People and the Sound

POWER AND THE ENVIRONMENT

A Planning Report prepared for the New England River Basins Commission by Federal Power Commission staff

New England River Basins Commission

The Long Island Sound Regional Study is a "level B water and related land resources study." It was conducted under provisions of the federal Water Resources Planning Act of 1965. The Plan which has been developed was prepared by a team of federal, state, and regional officials, local citizens, and the scientific community, under the overall coordination of the New England River Basins Commission. It is a part of the Commission's comprehensive, coordinated joint plan for the water and related land resources of its region, which includes New England and the New York portions of Long Island Sound.

The plan for Long Island Sound recommends a program for action by federal, state, and local governments; it does not bind them to undertake specific recommended actions. To assist in the evaluation and implementation process, the following reports have been prepared:

A PLAN FOR LONG ISLAND SOUND: A SUMMARY. Highlights of the plan and a brief discussion of the rationale leading to recommendations.

A PLAN FOR LONG ISLAND SOUND: SUPPLEMENT. A more comprehensive planning document which enumerates the major alternatives considered in formulating the recommendations, together with an explanation of how the plan was prepared, who did the work, and background information organized both by subject matter and by geographical sub-regions of the Study Area.

PLANNING REPORTS. Each planning report was developed by a "Work Group," chaired by a federal agency, with the active participation of state and local agencies, other federal agencies and citizen and scientific advisors. These reports incorporate data (originally published in a series of Interim Reports) which estimate people's demands for the resources of the Sound region, the requirements needed to meet those demands, the existing capacity of the region to meet the requirements, and any deficiencies noted.

The second half of each planning report develops solutions by stating objectives in terms of satisfying defined needs, suggesting alternative ways to achieve the objective, evaluating each alternative in terms of environmental, economic, and social criteria, developing economic, environmental, and composite plans, and finally making recommendations.

The following Planning Reports were prepared:
Water Management by the U. S. Environmental Protection Agency, and the States of New York and Connecticut.
Land Use by Ralph M. Field and Associates for the U. S. Department of Housing and Urban Development.
Outdoor Recreation by the U. S. Department of the Interior, Bureau of Outdoor Recreation.
Fish and Wildlife by the U. S. Department of the Interior, Fish and Wildlife Service; and the U. S. Department of Commerce, National Marine Fisheries Service.
Shoreline Appearance and Design by the U. S. Department of the Interior, National Park Service and Roy Mann and Associates.
Marine Transportation by the U. S. Department of the Army, Corps of Engineers.
Power and the Environment by Federal Power Commission staff.
Mineral Resources and Mining by the U. S. Department of the Interior, Bureau of Mines.
Flood Damage Reduction by the U. S. Department of the Army, Corps of Engineers; and the U. S. Department of Agriculture, Soil Conservation Service.
Erosion and Sedimentation by the U. S. Department of the Army, Corps of Engineers; and the U. S. Department of Agriculture, Soil Conservation Service.
OTHER REPORTS published in conjunction with the Study are:
An Economic Perspective by the U. S. Department of Agriculture, Economic Research Service; and the U. S. Department of Commerce, Bureau of Economic Analysis. An examination of the economic and demographic trends in the region, with data for use as the basis of all projections made in the Study.
Shoreline Appearance and Design: A Planning Handbook by Roy Mann Associates, Inc., for the U. S. Department of the Interior, National Park Service. Recommended management procedures for protecting and enhancing the region's scenic resources.
Sources and Movement of Water by the U. S. Geological Survey, Water Resources Division; and the National Oceanic and Atmospheric Administration. A summary of the hydrology and climate of the region.
Soils by the U. S. Department of Agriculture, Soil Conservation Service. An inventory and analysis of soil composition in the region.

For a complete listing of reports published by or in conjunction with the Study, see Appendix A of the Supplement. Copies of these reports are available from:

New England River Basins Commission
55 Court Street
Boston, Mass. 02108

National Technical Information Service
Springfield, Va. 22151

POWER AND THE ENVIRONMENT

a Planning Report

Long Island Sound Regional Study
New England River Basins Commission
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Prepared by the
New York Regional Office
of the
FederalPower Commission

FOREWORD

Long Island Sound is one of the nation's unique and irreplaceable natural resources. An almost fully enclosed arm of the ocean, it has over 1300 square miles of water surface and over 600 miles of coastline. Spreading eastward along both shores from the great metropolitan center which lies at the Sound's western end, a growing concentration of increasingly affluent people make ever greater demands on this urban sea. At the same time, there is a growing feeling that the conflicting demands are destroying the Sound, and that the problems must be resolved if the Sound is to be preserved.

The Long Island Sound Regional Study is a comprehensive planning effort by the Federal government and New York and Connecticut, led by the New England River Basins Commission. Assisting the Commission are professionals from many disciplines representing the Federal, state and regional agencies listed on the back cover, a Citizen Advisory Committee, and a Research/Planning Advisory Committee composed of members of the region's scientific community.

> THE GOAL OF THE STUDY IS TO PRODUCE A PLAN OF ACTION BY THE SPRING OF 1975 WHICH BALANCES THE NEEDS TO PROTECT, CONSERVE AND WISELY DEVELOP THE SOUND AND ITS RELATED SHORELANDS AS A MAJOR ECONOMIC AND LIFE-ENRICHING RESOURCE FOR THE 12 MILLION PEOPLE WHO LIVE NEAR IT.

