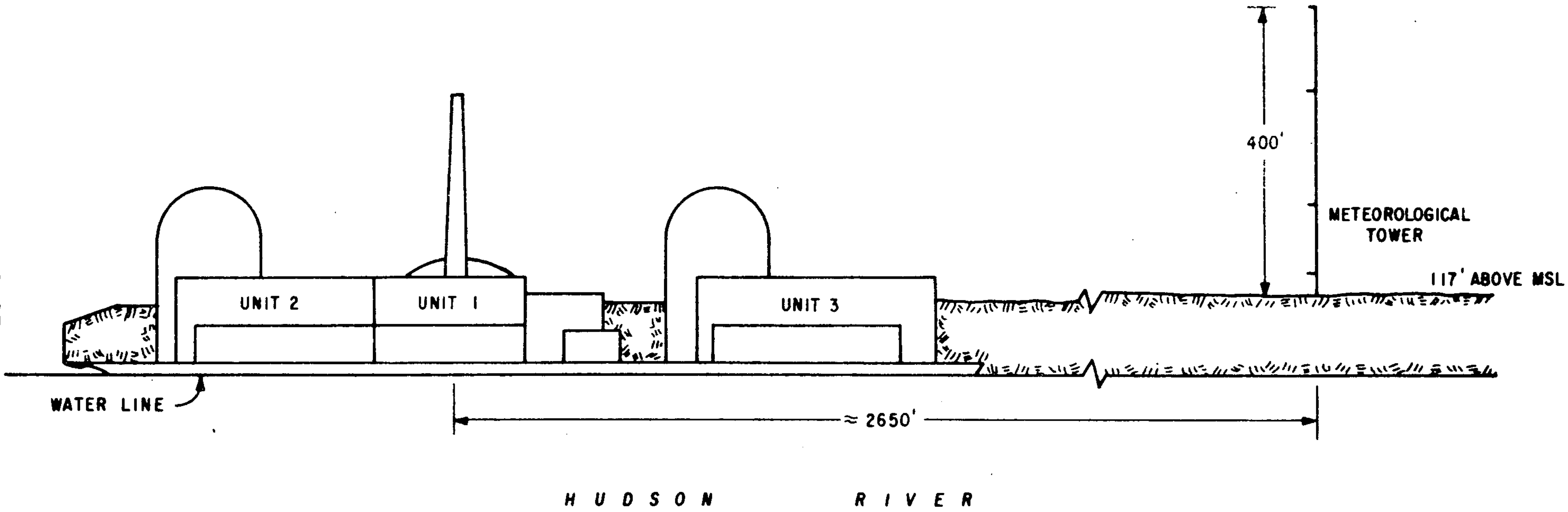
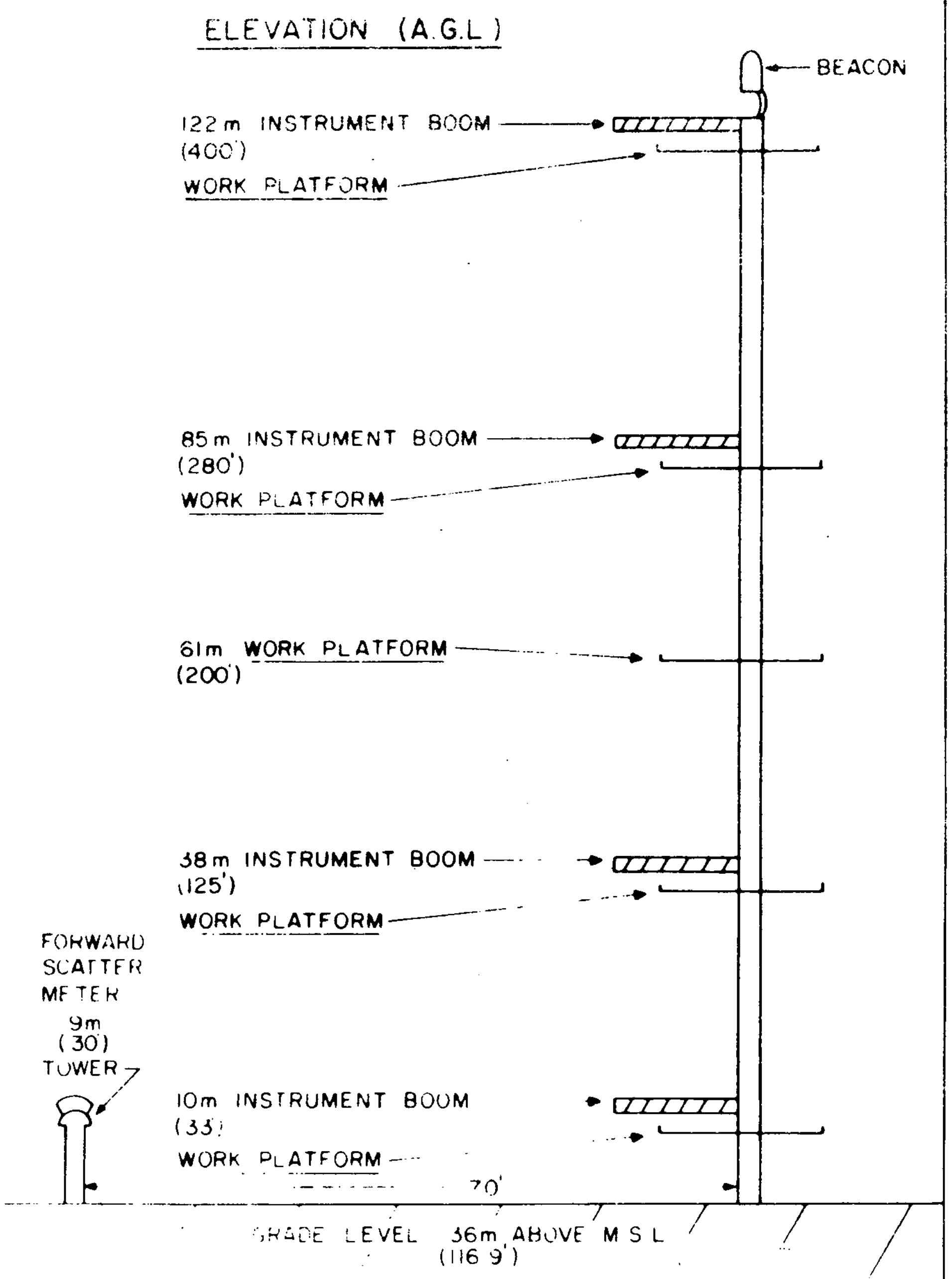


FIGURE 6-3
PROFILE OF NUCLEAR FACILITIES WITH METEOROLOGICAL TOWER



SENSORS	INSTRUMENT MANUFACTURER
WIND SPEED + DIRECTION	CLIMATRONICS CORP
TEMPERATURE DIFF (400' vs 33')	E G G
DEW POINT	E G G
WIND SPEED + DIRECTION	CLIMATRONICS CORP
TEMPERATURE DIFF (200' vs 33')	E G G
DEW POINT	E G G
WIND SPEED + DIRECTION	CLIMATRONICS CORP
NET RADIOMETER, DEW POINT	SWISSTECO
AMBIENT TEMPERATURE (33')	E G G
WIND SPEED + DIRECTION	CLIMATRONICS CORP
FORWARD SCATTER METER	E G G

FIGURE 6-4
METEOROLOGICAL TOWER SCHEMATIC

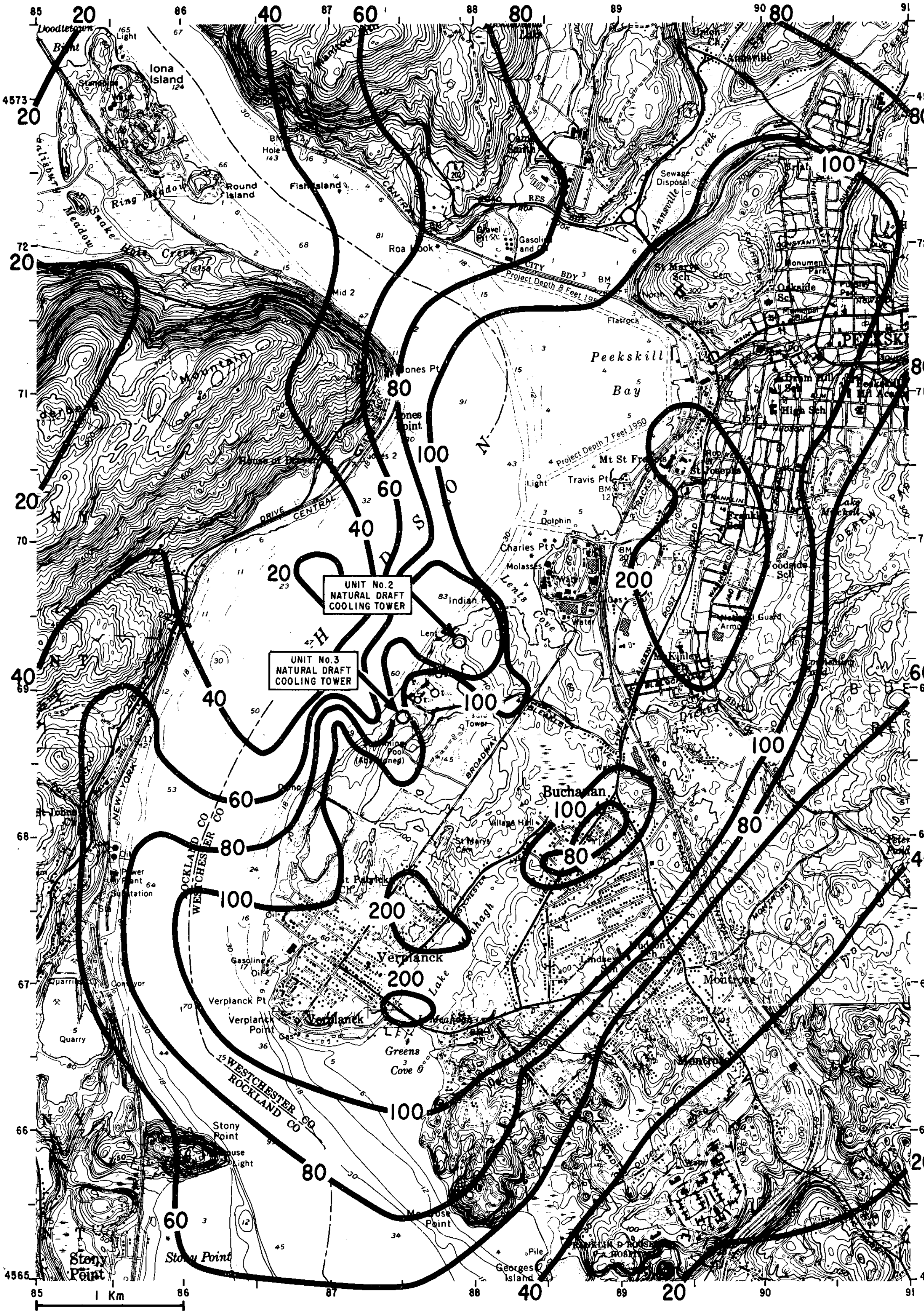


FIGURE 6-5

SALT ACCUMULATION AUGUST 1974 (Kg/Km^2)
UNIT 2 - NATURAL DRAFT WET TOWER
UNIT 3 - NATURAL DRAFT WET TOWER
DRIFT SALINITY 7000 ppm

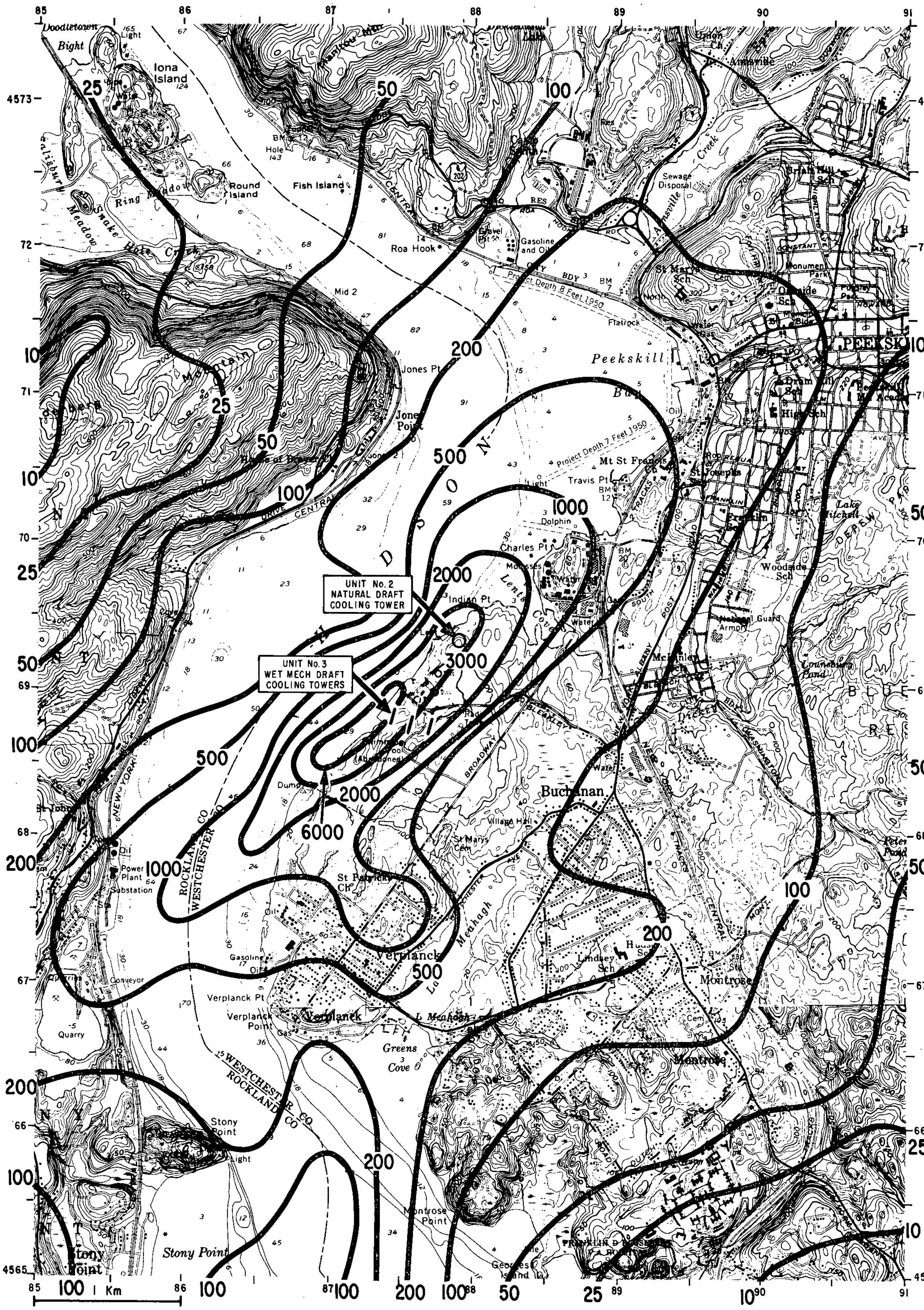


FIGURE 6-6

SALT ACCUMULATION AUGUST 1974 (Kg/Km^2)
UNIT 2 - NATURAL DRAFT WET TOWER
UNIT 3 - LINEAR MECHANICAL DRAFT WET TOWER
DRIFT SALINITY 7000 ppm