This planning report is one of a series. The first half of each report is problem-oriented. It summarizes demands placed upon the Sound and adjacent lands, their capacity to supply these demands, and present or expected needs to be met, if it is determined that supply should meet demand. The last half of each report is solution-oriented. It formulates tentative objectives and alternative measures for achieving the objectives. It evaluates the environmental, economic and social implications of each measure and formulates alternative plans. One plan is tentatively recommended. The planning reports are printed and distributed before the final version of main report. Therefore, final recommendations are to be found only in the main report, scheduled for publication in the Spring of 1975. Planning reports in this series include:

- Land Use
- Water Management
- Shoreline Appearance & Design
- Erosion and Sedimentation
- Flood Damage Reduction
- Recreation
- Fish and Wildlife
- Marine Transportation
- Minerals
- Power and the Environment

SUMMARY

PURPOSE OF THIS REPORT

To devise a program for supplying an adequate and reliable source of electrical energy with a minimum of environmental and social disruption.

DESCRIPTION OF THE POWER MARKET

In developing a regional plan for the Long Island study area, the planner is prevented from relying on isolated demand-supply relationships due to the flux of power flows into and out of the area. As in the past, the area's resources for bulk power generation serve markets extending beyond its boundaries. On the other hand, various sections of the study area obtain their supply of power from sources outside its boundaries. In view of this and other factors, the market examined for the survey has to be considerably greater than the particular boundary of the study area. The power market and its subdivisions are described as follows:

The Power Market consists of the service areas of all the utilities forming the New England Power Pool and the New York State Power Pool (Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island, and New York). Its land area is 111,000 square miles and it had a population of 30 million in 1970.

The Long Island Sound Service Area (LISSA) consists of the service areas of all the utilities serving the Long Island Sound study area (all of Connecticut plus the following counties in New York: Suffolk, Nassau, Queens, Kings, Richmond, Bronx, Manhattan, and part of Westchester). Its land area is 6,800 square miles and it had a population of 14 million in 1970.

The Long Island Sound Study Area (LIS Study Area) consists of the Long Island Sound shoreline and adjacent areas (part of Connecticut plus parts of Suffolk, Nassau, Queens, Bronx, and Westchester counties in New York). Its land area is 1,800 square miles and it had a population of about 5.3 million in 1970.

DEMAND AND SUPPLY

Power Market

The energy requirements in the power market area for 1972 were 175 billion kilowatt-hours, with an associated peak demand of almost 31 million kilowatts occurring in December. Of the 204 utility systems serving the market, only 64 were privately owned. However, these systems accounted for about 93 percent of the area's total energy requirements.

The market has shown a steady increase in the rate of growth of its energy requirements over the past 30 years. The 10-year compound rate of growth in the years 1940-1950 was 5.1 percent, then increased to 5.6 percent in the years 1950-1960, and finally reached 6.4 percent in the years 1960-1970. It is expected, at this time, that the rate of growth will reach its peak between 1970 and 1980 and then gradually decline.

In 1972, the market's energy requirements were supplied by 490 power plants of various types and sizes, generating 174 billion kilowatt-hours. The total installed capacity in these plants was 41 million kilowatts. As in the past, fossil steam generation provided the bulk of power (68%)for the area. It is anticipated that this mode of generation will continue to dominate in the near future, while nuclear steam generation will advance at a rapid rate and eventually overtake it. In 1972, nuclear steam generation accounted for less than 10 percent of the total market's generation.

Long Island Sound Service Area (LISSA)

In 1972, the energy requirements in the LISSA were 69 billion kilowatt-hours. The area was served by 20 utility systems, 11 of which were privately owned. However, the privately owned systems accounted for over 98 percent of the area's total energy requirements.

The utility systems in the LISSA operated 91 power plants in 1972, with a combined installed capacity of almost 19 million kilowatts. The total energy generated in the area during 1972 was 69 billion kilowatt-hours, which was sufficient to meet its energy requirements. This is not to say that every operating system operated in a closed self-supplied pattern. Rather, anticipated and unexpected variations in daily and seasonal loading patterns had to be met by interchanges of power. As in the market, the largest block of generation (70%) was in fossil steam. It is anticipated, at this time, that the nuclear portion of the generation mix will have the greatest rate of growth.

Long Island Sound Study Area

In 1972, 30 power plant sites were physically located within the boundaries of the LIS study area. These plants, with a combined installed capacity of over 5 million kilowatts, generated 25 billion kilowatt-hours and contributed to the energy supply of the market as a whole. But mainly, this generated energy was used to meet the demand of LISSA. Due to power flows into and out of the area, it is impossible to determine how much of this generated energy was actually used within the boundaries of the LIS study area.

The study area contained 30 percent of the service area's installed capacity in 1972 and generated almost 36 percent of LISSA's generation.

The largest block of generation (83%) was in fossil steam whereas the smallest was in hydroelectric generation.

FUTURE ELECTRIC ENERGY REQUIREMENTS

Forecasts of power consumption to 1990 may be made with reasonable degree of accuracy and to 2020 with far less precision. In general the principal tools used in the estimating process are the historical records of past experience, and current trends.