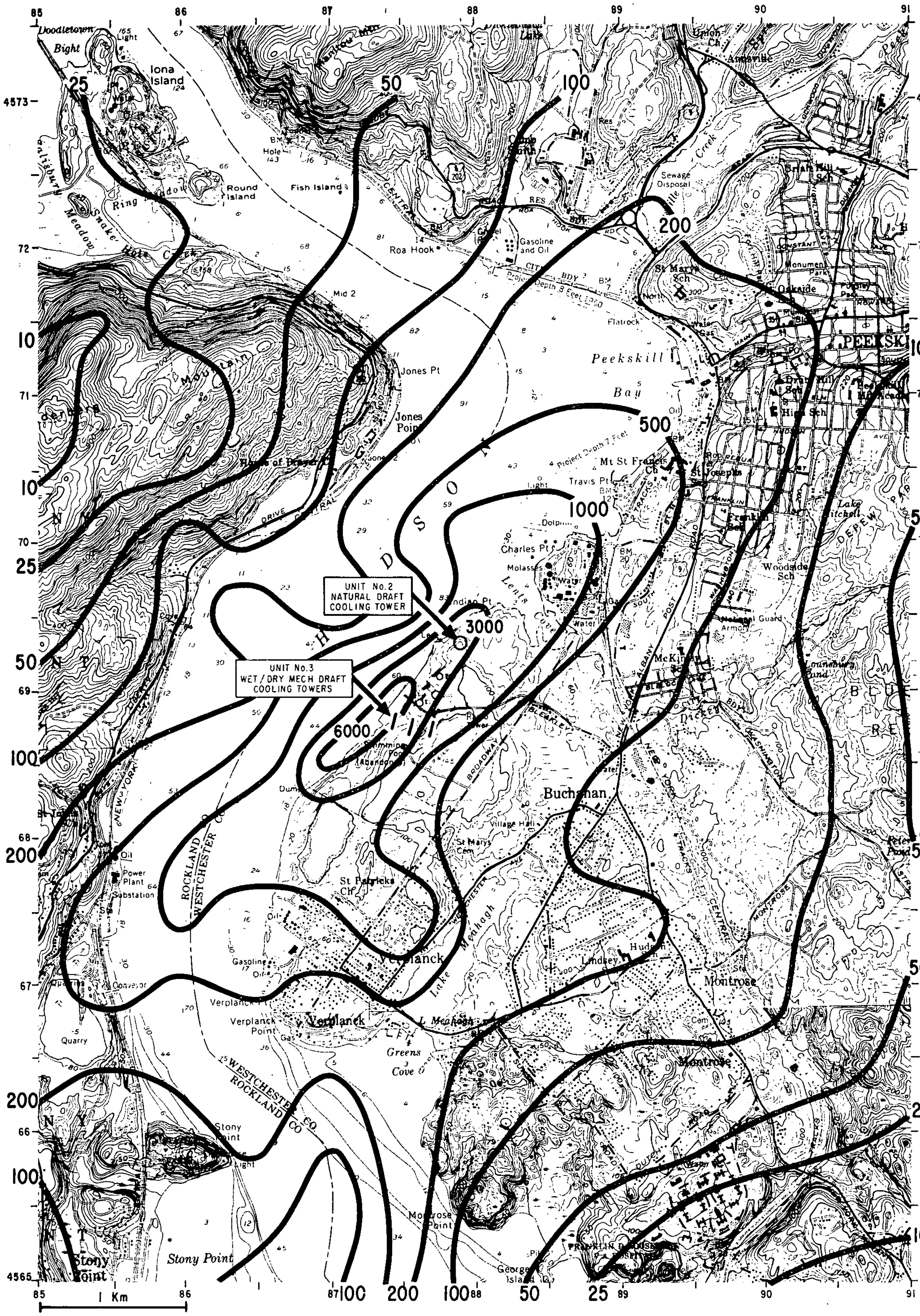


FIGURE 6-7

SALT ACCUMULATION AUGUST 1974 (Kg/Km^2)
UNIT 2 - NATURAL DRAFT WET TOWER
UNIT 3 - MECHANICAL DRAFT WET/DRY TOWER
DRIFT SALINITY 7000 ppm

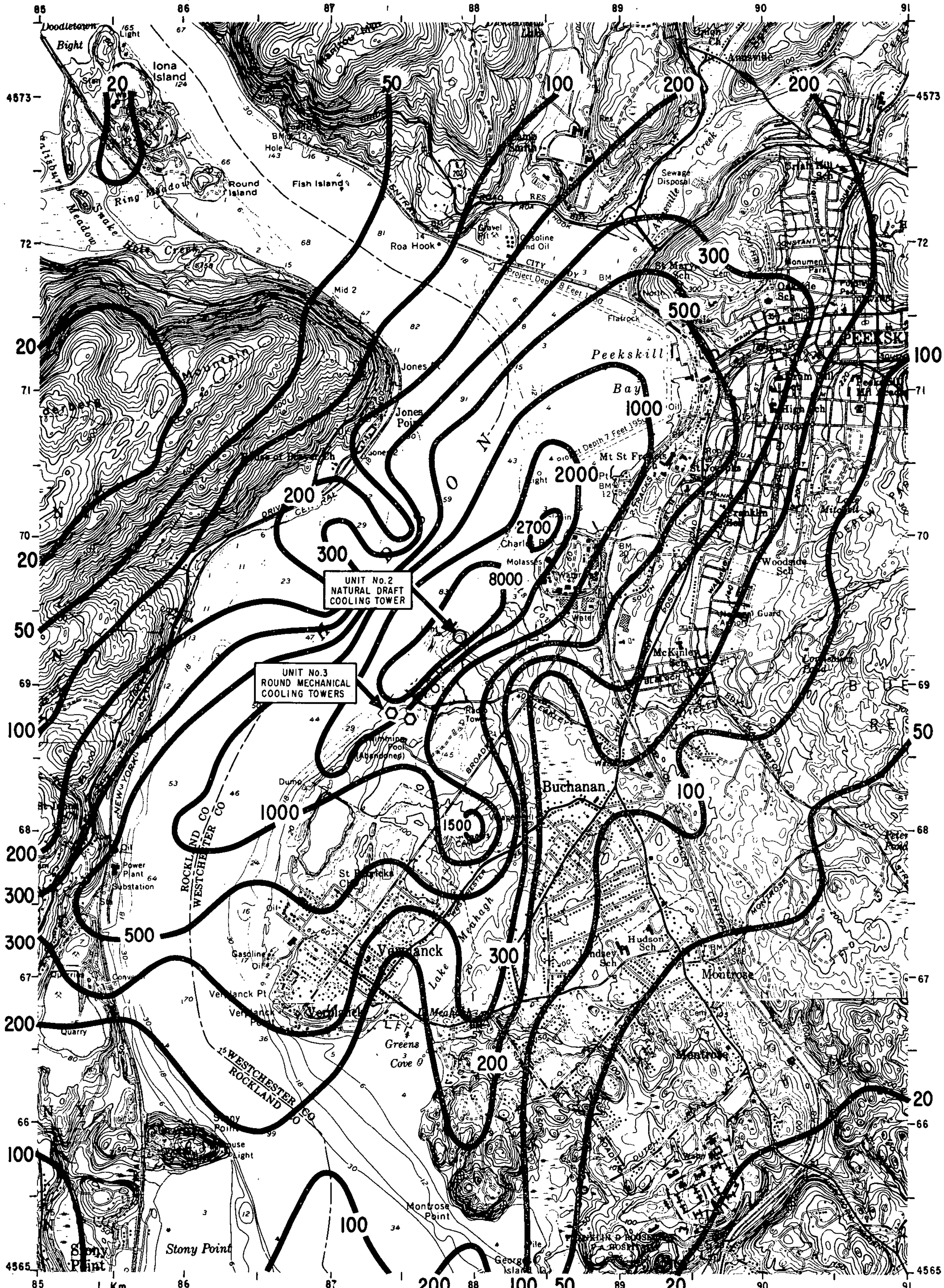


FIGURE 6-8

SALT ACCUMULATION AUGUST 1974 (Kg/Km^2)
UNIT 2 - NATURAL DRAFT WET TOWER
UNIT 3 - ROUND MECHANICAL DRAFT WET TOWER
DRIFT SALINITY 7000 ppm

FIGURE 6-9

SALT ACCUMULATION AUGUST 1974 (Kg/Km^2)
UNIT 2 - NATURAL DRAFT WET TOWER
UNIT 3 - FAN ASSISTED NATURAL DRAFT WET TOWER
DRIFT SALINITY 7000 ppm

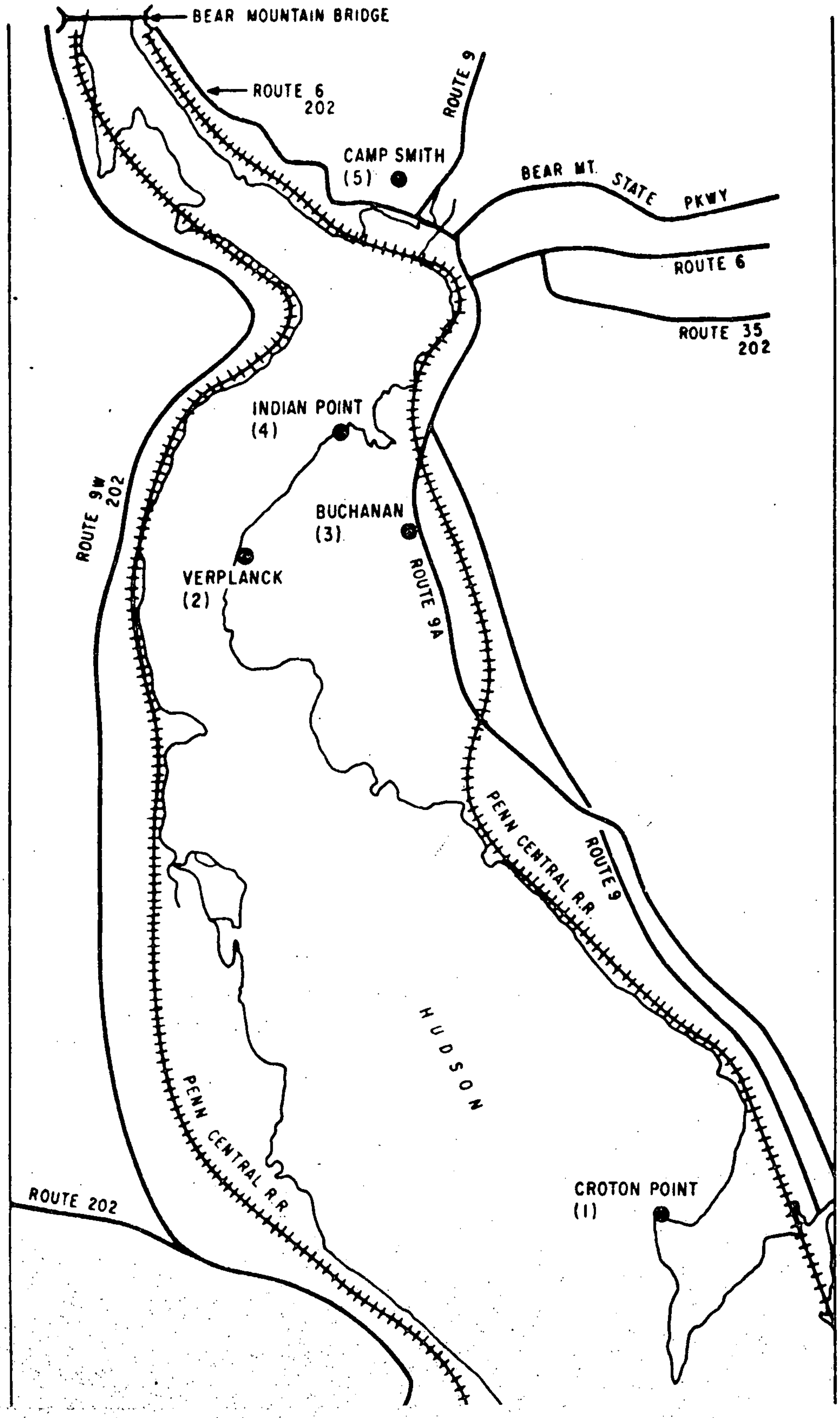
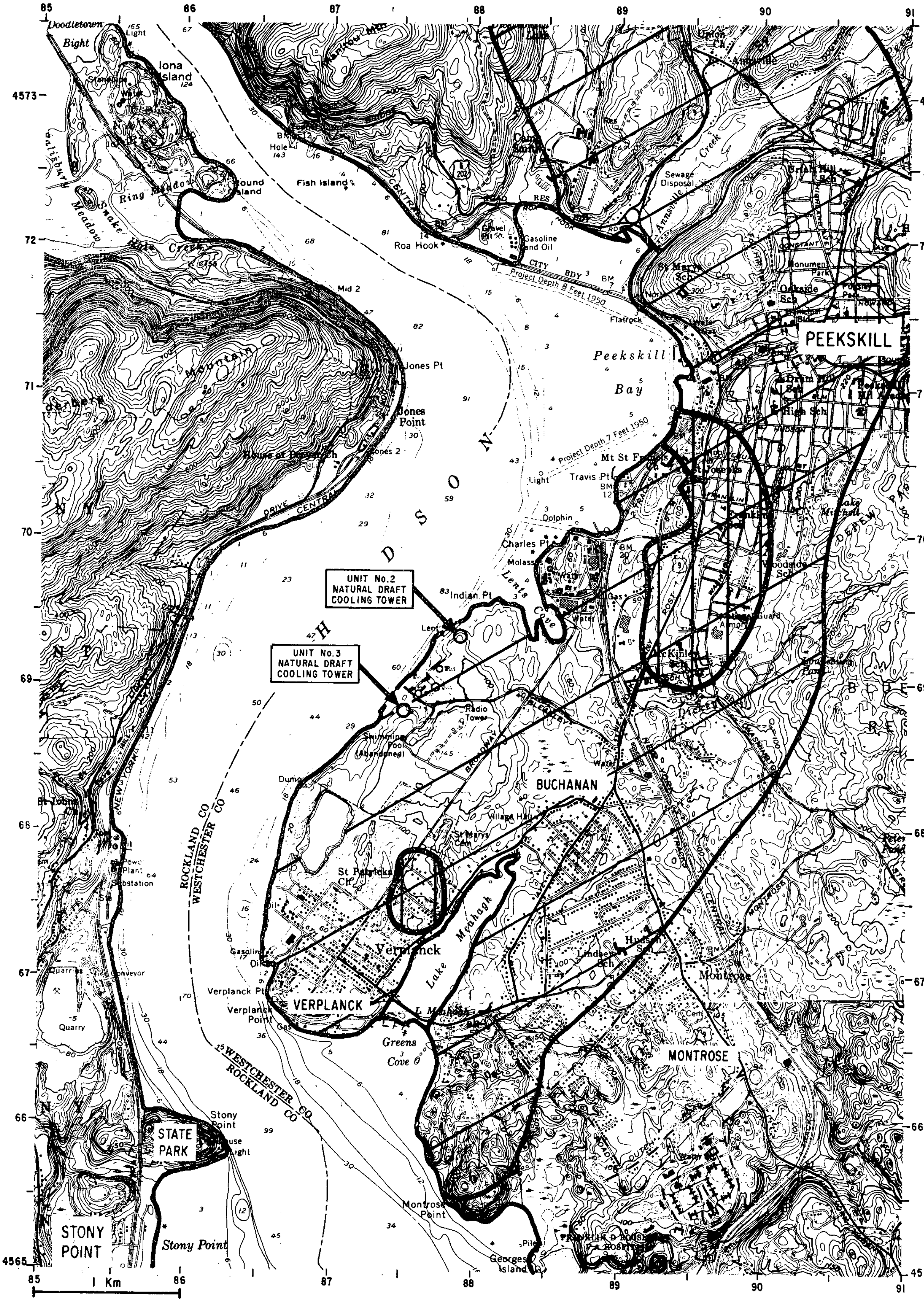


FIGURE 6-10
SAMPLING SITES FOR AMBIENT SALT



ALL HEMLOCKS POTENTIALLY INJURED; 5-20 % OF DOGWOOD AND WHITE ASH POTENTIALLY SLIGHTLY INJURED.

ALL HEMLOCKS POTENTIALLY INJURED; 20-100% OF DOGWOOD AND WHITE ASH POTENTIALLY INJURED.

FIGURE 6-11

AREA OF POTENTIAL BOTANICAL INJURY
UNIT 2 - NATURAL DRAFT WET TOWER
UNIT 3 - NATURAL DRAFT WET TOWER
14 DAY DROUGHT

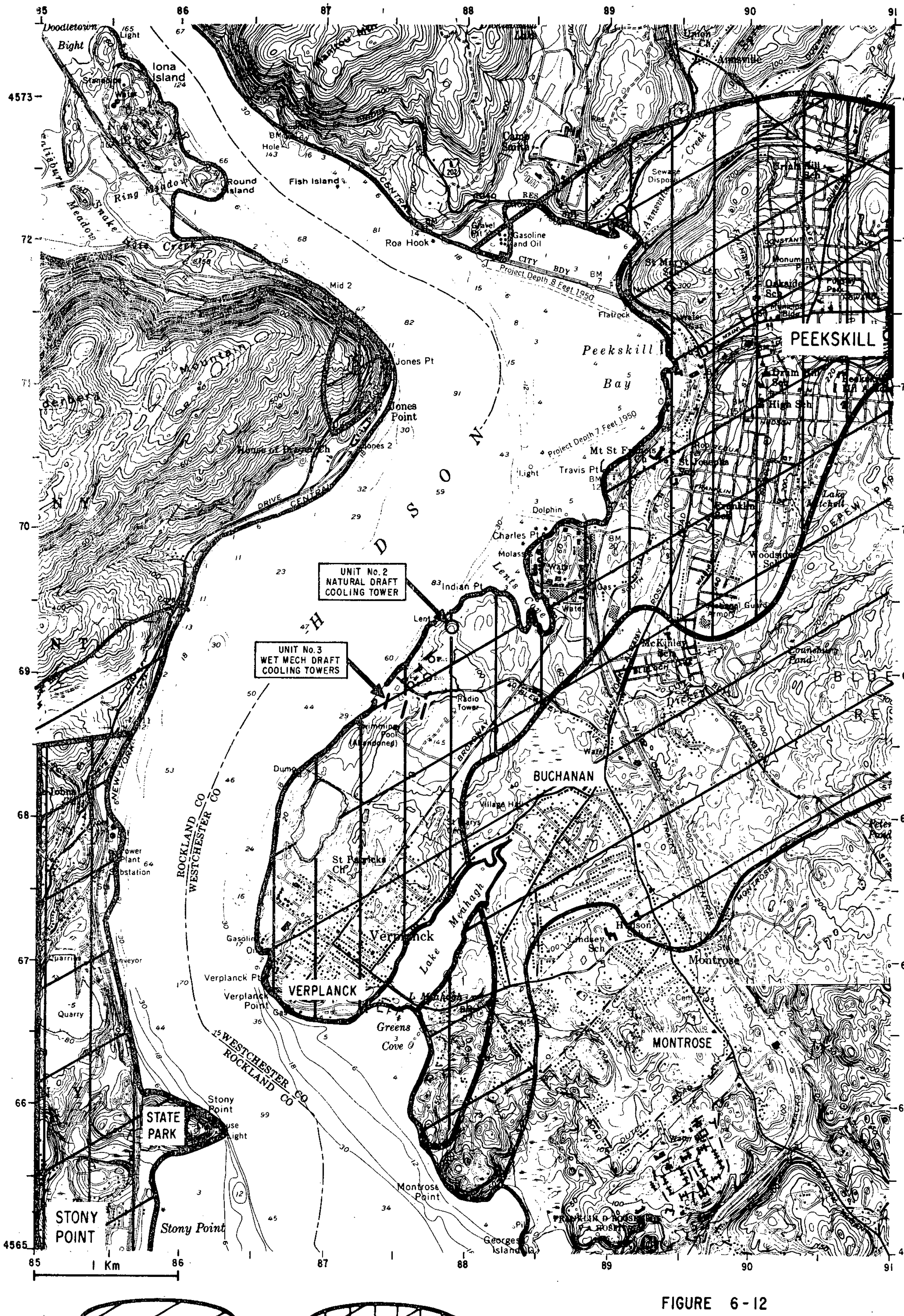
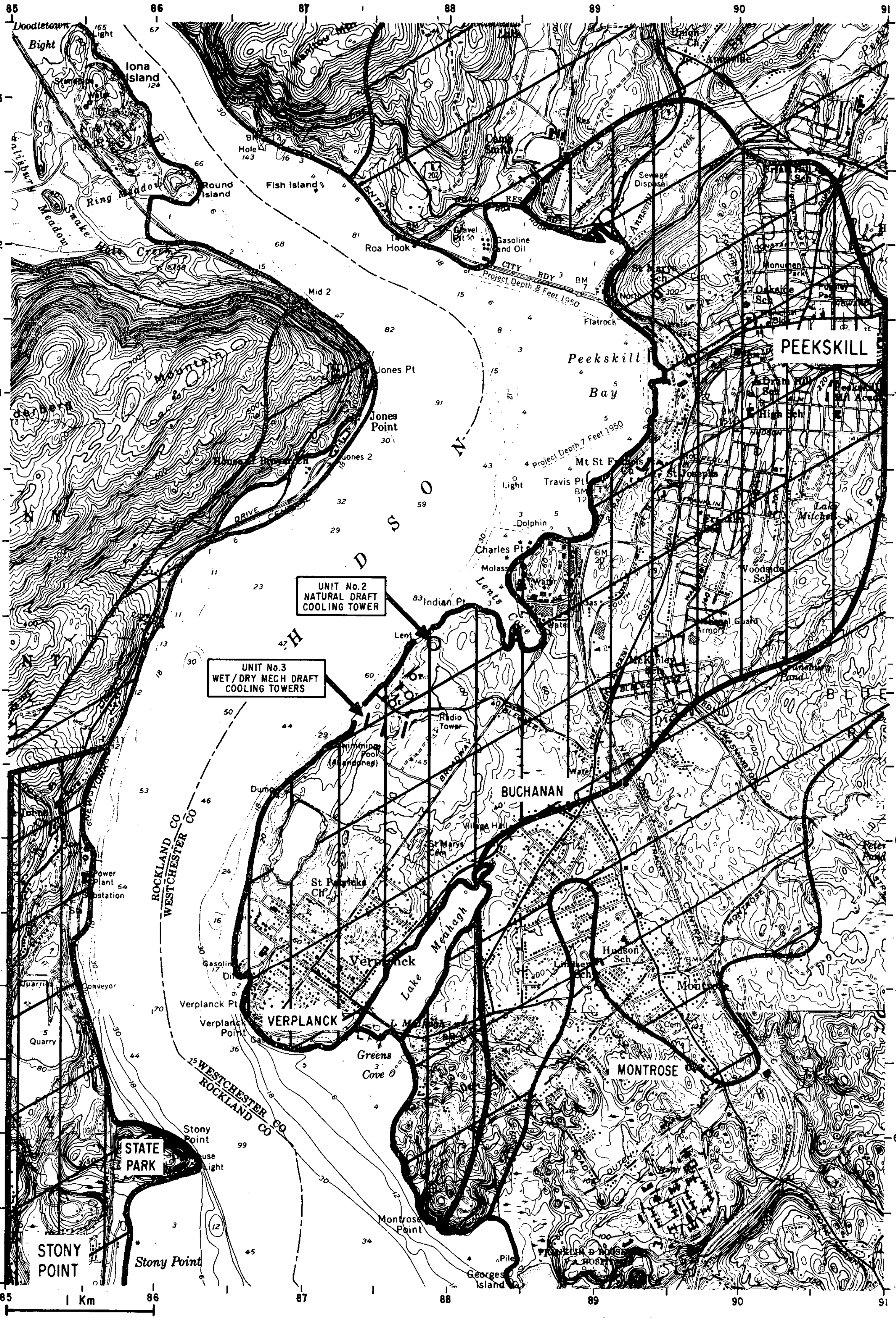


FIGURE 6-12

AREA OF POTENTIAL BOTANICAL INJURY
UNIT 2 - NATURAL DRAFT WET TOWER
UNIT 3 - LINEAR MECHANICAL DRAFT
WET TOWER - 14 DAY DROUGHT

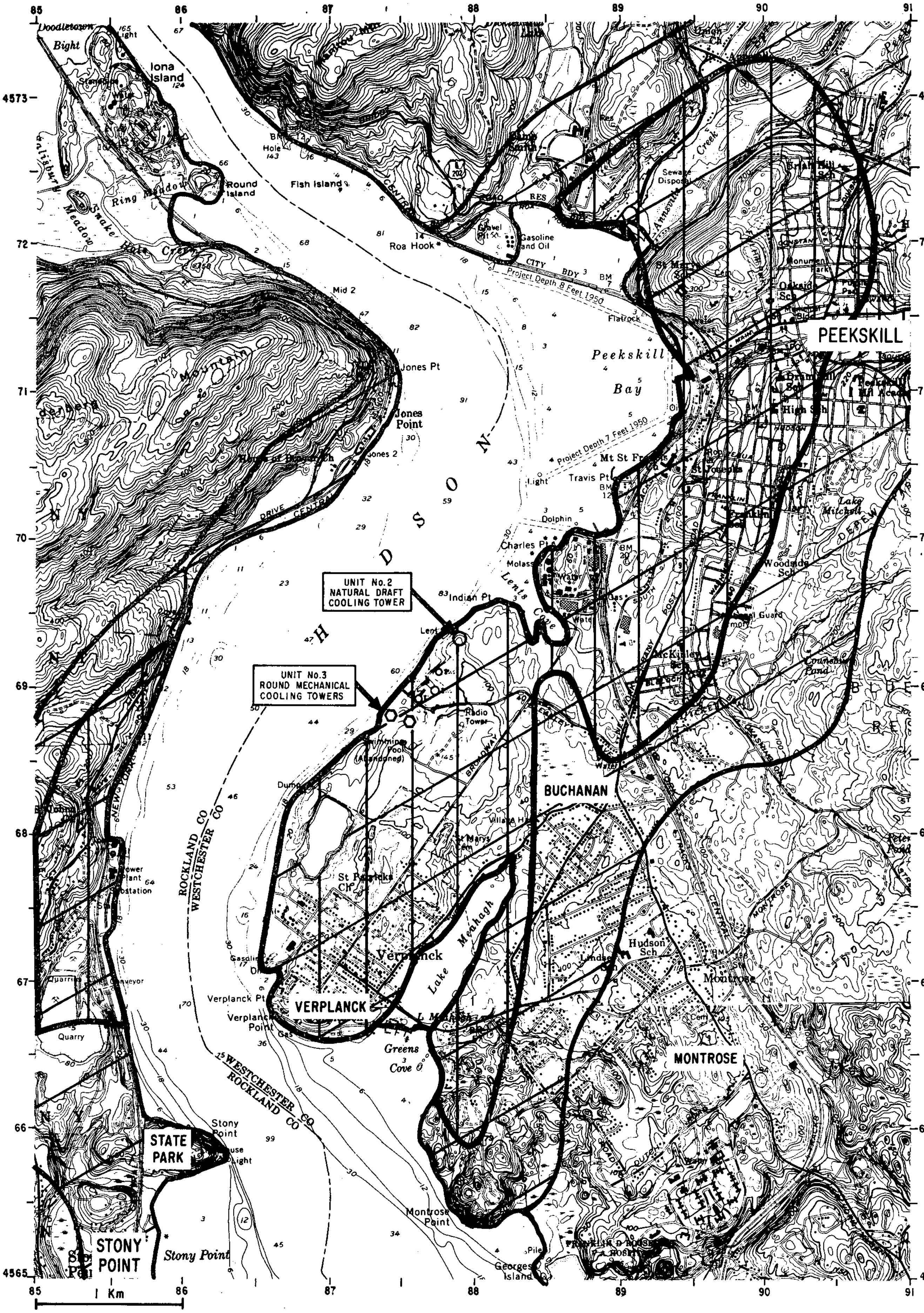


ALL HEMLOCKS POTENTIALLY INJURED; 5-20 % OF DOGWOOD AND WHITE ASH POTENTIALLY SLIGHTLY INJURED.

ALL HEMLOCKS POTENTIALLY INJURED; 20-100% OF DOGWOOD AND WHITE ASH POTENTIALLY INJURED.