In 1970, power requirements of the selected market area amounted to 158 billion kilowatt-hours, with an associated peak demand of 28 million kilowatts as compared with 85 billion kilowatt-hours and 16 million kilowatts in 1960. This represents a 10-year average annual compound rate of growth of 6.4 percent. It is estimated that this load will increase to 295 billion kilowatt-hours and 54 million kilowatts by 1980, and 2,240 billion kilowatt-hours and 400 million kilowatts by the year 2020. This would mean that the 10-year energy compound rate of growth for the years 1970-1980 would increase to 6.5 percent as compared with the decrease of the 20-year compound rate of growth to 4.6 percent for the years 2000-2020. Estimates were derived by forecasting the needs to 1990 of various classes of service making up the over-all load and then projecting these trends to the year 2020. However, the projections are not straight line extrapolations but are tempered by an expected decrease in the rate of growth of demand. All forecasts must be considered in the light of future possible public or private conservation measures which may be taken. Conservation techniques or special limits on growth could have significant effects on the needs and timing of new capacity.

OBJECTIVE AND ALTERNATIVES MEASURES

The objective was to meet future energy demand in the Long Island Sound region and adjoining areas with full awareness of the likely impact of the development strategy on the physical environment and on consumer costs. Ten alternative measures were considered - they fall into 7 classes...(1) More efficient use of existing facilities, by unit additions or site redevelopment; (2) Urban site acquisition either coastal or inland; (3) Rural site acquisition either coastal or inland, (4) Offshore sites; (5) Reducing the demand; (6) Sanctioned power deficiencies, (7) Reliance on exotics.

EVALUATION

All measures were evaluated in terms of environmental, legal and institutional, social, and economic criteria. All the basic environmental effects that could be identified without complete site investigation were included, some of which are; effect on wildlife, esthetics, historical and cultural considerations, water quality, health and safety, and disturbance of land patterns. Economic considerations included, cost of land, water and cooling devices, fuel transport costs, safety and waste disposal, transmission, and a variety of primary and secondary considerations. Social factors included, community disruption, plant design and landscaping, local tax rates and employment.

ALTERNATIVE PLANS

Historically, the LISSA has been a major energy supplier to the market's demand and this trend is expected to continue. The alternative plans reflect three possible levels of future capacity allocations, national economic efficiency (NED) Plan C, environmental quality (EQ), Plan B, and a composite of the two, Plan A.

Plan A - The service area would continue participation in the market with almost the same percentage of capacity that it has in the past. It would consequently continue to have sufficient capacity to meet its own demand.

Plan B - The service area would have a lower level of participation in the market's capacity requirements, thus putting it into a position of being a net importer of power.

Plan C - The service area, would have a higher level of participation in the market's capacity requirements and would become an exporter of power.

RECOMMENDATION

The recommended plan (Composite Plan A) if implemented, would reinforce the objective of supplying adequate and reliable sources of electric energy to the Long Island Sound Area, maintain the area's high economic potential, assure the least likely impact on the physical environment, and provide for the social well being of the regions inhabitants.

The 1990 plan coalesces five alternative measures with the greatest dependence on, (1) more efficient use of existing sites and (2), rural site acquisition.

The 2020 plan utilizes eight alternatives with the emphasis placed on (1) rural site acquisition, (2) more efficient use of existing sites, and (3) the use of exotic fuel types.

Construction costs in 1974 dollars for the 1990 plan in private investment could be over $5 billion. Construction costs for the 2020 plan, not including research and development costs for exotic types, could be over $30 billion.

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1.0 INTRODUCTION

The objective of Study Element P-10 Power and the Environment is to devise and plan a program for meeting and supplying adequate and reliable sources of electrical energy in the Long Island Sound region and adjoining areas. The likely impact of the development strategy on the physical environment and social values will be explored. The plan will include pertinent data about Long Island Sound's generation capability and alternatives which are presently feasible to meet forecasted needs. Considerations will be given to land and water use criteria, technical innovations, social costs, and environmental effects that have a direct bearing on the location, magnitude, and public preference on power siting.

The Long Island Sound Study is being conducted concurrently with a similar study chaired by the New England River Basins Commission for the Southeastern New England region. The market area for power developed in both regions are quite similar. The market for the Long Island Sound Study includes New York and all of New England, while the Southeastern New England Study is restricted to the six New England States. Interrelationships, tradeoffs and decisions affecting the two regions have been adequately explored by the work group. Objectives and goals have been coordinated to provide a balanced regional supply of power.

The FPC staff, as lead agency, has drawn together information on electric power from other Federal Agencies, State Agencies, regional and municipal agencies, public utilities and private citizens for this report. Electric Power Generation, an Interim Report prepared in July, 1973 for the Long Island Sound Regional Study, has served as the basis for all the inventory information necessary to prepare this final report. Many of the tables from the interim report have been updated to provide the latest information available.

The program suggested in this report, in concert with other study elements and management plans in the Long Island Sound Regional Study, will lead to alternative resource management techniques and public policies for resolving many of the issues that confront the Sound today. It is through the resolution of these issues that we can provide an environment of clean water, open space and beauty that enriches man's experience and enjoyment while maintaining and enhancing the region's economic opportunities.