FIGURE 6-13

AREA OF POTENTIAL BOTANICAL INJURY
UNIT 2- NATURAL DRAFT WET TOWER
UNIT 3- MECHANICAL DRAFT WET / DRY
TOWER - 14 DAY DROUGHT

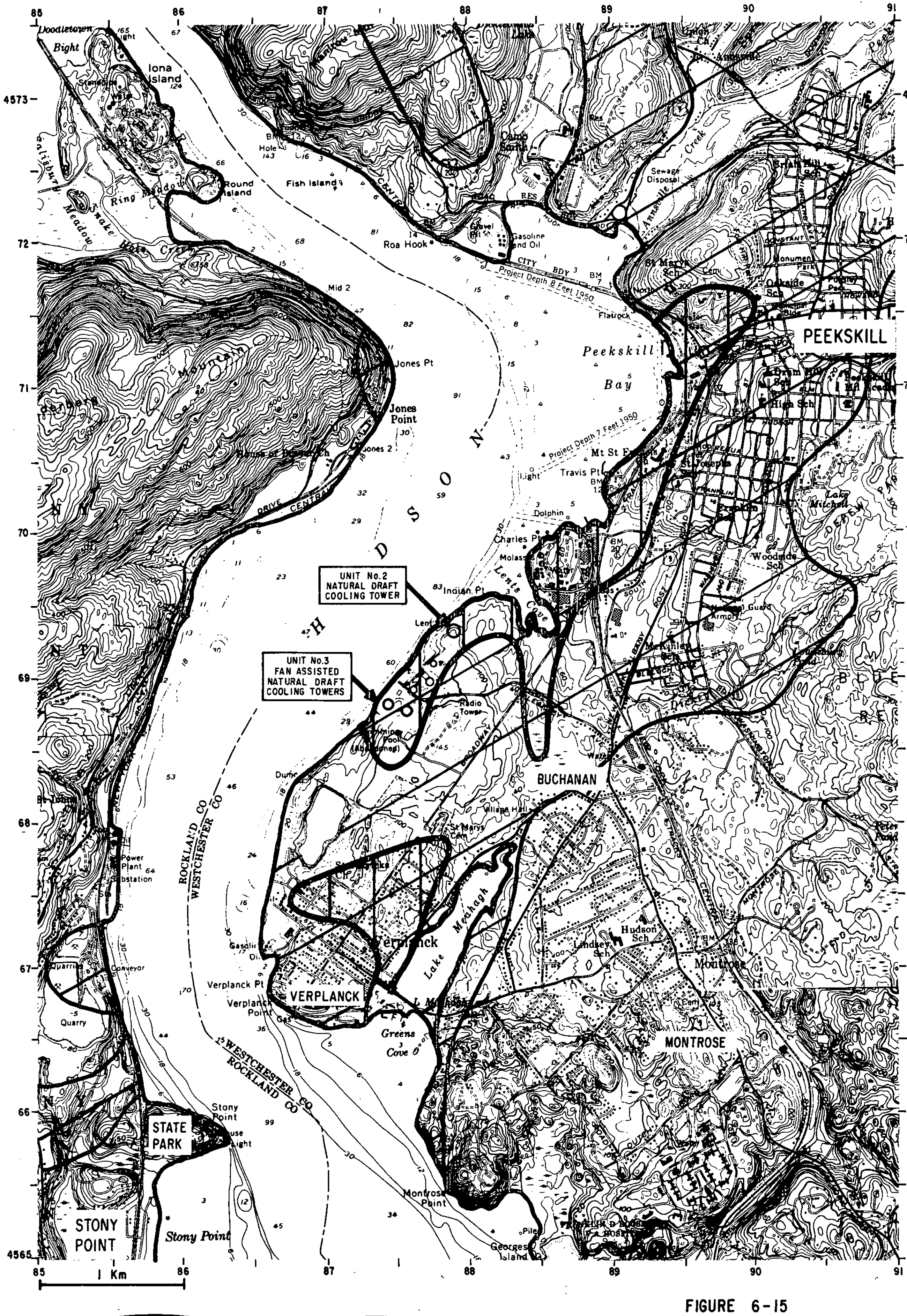


ALL HEMLOCKS POTENTIALLY INJURED; 5-20 % OF DOGWOOD AND WHITE ASH POTENTIALLY SLIGHTLY INJURED.

ALL HEMLOCKS POTENTIALLY INJURED; 20-100% OF DOGWOOD AND WHITE ASH POTENTIALLY INJURED.

FIGURE 6-14

AREA OF POTENTIAL BOTANICAL INJURY
UNIT 2 - NATURAL DRAFT COOLING TOWER
UNIT 3 - ROUND WET MECHANICAL DRAFT
COOLING TOWERS - 14 DAY DROUGHT



ALL HEMLOCKS POTENTIALLY INJURED; 5-20 % OF DOGWOOD AND WHITE ASH POTENTIALLY SLIGHTLY INJURED.

ALL HEMLOCKS POTENTIALLY INJURED; 20-100 % OF DOGWOOD AND WHITE ASH POTENTIALLY INJURED.

FIGURE 6-15

AREA OF POTENTIAL BOTANICAL INJURY
UNIT 2- NATURAL DRAFT COOLING TOWER
UNIT 3- FAN ASSISTED NATURAL DRAFT
COOLING TOWERS - 14 DAY DROUGHT

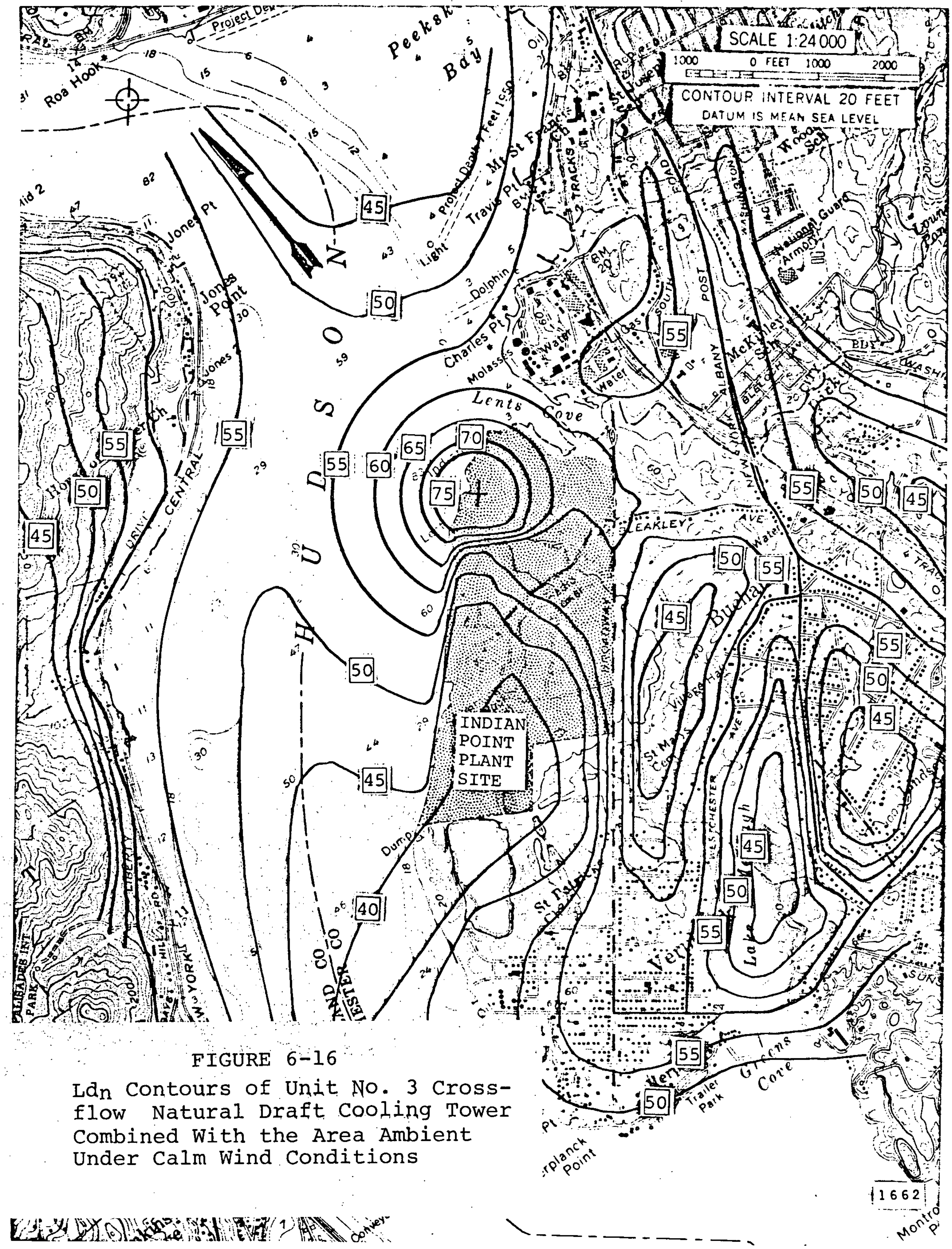


FIGURE 6-16

Ldn Contours of Unit No. 3 Cross-flow Natural Draft Cooling Tower Combined With the Area Ambient Under Calm Wind Conditions

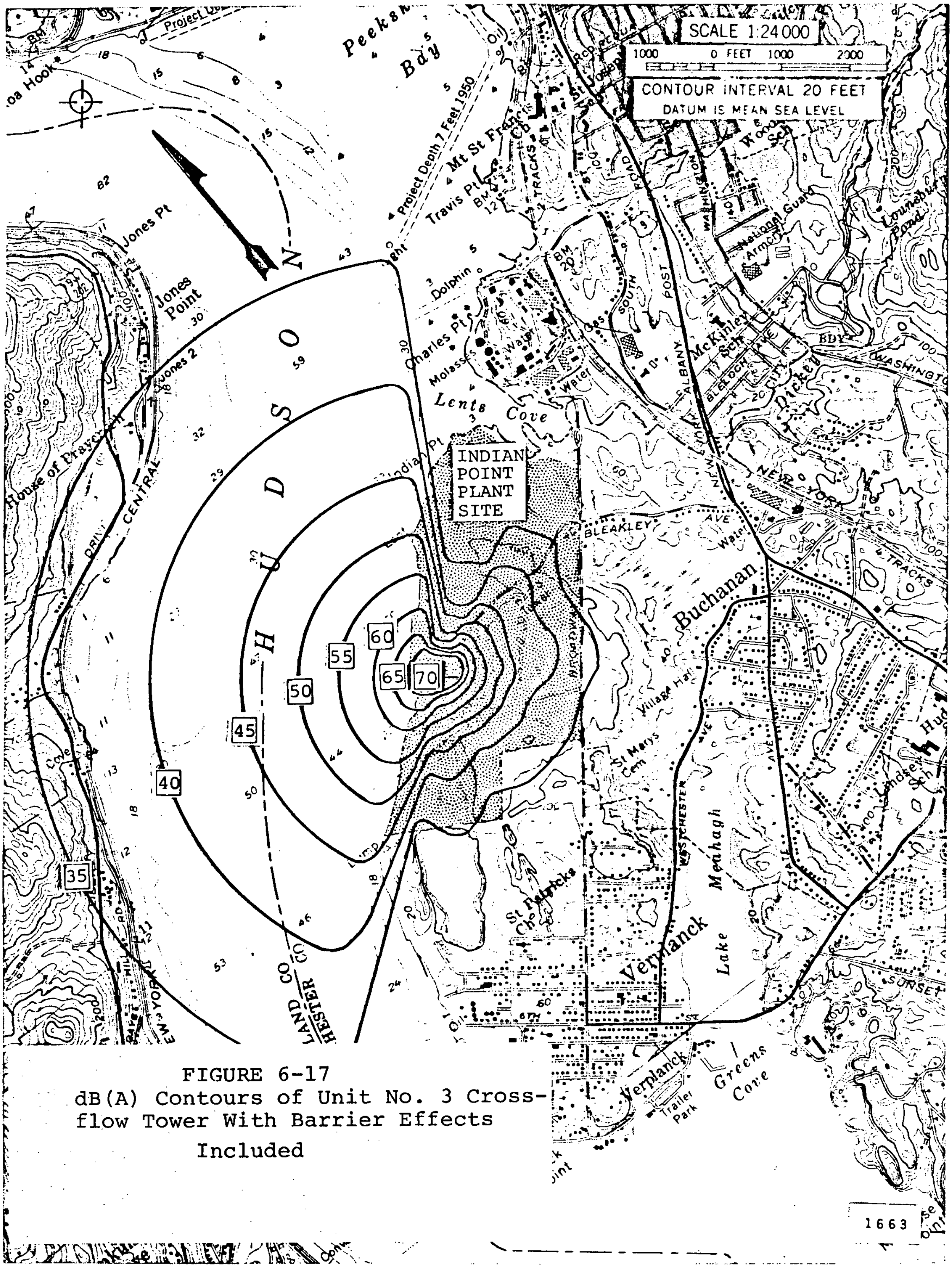


FIGURE 6-17
dB(A) Contours of Unit No. 3 Cross-flow Tower With Barrier Effects Included

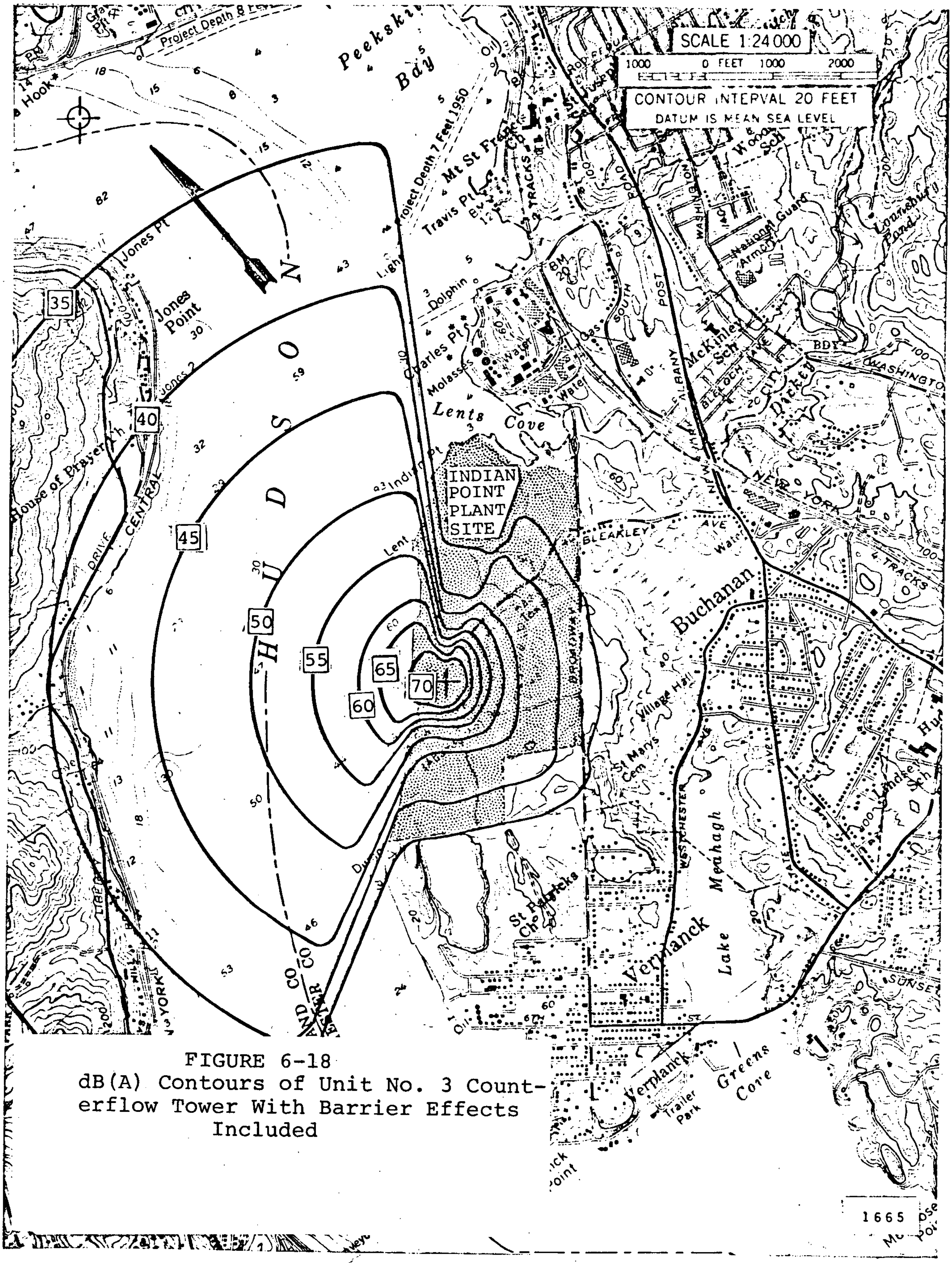


FIGURE 6-18
dB(A) Contours of Unit No. 3 Counterflow Tower With Barrier Effects Included

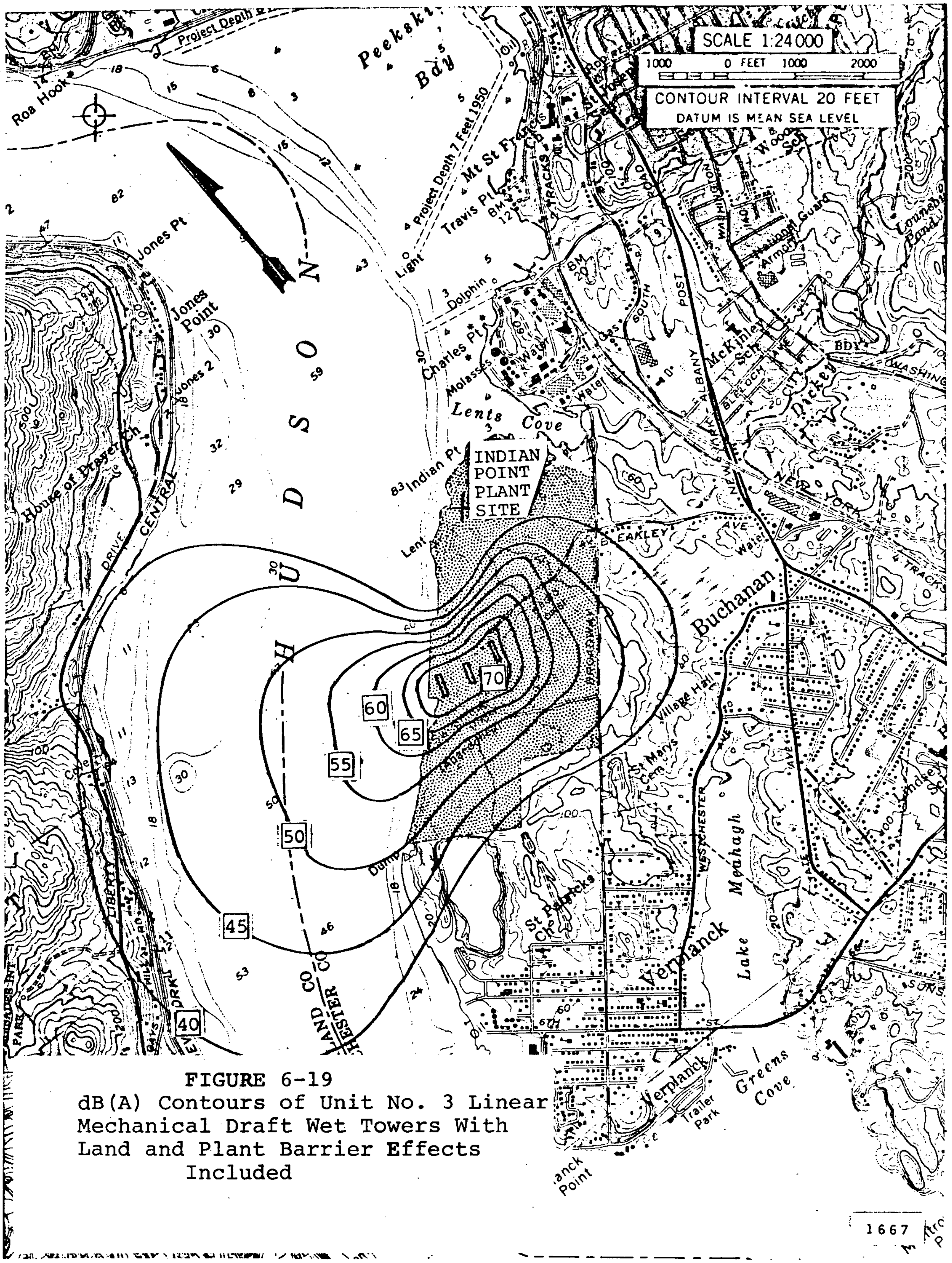


FIGURE 6-19
dB(A) Contours of Unit No. 3 Linear Mechanical Draft Wet Towers With Land and Plant Barrier Effects Included

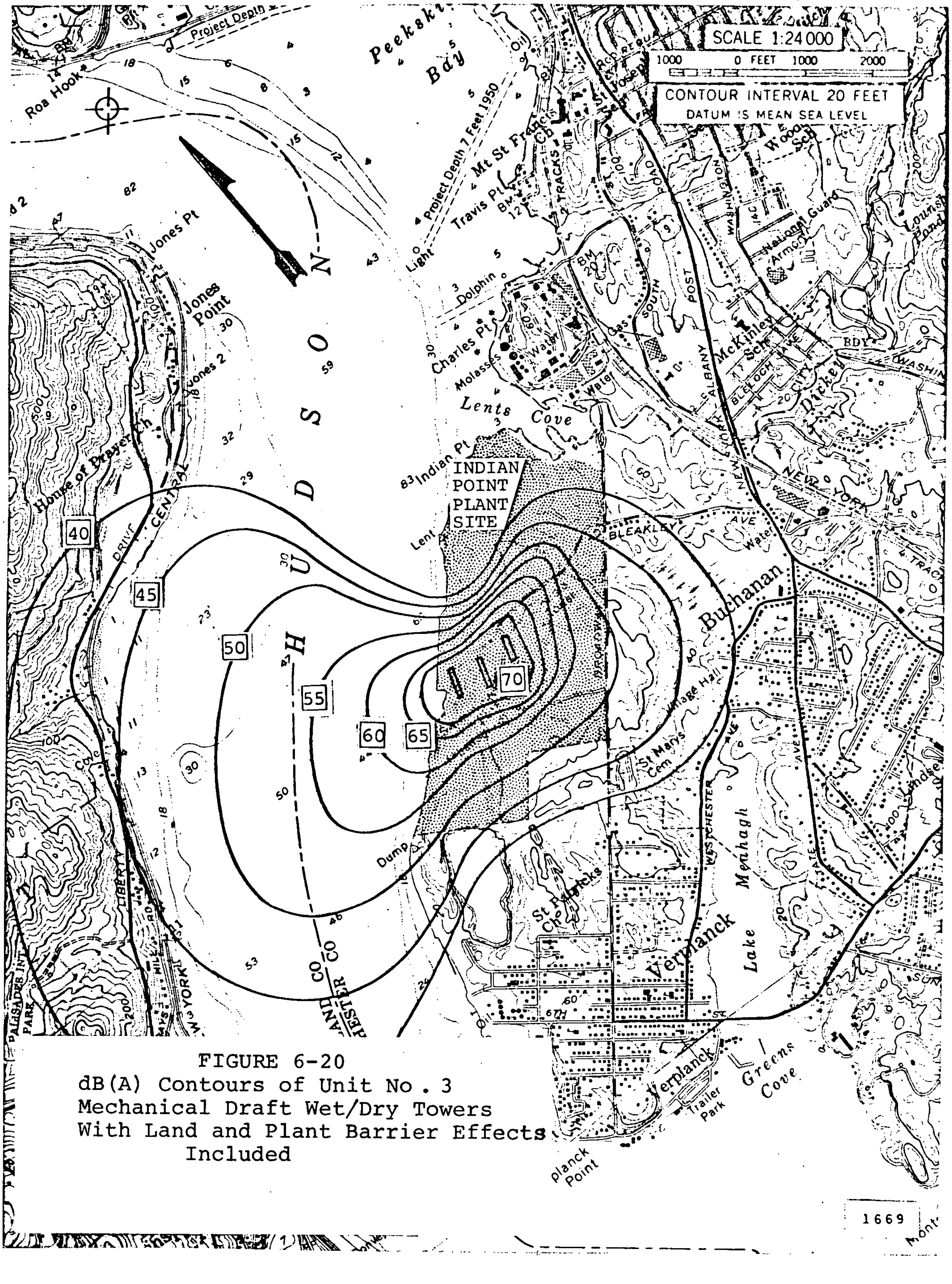


FIGURE 6-20
dB(A) Contours of Unit No. 3
Mechanical Draft Wet/Dry Towers
With Land and Plant Barrier Effects
Included

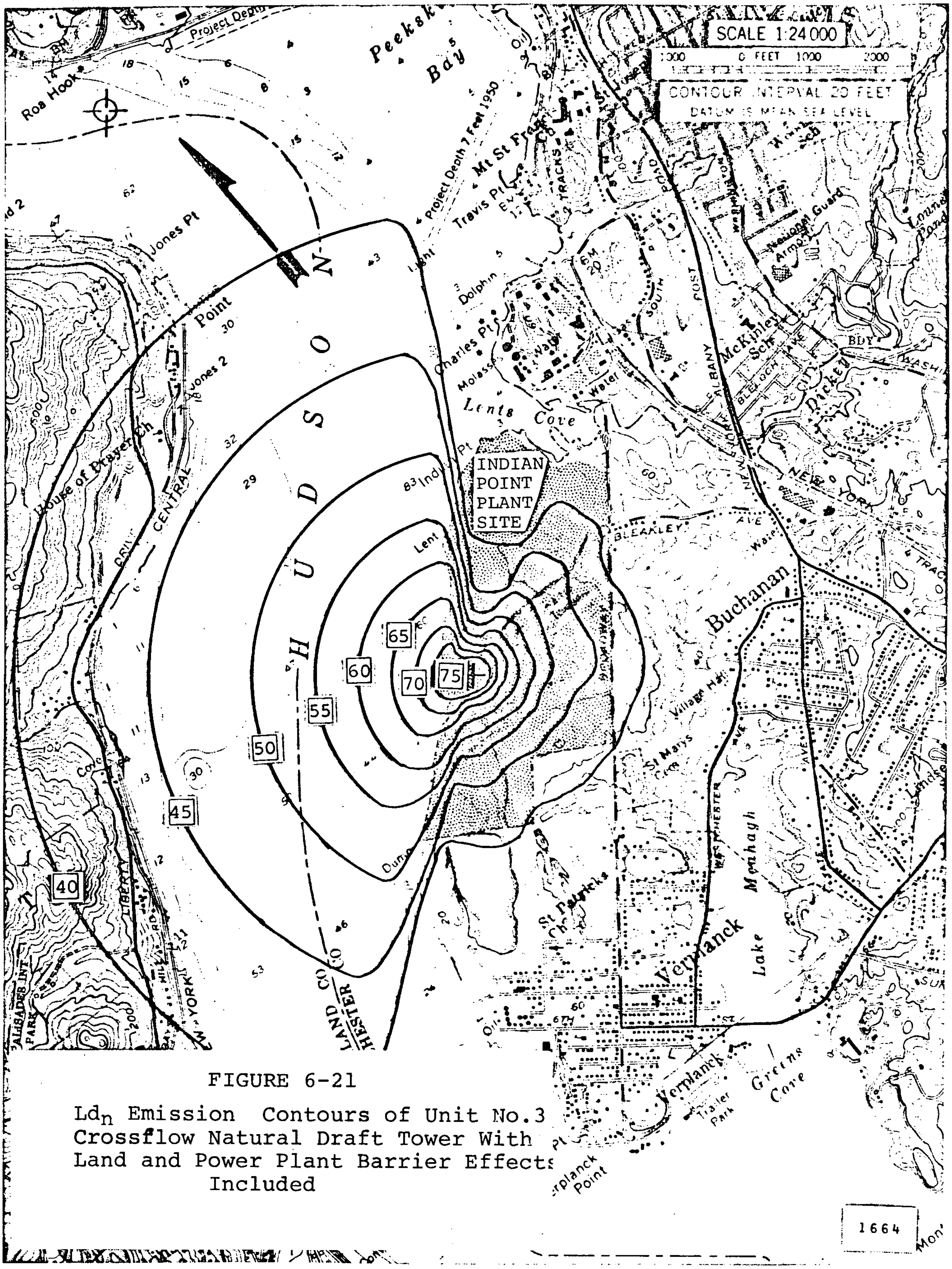


FIGURE 6-21

Ld_n Emission Contours of Unit No.3 Crossflow Natural Draft Tower With Land and Power Plant Barrier Effects Included

1664

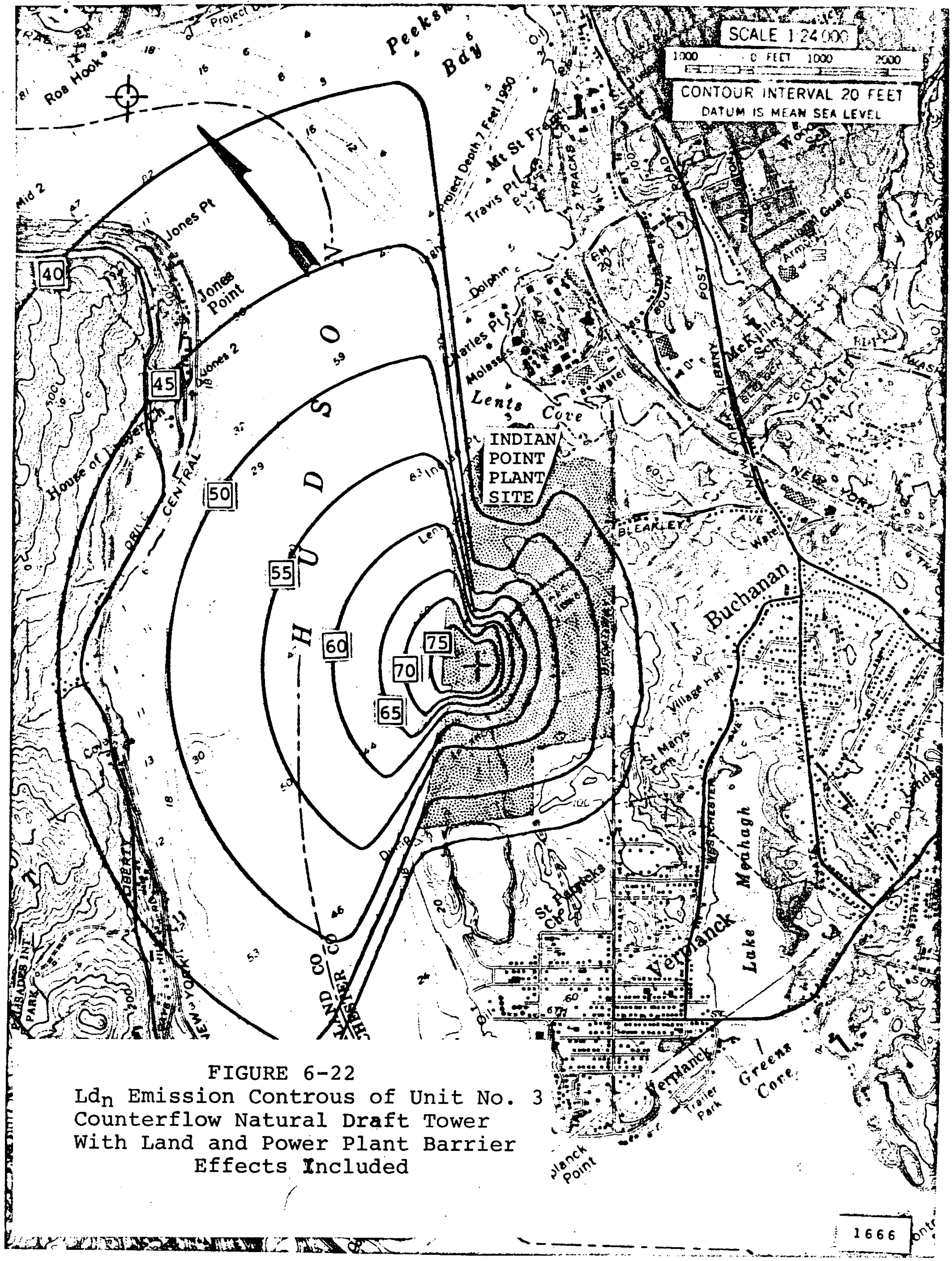


FIGURE 6-22
Ld_n Emission Controus of Unit No. 3
Counterflow Natural Draft Tower
With Land and Power Plant Barrier
Effects Included