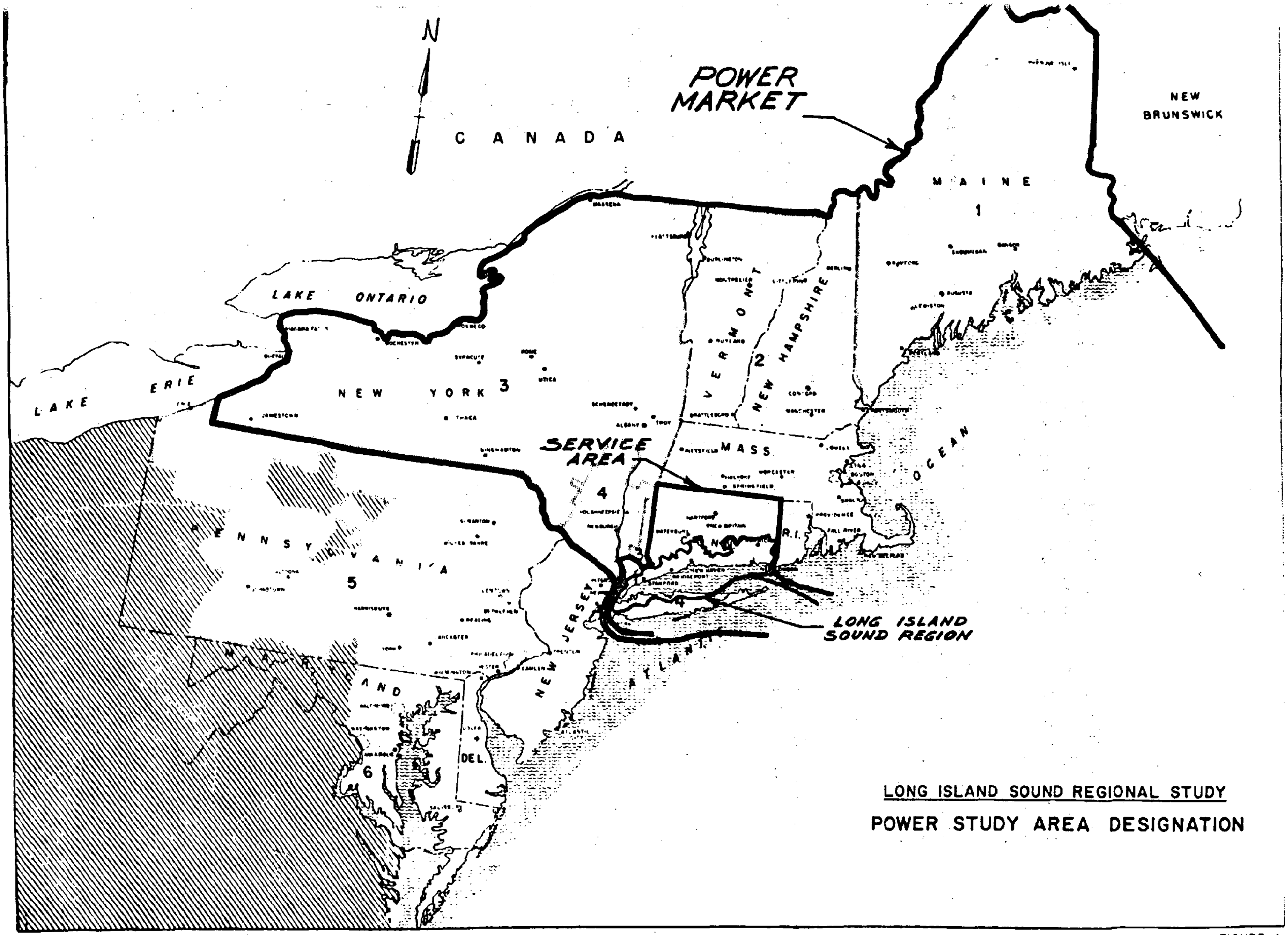
2.0 DESCRIPTION OF THE POWER MARKET

The Federal Power Commission in its regulatory work relating to the assemblage and analysis of statistics on power requirements and supply for the electrical utility industry has divided the contiguous United States into 48 Power Supply Areas (PSA). The PSA's are generally determined on the basis of service areas and operating relationships of utility systems comprising them.

The utilization of any available resources of the Long Island Sound region for bulk power generation would serve, as in the past, markets extending beyond the boundaries of the study area. On the other hand, the economics and technology of modern power generation and transmission also make it advantageous for various sections of the study area to obtain their supply of power from sources outside the area. There are seasonal, chronologic, and contingency needs that require flexibility in meeting an area's demand for electricity. Thus, the flow of power prevents the planner from relying on isolated demand-supply relationships in developing a regional plan. In consideration of these factors and of the existing groupings and operating characteristics among the utility systems serving the Long Island Sound study area, the market examined for the survey has to be considerably greater than the actual boundary of the study area.

The "Power Market" selected for this study consists of the service areas of all the utilities forming the New England Power Pool and the New York Power Pool. The New England area is designated by the Federal Power Commission as Power Supply Area (PSA) 1 (Maine) and PSA 2 (N.H., Vt., Mass., Conn., and R.I.); and New York State, PSA 3 (Upstate N.Y.), and PSA 4 (Downstate N.Y.); see Figure 1. The land area encompassed by the market is about 111,000 square miles and had a population of 30 million persons in 1970. It projected that the number of people will increase to 37.8 million in 1990 and 44 million by 2020.