1666

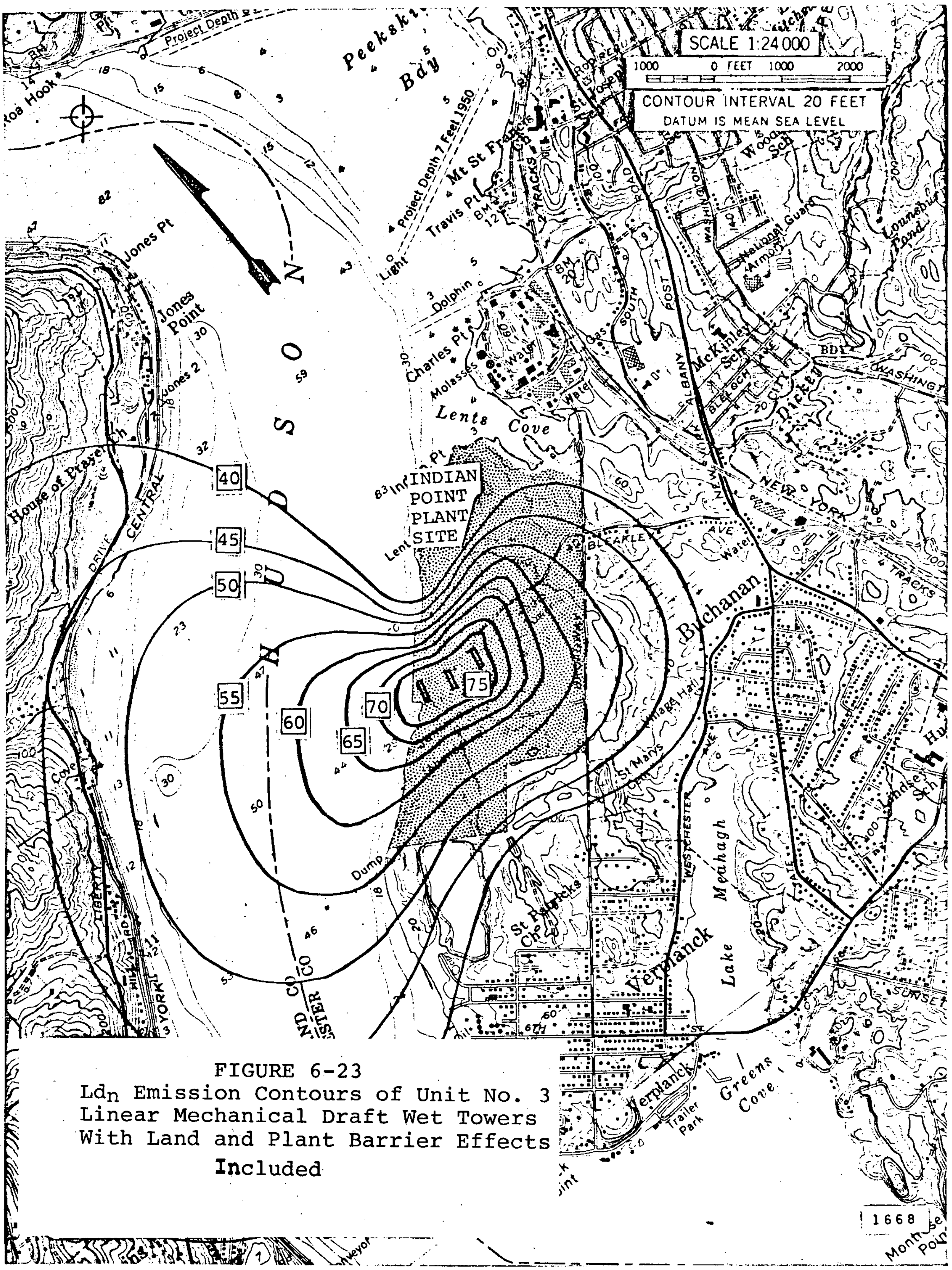


FIGURE 6-23
Ld_n Emission Contours of Unit No. 3
Linear Mechanical Draft Wet Towers
With Land and Plant Barrier Effects
Included

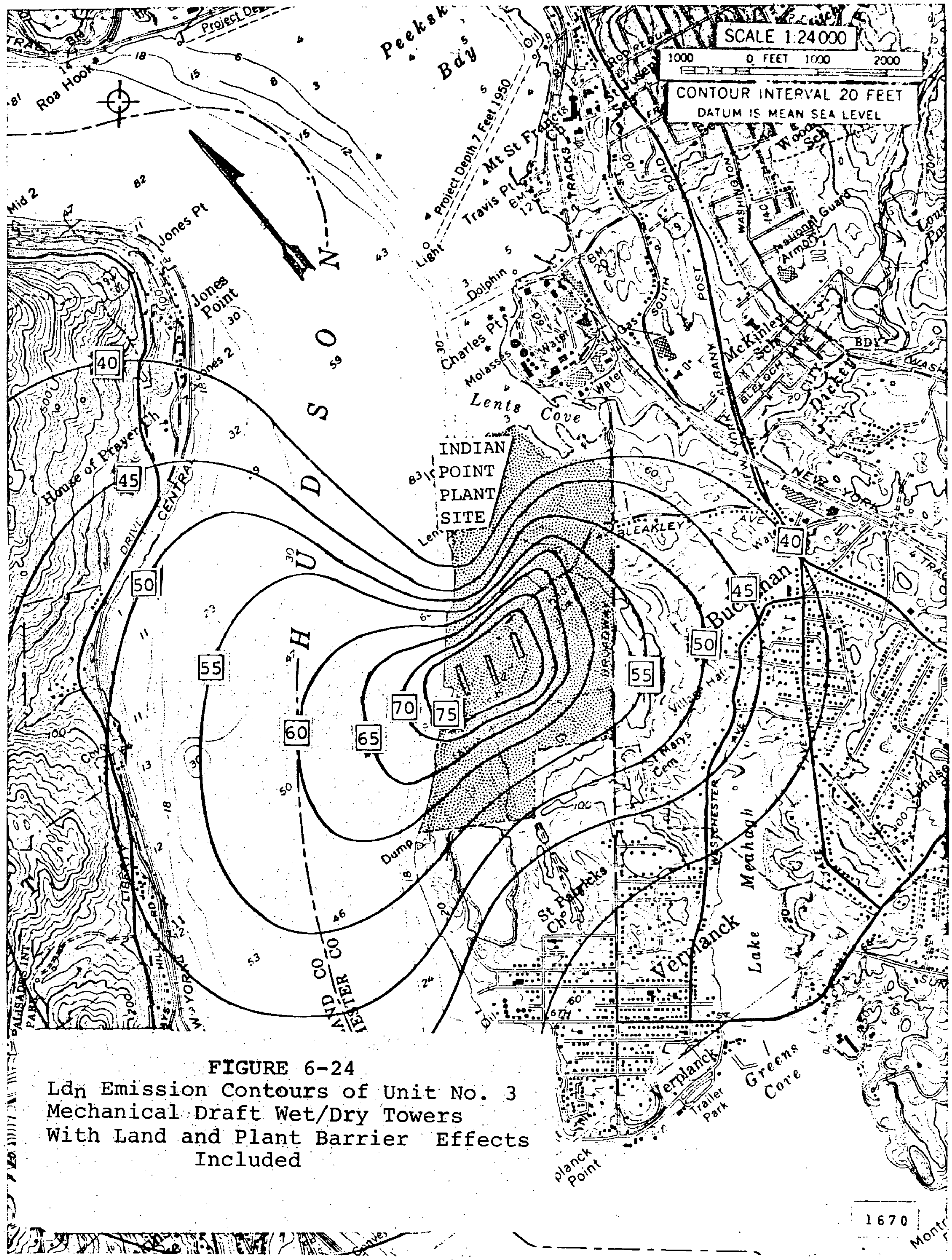


FIGURE 6-24
Ldn Emission Contours of Unit No. 3
Mechanical Draft Wet/Dry Towers
With Land and Plant Barrier Effects
Included

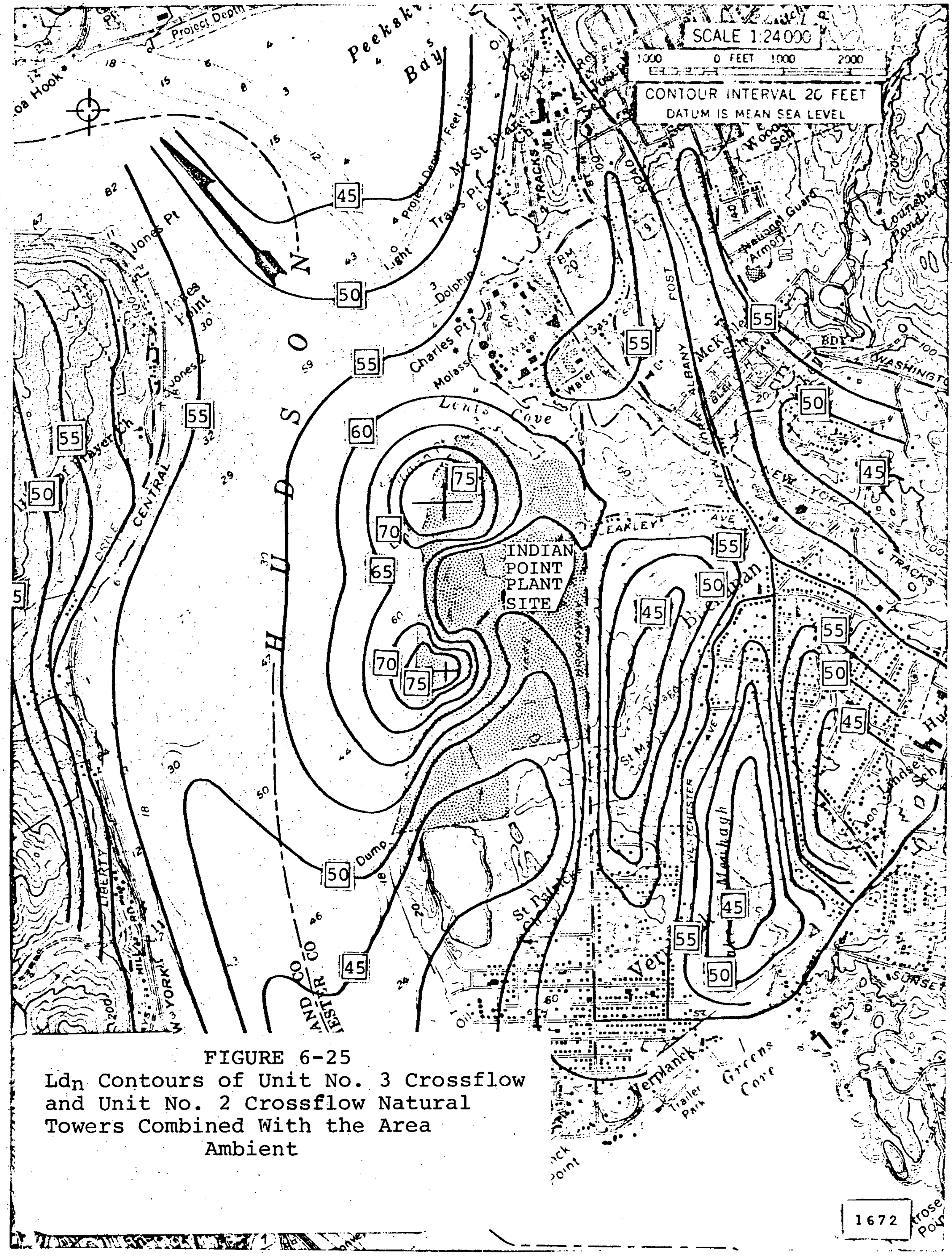


FIGURE 6-25
L_{dn} Contours of Unit No. 3 Crossflow and Unit No. 2 Crossflow Natural Towers Combined With the Area Ambient

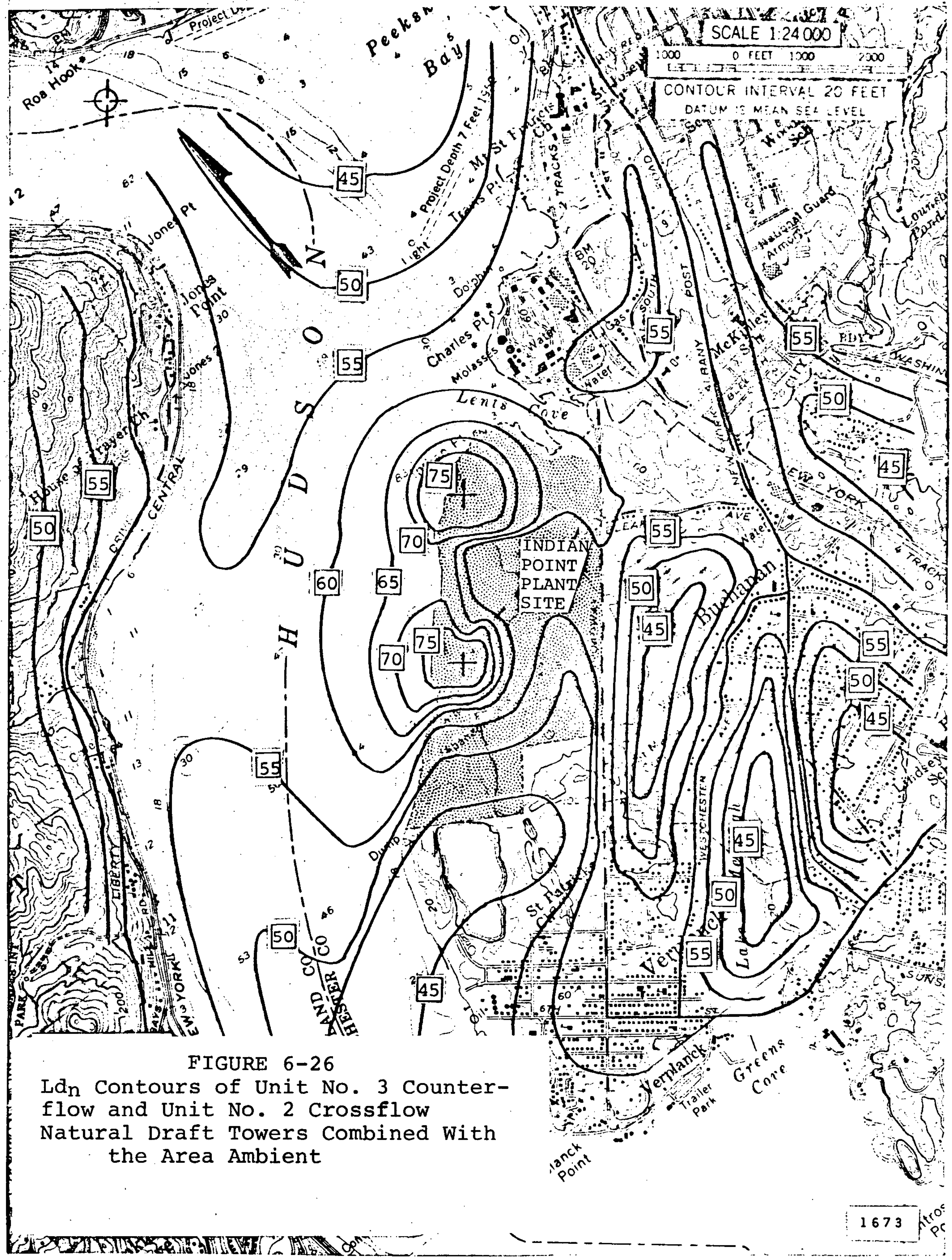


FIGURE 6-26
L_{dn} Contours of Unit No. 3 Counter-flow and Unit No. 2 Crossflow Natural Draft Towers Combined With the Area Ambient

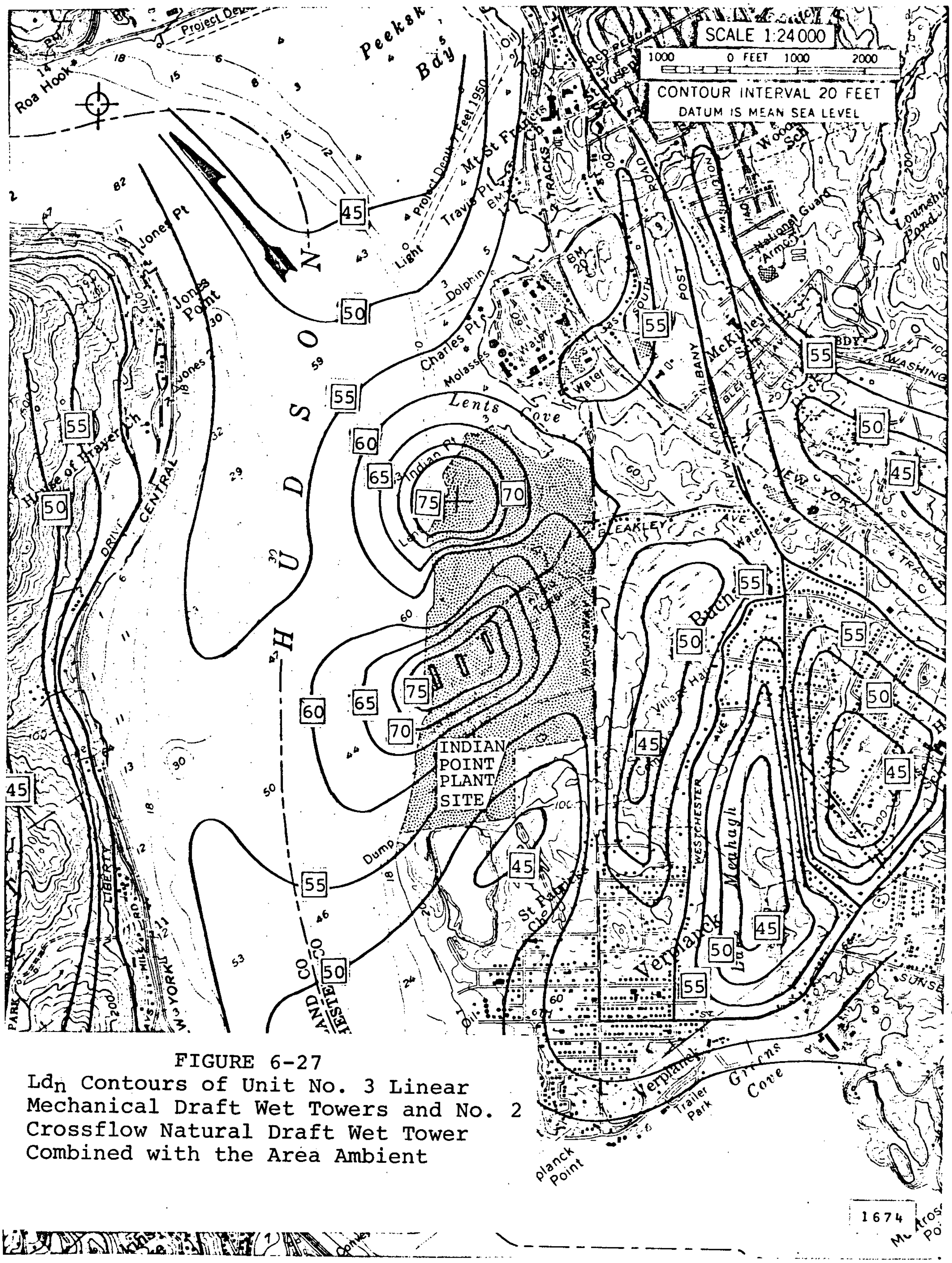


FIGURE 6-27
L_{dn} Contours of Unit No. 3 Linear Mechanical Draft Wet Towers and No. 2 Crossflow Natural Draft Wet Tower Combined with the Area Ambient

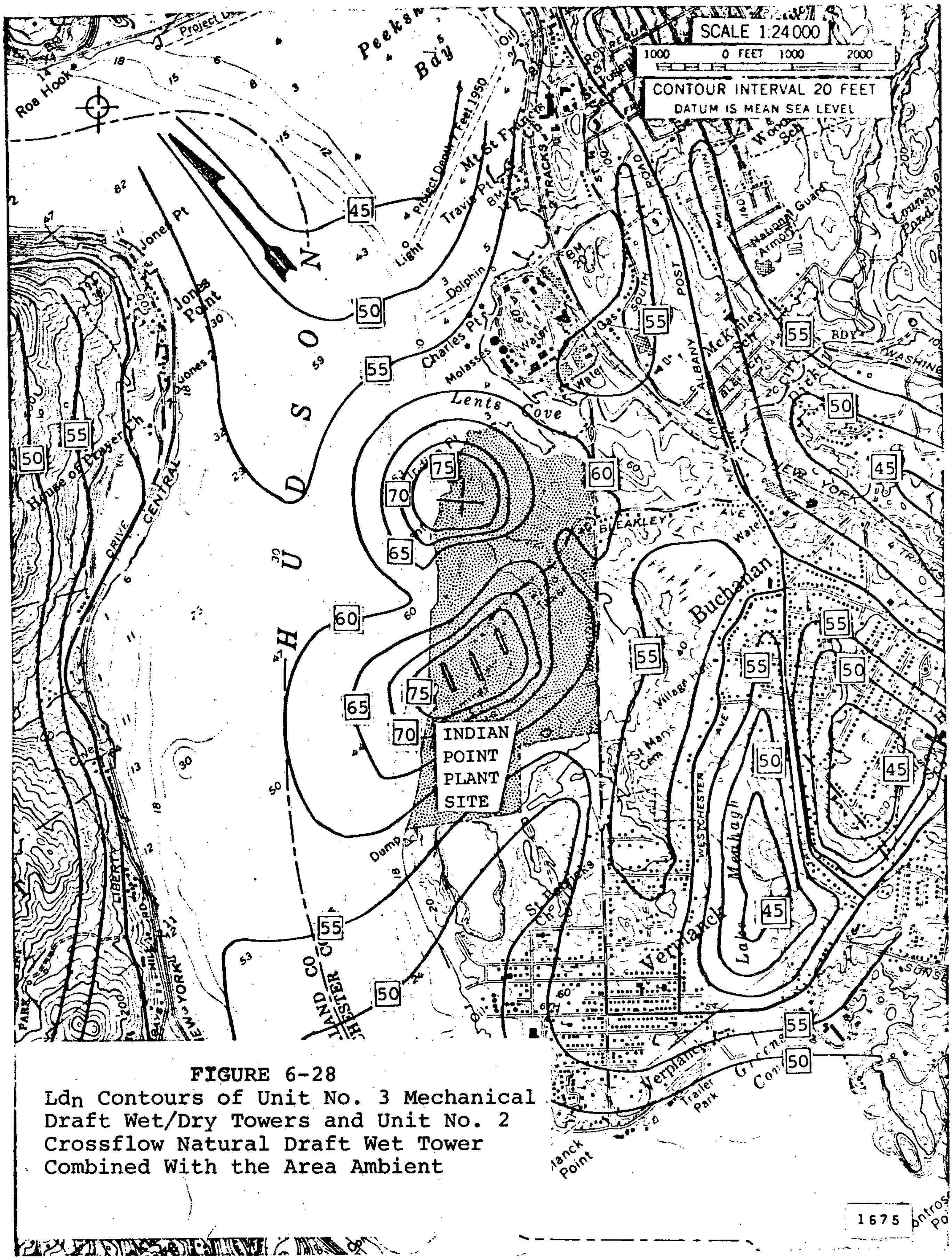


FIGURE 6-28
Ldn Contours of Unit No. 3 Mechanical Draft Wet/Dry Towers and Unit No. 2 Crossflow Natural Draft Wet Tower Combined With the Area Ambient

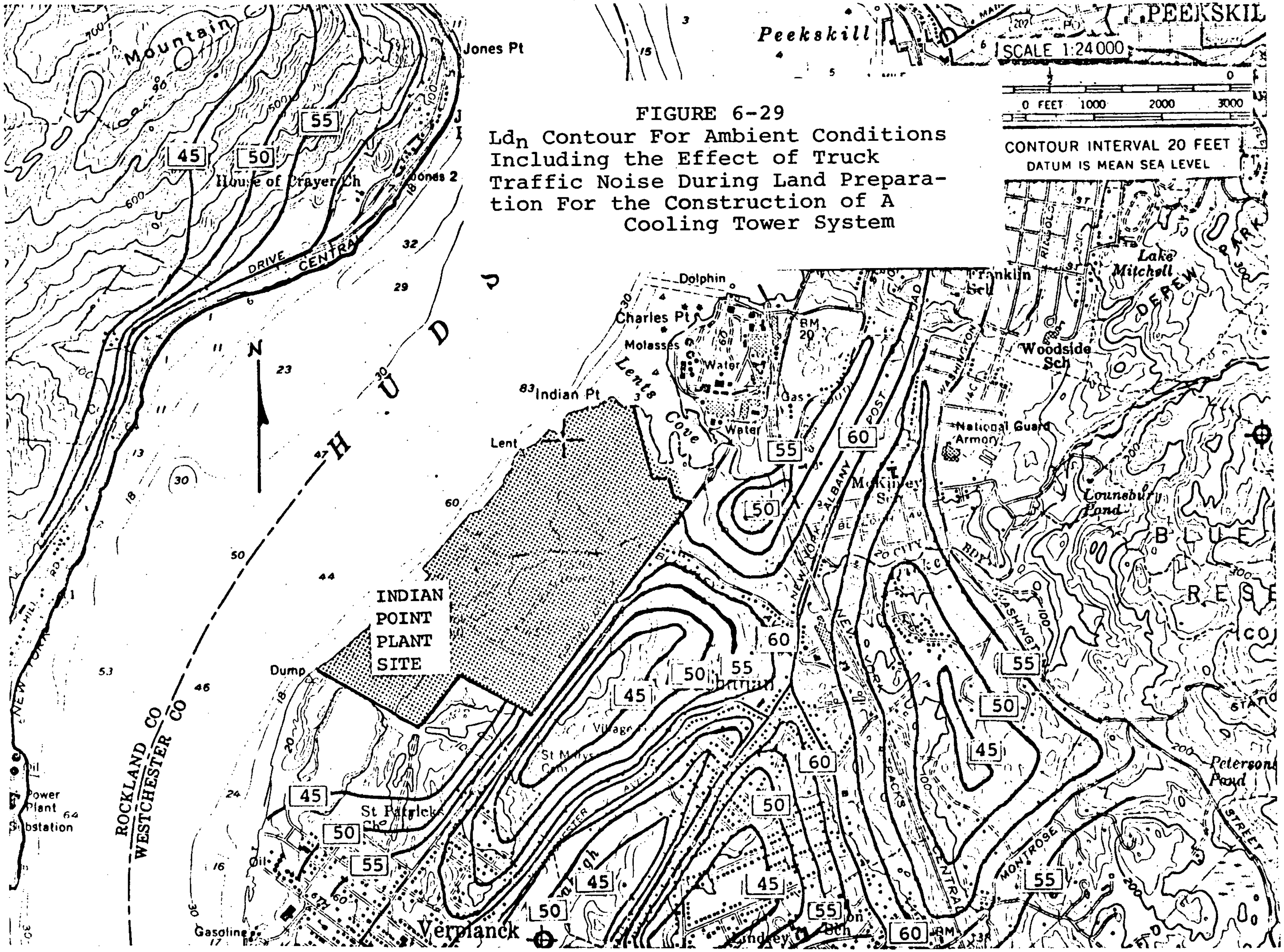
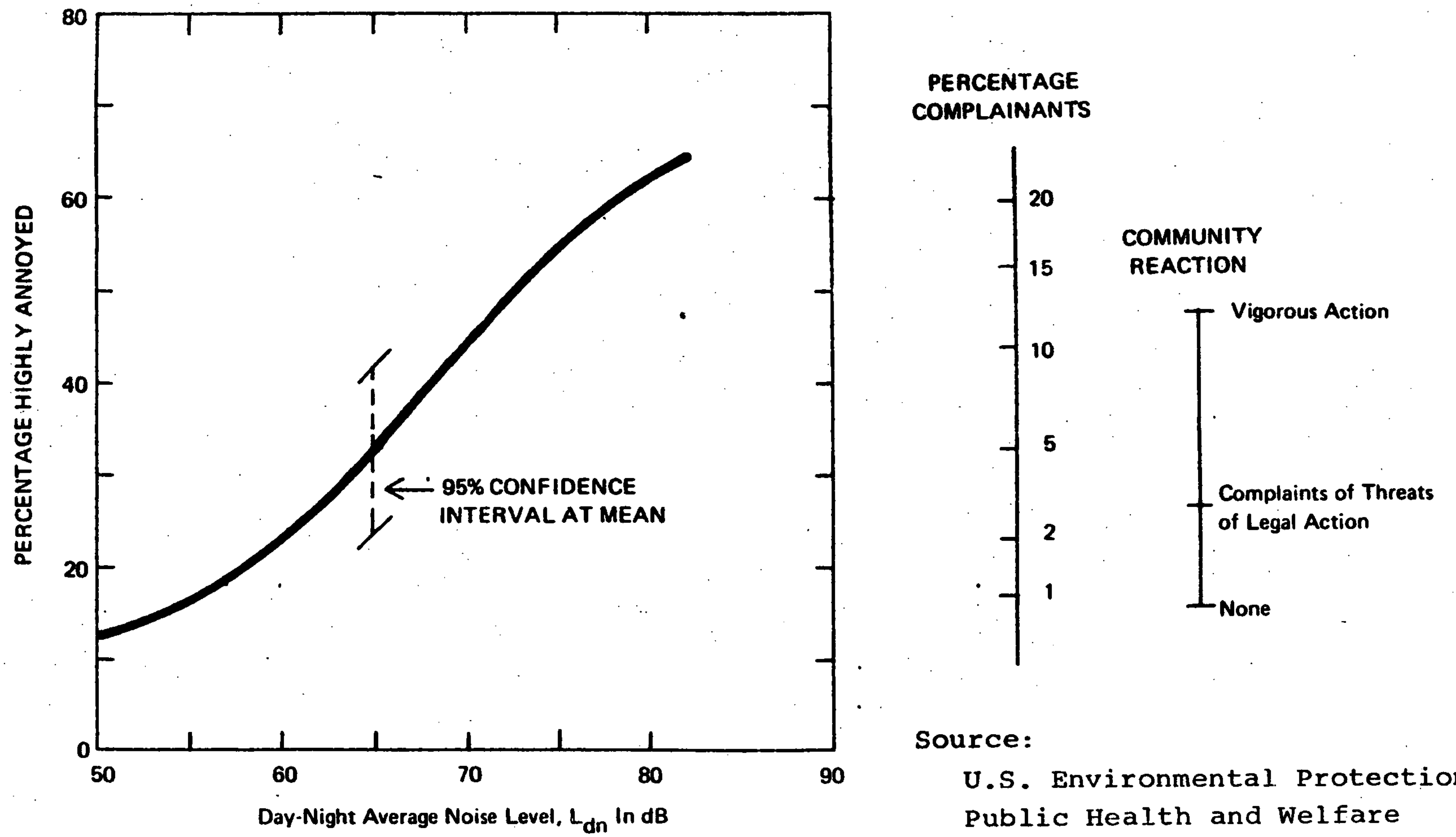