In order to more closely conform to the Long Island Sound Study Area limits, an area which represents those utilities that actually serve the Long Island Sound has been designated as the "service area" (LISSA). This is necessitated by the lack of reported data on power requirements that are associated with local areas and townships within the study area. The service area includes all of the state of Connecticut, and the following counties in New York State: Suffolk, Nassau, Queens, Kings, Richmond, Bronx, Manhattan, and part of Westchester. The land area encompasses about 6,800 square miles and in 1970 had a population of almost 14 million people. The number of persons in the service area is projected to grow to 17 million in 1990 and to 21.0 million by the benchmark year of 2020.



LONG ISLAND SOUND REGIONAL STUDY

POWER STUDY AREA DESIGNATION

FIGURE 1

In contrast, the Long Island Sound Study Area has an area of about 1800 square miles with a population of about 5.3 million in 1970. Its projected, population is estimated at 7.2 million persons in 1990 and 9.2 million by the year 2020, based on OBERS Projection Series "E".

The above data on population projections have been extrapolated from economic base studies. They are presented here to give the reader a feel for the magnitude and relationship of each successive area of analysis.

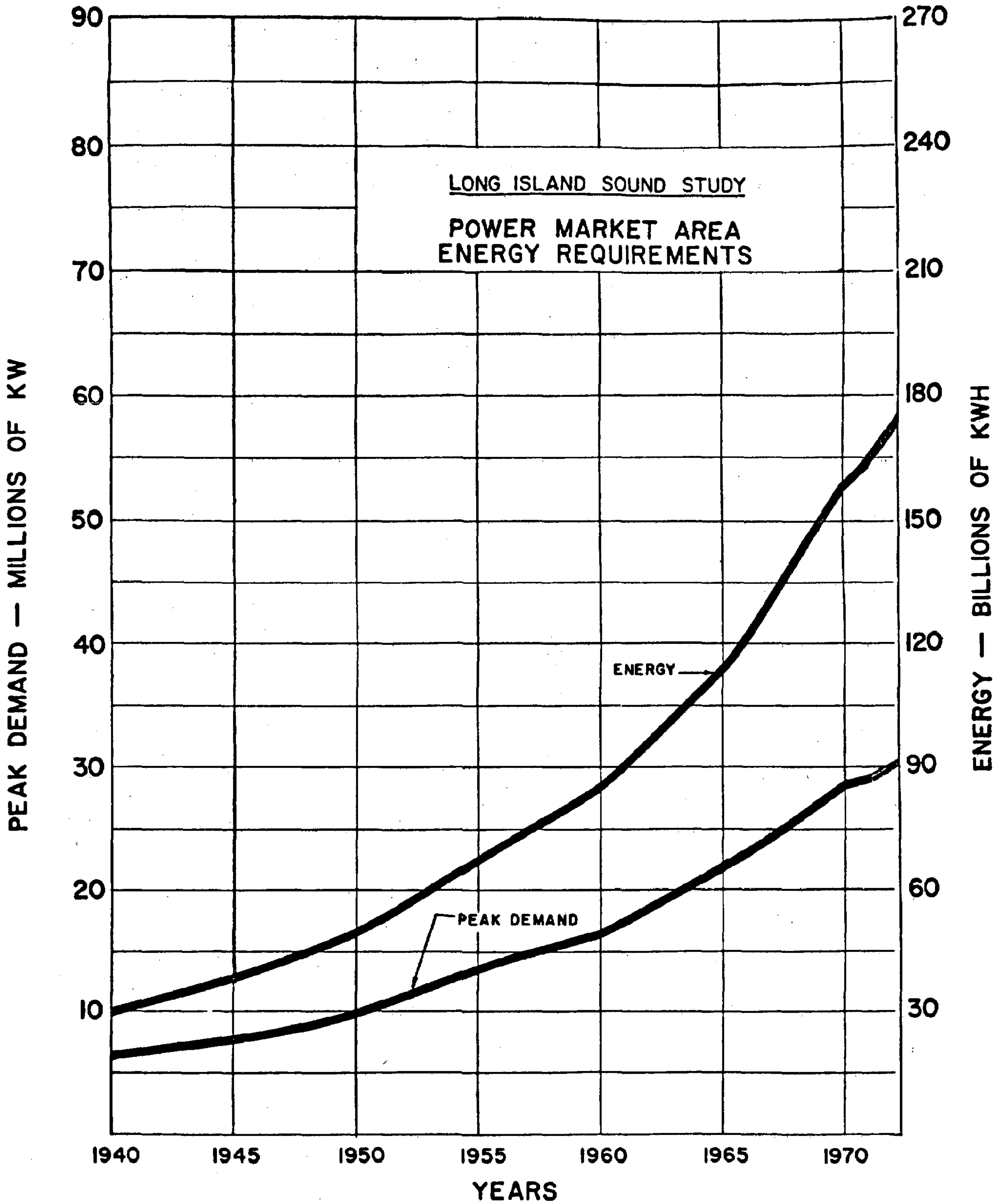
2.1 Market Area and Service Area Requirements and Supply

The energy requirements in the power market area for 1972 were 175,518,000 Megawatt-hours. Total power market area requirements for past years are shown on Table 1 and are graphically represented in Figure 2.

TABLE 1. POWER REQUIREMENTS IN THE MARKET AREA

Year		Energy Requirements /1	Peak Demand /2	Month /3	Load Factor %
1940	New England	8,975	2,102	Dec	48.7
	New York	21,121	4,213	Dec	57.2
	Market	30,096	6,315	Dec	54.4
1950	New England	16,669	3,608	Dec	52.7
	New York	32,782	6,324	Dec	59.2
	Market	49,451	9,932	Dec	56.8
1960	New England	30,468	6,181	Dec	56.1
	New York	54,716	10,074	Dec	61.8
	Market	85,184	16,255	Dec	59.8
1970	New England	61,409	11,868	Dec	59.1
	New York	96,760	17,001	July	65.0
	Market	158,169	28,468	Dec	63.4
1971	New England	65,172	12,098	Dec	61.5
	New York	99,860	18,113	July	62.9
	Market	165,032	29,020	July	64.9
1972	New England	70,956	13,384	Dec	60.5
	New York	104,562	18,915	July	63.1
	Market	175,518	30,701	Dec	65.3

/1 Energy requirements in 1000 Megawatt-hours (MWh)
/2 Peak demand in Megawatts (MW)
/3 Market demand coincident as to month. See glossary under "Demand".



LONG ISLAND SOUND STUDY
POWER MARKET AREA
ENERGY REQUIREMENTS
ENERGY
PEAK DEMAND
PEAK DEMAND — MILLIONS OF KW
ENERGY — BILLIONS OF KWH
YEARS
90
80
70
60
50
40
30
20
10
270
240
210
180
150
120
90
60
30
1940
1945
1950
1955
1960
1965
1970

FIGURE 2

Table 2 summarizes data on installed capacity and energy requirements for 1971 in the market area as well as the Long Island Sound Service Area. Except for obvious differences in magnitude, there are many similarities between the Long Island Sound Service Area and the power market. Table 2 shows that major systems in the market account for over 98 percent of the area's energy requirements, while LISSA is almost entirely supplied by major systems. In the market totals, privately owned systems account for about 93 percent of requirements and LISSA, over 98 percent. Whereas LISSA has only about 10% of the number of the market's systems, it supplies almost 40 percent of total energy requirements and has almost 45 percent of the installed capacity.

A yardstick useful in the determination of power use and a tool for defining future needs is an analysis of classified sales. Table 3 indicates distribution of sales by class of ownership for 1972, and indicates percent energy distribution by class of service. Table 4 shows the 1972 average use per person. It can be inferred from data shown on Table 4, that LISSA's substantially lower per capita use is directly related to the lack of high industrial energy users, and the concentration of low income in urban areas.

Total utility load is the coincident summation of the demands of various types of customers having differing characteristics and requirements and therefore subject to assignment into distinct categories. Classes of power use may be broadly defined as rural and agricultural, residential, commercial, industrial, and "all other". Relatively small in magnitude, the latter would include street and highway lighting, water pumping, electrified transportation, schools, and other municipal services. Electrified transportation energy requirements, however, are fairly sizable in the New York - New England area. Rural consumption includes electric energy used in agriculture, and can vary greatly depending upon the type of farm served and the extent that labor saving devices are utilized. Residential use is a function of population, the amount of disposable income, and the market saturation of high energy-use appliances. The commercial category encompasses those utility customers that directly serve the functional and recreational needs of the population. These include retail stores, auto service stations, theaters, shopping centers, and other such establishments. The industrial customer usually includes the large bulk power consumers in industries such as the processing of primary and nonferrous metals, chemical production, and general manufacture.

A list of electric utilities that serve the Long Island Sound Service Area is shown in Table 5. Of the 20 utilities in the service area, all but three publicly owned systems in Connecticut generate electricity.

TABLE 2. ELECTRIC UTILITIES SERVING THE MARKET AREA AND SERVICE AREA 1971

	Systems (No.)	Systems (%)	Installed Capacity (MW)	Annual Energy Requirements (1000 MWh)	Annual Energy Requirements (%)
TOTAL MARKET					
Privately Owned					
Major Systems /1	29	14.2	32,639	153,131	92.8
Minor Systems	35	17.2	1,370	443	0.3
Total-Private	64	31.4	34,009	153,574	93.1
Publicly Owned					
Major Systems /1	23	11.3	3,544	8,859	5.4
Minor Systems	117	57.3	97	2,599	1.5
Total-Public	140	68.6	3,641	11,458	6.9
Total Major Systems /1	52	25.5	36,183	161,990	98.2
Total Minor Systems	152	74.5	1,467	3,042	1.8
Grand Total	204	100.0	37,650	165,032	100.0
Long Island Sound Service Area					
Privately Owned					
Major Systems /1	7	35.0	17,926	64,687	98.2
Minor Systems	4	20.0	12	90	0.1
Total-Private	11	55.0	17,938	64,777	98.3
Publicly Owned					
Major Systems /1	5	25.0	100	1,006	1.5
Minor Systems	4	20.0	19	105	0.2
Total-Public	9	45.0	119	1,111	1.7
Total Major Systems /1	12	60.0	18,026	65,693	99.7
Total Minor Systems	8	40.0	31	195	0.3
Grand Total	20	100.0	18,057	65,888	100.0

/1 Energy requirements greater than 100,000 Megawatt-hours.