FIGURE 6-29
Ld_n Contour For Ambient Conditions Including the Effect of Truck Traffic Noise During Land Preparation For the Construction of A Cooling Tower System



Source:
U.S. Environmental Protection Agency
Public Health and Welfare
Criteria for noise, July 27, 1973

Figure 6-30

Intercomparison of Various Measures of Individual Annoyance and Community Reaction as a Function of the Day-Night Average Noise Level

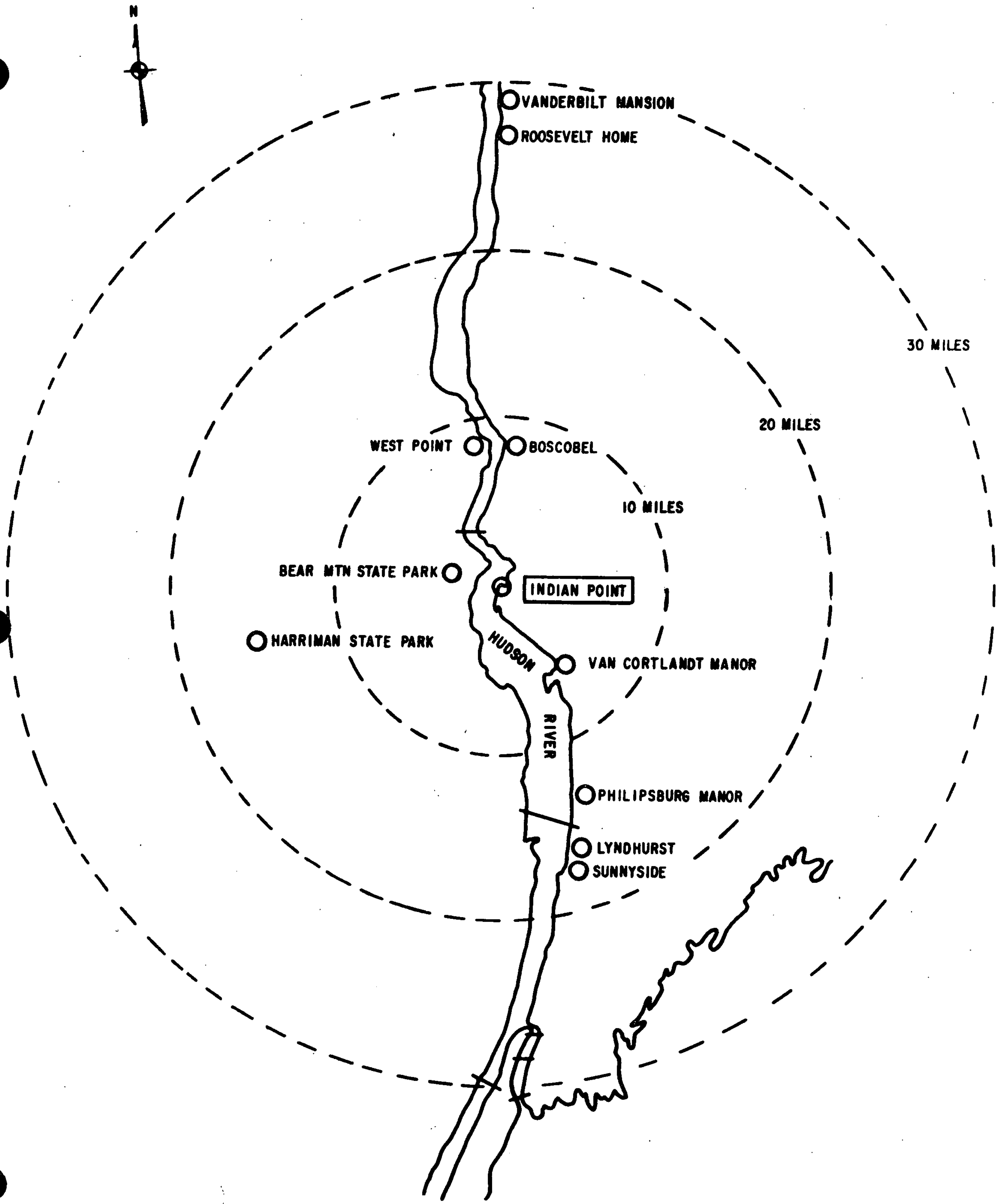


FIGURE 6- 32
MAJOR RECREATIONAL FACILITIES
NEAR INDIAN POINT SITE

7.0 TECHNICAL SPECIFICATION REVISIONS

Operation of Indian Point Unit No. 3 with an alternative closed-cycle cooling system is expected to meet the requirements of the present radiological technical specifications set forth in Appendix A to Facility Operating License No. DPR-64. The present environmental technical specification requirements for three unit operation, Appendix B to that License, however, were prepared specifically for the existing once-through cooling system. If a closed-cycle cooling alternative is to be backfitted on Indian Point Unit No. 3, the environmental technical specifications must be revised to reflect such a change.

For example, a closed-cycle cooling system would alter the thermal and hydraulic characteristics of plant operation. Both the non-recoverable heat and the cooling water discharged to the Hudson River as well as the water withdrawn from the Hudsn River in closed-cycle operation are only a fraction of the once-through cooling system requirement. Therefore, the limiting conditions for operation, monitoring requirements, and surveillance programs must be modified accordingly. With respect to chemical and radioactive emissions, closed-cycle cooling operation would increase the concentration of such effluents; however, since the operation of Indian Point Unit No. 3 would still be within the present technical specification requirements relating to such effluents, revision of those environmental technical specifications is considered minor.

Revision of the environmental technical specifications would not influence the evaluation of the economic and environmental impact of a closed-cycle cooling alternative. Therefore, a detailed study of such revisions is not presented in this report. Con Edison will submit to the NRC its proposed changes to Appendix B to Facility Operating License DPR-64 prior to the cessation of once-through cooling at Unit No. 3. Revisions to the radiological technical specifications required for the construction of an alternative closed-cycle cooling system will be submitted to the NRC prior to the commencement of such construction. The form and extent of all such revisions would take into account the type of cooling system in use at that time at Indian Point Unit No. 3.

8.0 PREFERRED ALTERNATIVE CLOSED CYCLE COOLING SYSTEM

On the basis of the economic and environmental evaluations which Con Edison has conducted over the past year and has presented in this report and the Indian Point Unit No. 2 cooling Tower Report dated December 2, 1974, a natural draft wet cooling tower system has been selected as the preferred alternative to be constructed and operated at Indian Point Unit No. 3 in the event that a closed cooling system is determined to be necessary. This preference is identical to that established for Indian Point Unit No. 2. A synopsis of this evaluation follows and a detailed summary is contained in Table 8-1.

The annual levelized revenue requirements during the entire service life of the natural draft wet cooing tower system are estimated to be $47,355,000 versus $61,313,000 for linear mechanical draft wet, $66,277,000 for mechanical draft wet/dry $51,231,000 for round mechanical draft wet and $48,666,000 for fan-assisted natural draft wet cooling tower systems. On the basis of purely economic evaluation, then the natural draft wet cooling tower is the preferred alternative Point Unit No. 3.

The environmental evaluation assesses the combined potential impacts of the operation of either natural draft wet, linear or round mechanical draft wet, mechanical draft wet/dry, or fan-assisted natural draft wet cooling tower on Indian Point Unit No. 3, and natural draft wet cooling tower on Indian Point Unit No.

2. The analyses indicate that for the case including either linear or round mechanical draft wet, or fan-assisted natural draft wet cooling towers at Indian Point Unit No. 3 will induce a moderate frequency of occurrence of fogging and icing. For the cases either natural draft wet or mechanical draft wet/dry towers being operated at Indian Point No. 3, the induced fogging and icing problems are not considered significant.

The summer monthly maximum saline deposition from drift discharged by natural draft cooling towers at Indian Point Units No. 2 and 3 is predicted to be 250 Kg/Km^2, and is less than 17 percent of that for the cases using either of the three mechanical draft cooling towers at Indian Point Unit No. 3. The results of botanical studies indicate that the extent and risk of botanical injury due to saline drift from the three types of mechanical draft towers will be much greater than that from either conventional or fan-assisted natural draft towers.

Noise emissions from mechanical draft and fan-assisted natural draft cooling towers will increase noise levels in the neighboring residential zone and risk adverse community reaction. Noise emissions from natural draft cooling towers are not expected to cause an adverse impact.

All feasible alternatives will create an aesthetic intrusion on the Hudson River Valley in the region of Indian Point. The effects of mechanical draft systems are considered markedly less extensive in this regard than those of natural draft alternatives. While the intrusive effect of a hyperbolic structure is a real concern, it is nevertheless a subjective aesthetic impact.

Other environmental impacts of closed-cycle systems which are evaluated include fish mortality due to impingement and entrainment, blowdown toxicity, and atmospheric discharges from fossil-fired facilities used to replace plant annual deratings and energy lost during final tower cut-in. These effects are essentially the same for the five types of closed-cycle cooling systems evaluated, with the exception that mechanical draft systems result in greater use of fossil-fired capability than a natural draft alternate because of larger annual deratings.

From an environmental point of view, linear and round mechanical draft wet cooling towers, due to the significant potential for fogging, icing, botanical injury from drift deposition, and noise emissions, appear to be the least desirable among the five closed-cycle cooling alternatives. The potential problems of botanical injury due to drift deposition and noise emissions also render the mechanical draft wet/dry cooling tower unsatisfactory. The potential problems of fogging, salt deposition, and noise emissions also make the fan-assisted natural draft cooling tower undesirable even if it was considered to be a technically proven alternative for Indian Point Unit No. 3.

A natural draft cooling tower is considered the least objectionable alternative at Indian Point Unit No. 3. As indicated, mechanical draft alternatives can create more adverse environmental impacts than those from a natural draft system. Con Edison's economic and environmental evaluations conclude that a natural draft wet cooling tower system is the preferred alternative closed-cycle cooling system in the event that a closed-cycle cooling system should be determined to be necessary.

TABLE 8-1

ECONOMIC AND ENVIRONMENTAL IMPACTS COMPARISON IN SELECTING A PREFERRED COOLING ALTERNATIVE

Economic Impacts	Natural Draft Wet	Linear Mechanical Draft Wet	Linear Mechanical Draft Wet/Dry	Round Mechanical Draft Wet	Fan-Assisted Natural Draft Wet	Sections
1. Incremental Generating Cost $1,000,000						
Present Value	126.9	164.3	177.6	137.3	130.4	5.3
Annualized	47.4	61.3	66.3	51.2	48.7	5.3
2. Lost Capacity, MWe						
Average Annual derating	33.5	48.5	49.5	48.5	35.5	3.1
Peak Ambient tamp. derating	77.5	82.5	83.5	82.5	79.5	3.1
Environmental Impacts						
1. Natural Surface Water Body						
1.1 Fish impingement or entrapment by cooling water intake structure, lb/year	0	0	0	0	0	6.6
1.2 Passage through or retention in cooling systems						
1.2.1 Fish (striped bass only) % reduction of juvenile	negligible	negligible	negligible	negligible	negligible	6.7

TABLE 8-1 (continued)

Environmental Impacts	Natural Draft Wet	Linear Mechanical Draft Wet	Linear Mechanical Draft Wet/Dry	Round Mechanical Draft Wet	Fan-Assisted Natural Draft Wet	Sections
1.3 Thermal Discharge						
1.3.1 Physical heat, 10^9 BTU/hr.	0.251	0.251	0.251	0.251	0.251	6.2.4
1.3.2 Nonmigratory fish relative scale	0	0	0	0	0	6.2.4
1.3.3 Migratory fish relative scale	0	0	0	0	0	6.2.4
1.4 Chemical Effluents						
1.4.1 Aquatic biota	0	0	0	0	0	6.2.3
1.5 Consumptive use (evaporative losses) 1,000 gpm	15	15	15	15	15	6.2.2
1.6 Radionuclide Effluents						
1.6.1 Tritium, compared with 10CFR20 limits	below limit	below limit	below limit	below limit	below limit	6.3
1.6.2 All other radionuclides compared with 10CFR20 limits	below limit	below limit	below limit	below limit	below limit	6.3

TABLE 8-1 (continued)

Environmental Impacts	Natural Draft Wet	Linear Mechanical Draft Wet	Linear Mechanical Draft Wet/Dry	Round Mechanical Draft Wet	Fan-Assisted Natural Draft Wet	Sections
2. Air*						
2.1 Fogging and icing caused by evaporation and drift, hr/year	4	180	1	130	31	6.1.3
2.2 Increase in acreage within 2,000 meters of Units 2&3 corresponding increased community noise						
$(L_{dn} > 55\text{dB})$	2.1 to 3.6	10.7	26.4	$\sim$ 10.7	$\sim$ 10.7 to 26.4	6.4
$(L_{dn} > 60\text{dB})$	0	2.8	4.0	$\sim$ 2.8	$\sim$ 2.8 to 4.0	6.4
3. Land*						
3.1 Pre-emption of land, acres	23	31	33	27	27	6.5
3.2 Aesthetic impacts	severe	moderate	moderate	moderate	severe	6.5
3.3 Salt discharged from cooling towers						
3.3.1 Summer monthly maximum deposition, kg/km^2	250	2,600	1,500	5,000	1,000	6.1.4

*Included impacts from a natural draft wet cooling tower system designed for Indian Point Unit No. 2.

TABLE 8-1 (continued)

Environmental Impacts	Natural Draft Wet	Linear Mechanical Draft Wet	Linear Mechanical Draft Wet/Dry	Round Mechanical Draft Wet	Fan-Assisted Natural Draft Wet	Sections
3.3.2 Botanical effects during a 14-day draught - Area of potential injury of hemlock and 5% - 20% of dogwood and white ash in:						
August, KM^2	22	37	45	31	24	6.1.6
October, KM^2	9	28	28	12	10	6.1.6
3.3.3 Facilities effects (structural)	light	moderate	moderate	moderate	light	6.1.7
3.3.4 Electrical equipment effects	light	moderate	moderate	moderate	light	6.1.7

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