TABLE 3. 1972 CLASSIFIED SALES - 1000 MWh

	Area	Sales	% Distribution /1	% of Market
Rural & Residential	New England	24,805	35.0	47.1
	New York	27,823	26.6	52.9
	Market	52,628	30.0	100.0
	LISSA	20,752	29.9	39.4
Commercial	New England	17,884	25.2	37.7
	New York	29,538	28.2	62.3
	Market	47,422	27.0	100.0
	LISSA	22,849	33.0	48.2
Industrial	New England	19,764	27.9	41.3
	New York	28,114	26.9	58.7
	Market	47,878	27.3	100.0
	LISSA	11,783	17.0	24.6
All Other	New England	2,055	2.9	18.2
	New York	9,249	8.8	81.8
	Market	11,304	6.4	100.0
	LISSA	7,420	10.7	65.6
Total Sales	New England	64,508	91.0	40.5
	New York	94,724	90.5	59.5
	Market	159,232	90.7	100.0
	LISSA	62,804	90.6	39.4
Losses	New England	6,448	9.0	39.6
	New York	9,838	9.5	60.4
	Market	16,286	9.3	100.0
	LISSA	6,502	9.4	39.9
Total Energy	New England	70,956	100	40.4
	New York	104,562	100	59.6
	Market	175,518	100	100.0
	LISSA	69,306	100	39.5

/1 Total Energy = 100

TABLE 4. AVERAGE USE PER PERSON - 1972

	Total Energy (1000 MWh)	Population /1	KWh per Person
New England	70,956	12,185,000	5,823
New York	104,562	18,718,000	5,586
Market	175,518	30,903,000	5,680
LISSA	69,306	14,026,000	4,940

/1 Estimated, based on provisional 1972 census data.

In Table 6, the actual number of plants and units are shown for each of the prime mover types and these are matched with their total capacity and generation. This is shown for both the market area and the Long Island Sound Service Area. Table 6 also shows LISSA's present portion of nuclear capacity at about 30 percent of the market; its portion of generation is over 50 percent. Fossil steam generation provides the bulk of the power for both the market and service area. This pattern will remain for the near future but it is anticipated that nuclear steam will advance at a rapid rate and eventually overtake fossil steam generation.

TABLE 5. ELECTRIC UTILITIES SERVING THE LONG ISLAND SOUND SERVICE AREA
1972

	State	Type /2	Energy Requirements (1,000) MWh	Installed Capacity MW
Bozrah Light & Power Co.	CT	P	22	0.3
Connecticut Light & Power Co. /1, /3	CT	P	8,915	2,013.4
Connecticut Yankee Atomic Power Co.	CT	P	83	600.3
Farmington River Power Co.	CT	P	68	8.0
Hartford Electric Light Co. /1, /3	CT	P	5,308	1,066.2
Millstone Point Co. /1	CT	P	-	125.6
United Illuminating Co.	CT	P	4,672	1,001.7
Groton	CT	M	324	-
Jewett City	CT	M	12	-
Norwalk	CT	M	33	-
Norwich	CT	M	199	34.0
South Norwalk	CT	M	53	15.3
Wallingford	CT	M	273	22.5
Total Connecticut			19,962	4,887.3
Consolidated Edison Co.	NY	P	36,810	10,424.7
Fisher Island	NY	P	4	1.8
Lawrence Park	NY	P	4	1.6
Long Island Lighting Co.	NY	P	12,242	3,203.4
Freeport	NY	M	154	35.3
Greenport	NY	M	13	8.4
Rockville Centre	NY	M	117	26.3
Total New York			49,344	13,701.5
Total LISSA			69,306	18,588.8

/1 Members of Northeast Utilities
/2 P - privately owned
M - municipals
/3 Does not include share of Northfield Mt. Pumped Storage

TABLE 6. 1972 UTILITY CAPACITY AND GENERATION - MARKET AREA AND LONG ISLAND SOUND SERVICE AREA

	Market Area			
	No. of Plants	No. of Units	Capacity (MW)	Generation (1000 MWh)
Fossil Steam	84	304	25,316	116,668
Nuclear Steam	9	9	4,910	16,544
Combustion /1	139	384	5,463	7,965
Conventional Hydro	255	653	4,898	32,713
Pumped Storage	3	16	482	(311)
Total	490	1366	41,069	173,579

	LISSA			
	No. of Plants	No. of Units	Capacity (MW)	Generation (1000 MWh)
Fossil Steam	27	128	13,077	53,653
Nuclear Steam	3	3	1,537	8,593
Combustion /1	45	135	3,840	6,651
Conventional Hydro	14	33	104	535
Pumped Storage	1	3	31	2
Total	90	308	18,589	69,434

/1 Includes Gas Turbine & Diesel

3.0 EXISTING GENERATING FACILITIES IN THE STUDY AND SERVICE AREAS

A study of generation facilities operating in 1972 shows that the study area contains 30 percent of the capacity installed in the service area. Table 7 gives the breakdown of the generation mix for the Long Island Sound Study Area and for the Long Island Sound Service Area. The largest block of generation in the study area is fossil steam, whereas the smallest is in hydroelectric generation. The study area, amply supplied with vast expanses of water for condenser cooling purposes, supports a large proportion of base load steam. However, with the development of large capacity non-water dependent multiple-unit combustion turbine installations, there may be a relative increase in this form of generation in the next decade.

Table 8 is a comprehensive list of generating facilities in the service area. These are presented by states and type of prime mover and include the plant name, location, ownership, installed capacity, and net generation. Those plants physically located within the study area are designated by a map reference number. Figure 3 shows the location of all the existing generating plants in the study area.

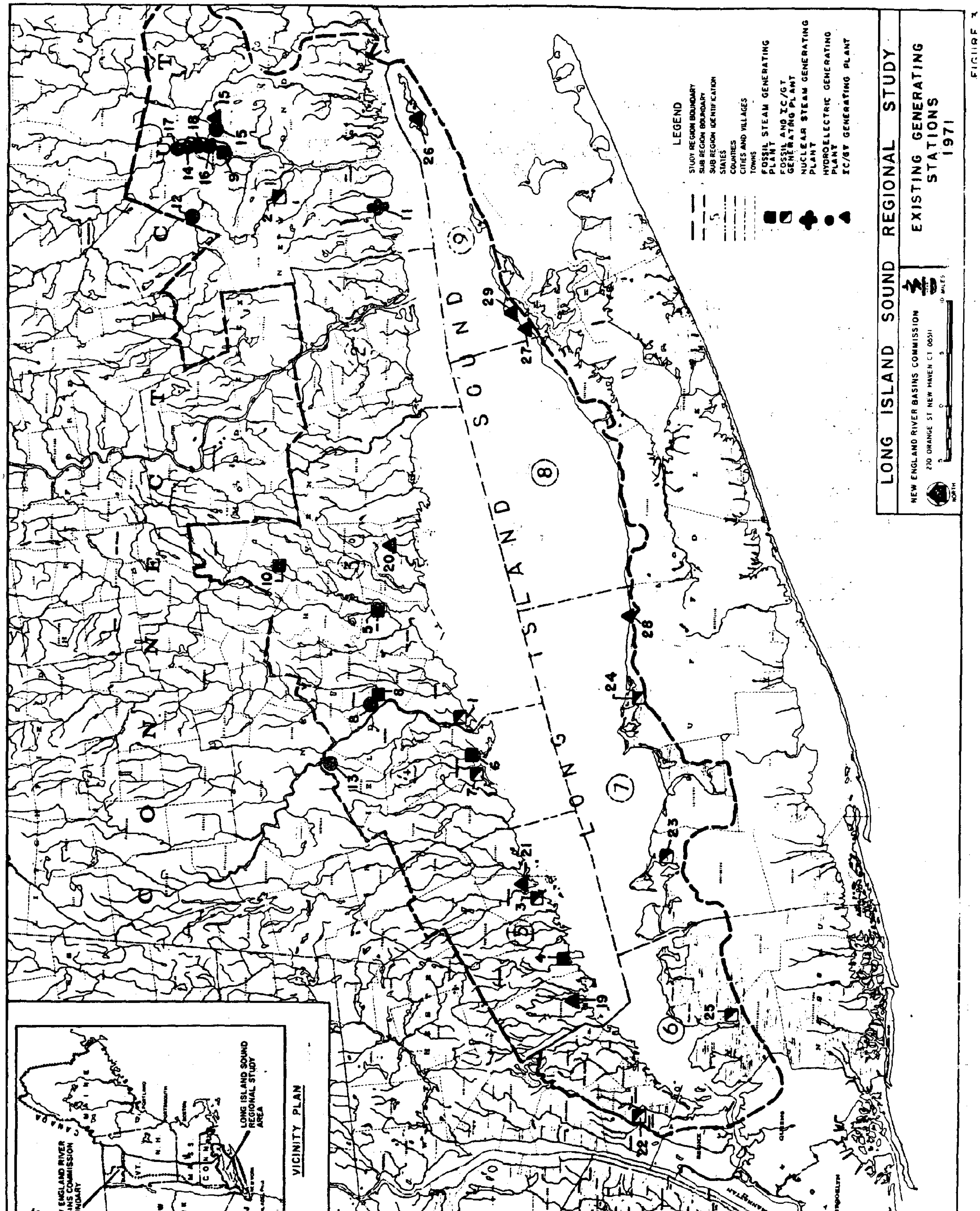
The study area has been divided into nine planning areas. Planning report P-1 Land Use, provides a full description of each area. Existing and future electrical facilities have been referenced to these areas.

Industrial generating capacity is of minor importance in the overall scheme of the Study Area's power requirements, yet significant in terms of the number of plants. Table 9 lists, by plant name and ownership, the 1971 capacity and generation of the industrial sector in the Long Island Sound Study Area.

4.0 TENTATIVE PLANNING OBJECTIVES

The goal of the Long Island Regional Study is to produce a plan of action by January, 1975 which balances the need to wisely protect, wisely conserve and wisely develop the Sound and its related shorelands as a major economic and life-enriching resource for the millions of people who live near it.

This goal can be attained by reflecting society's informed preferences for attainment of two major overall study objectives, as established by the U.S. Water Resources Council.



LEGEND
STUDY REGION BOUNDARY
SUB REGION BOUNDARY
SUB REGION IDENTIFICATION
STATES
COUNTIES
CITIES AND VILLAGES
TOWNS
FOSSIL STEAM GENERATING PLANT
FOSSIL AND IC/GT GENERATING PLANT
NUCLEAR STEAM GENERATING PLANT
HYDROELECTRIC GENERATING PLANT
IC/GT GENERATING PLANT
LONG ISLAND SOUND REGIONAL STUDY
NEW ENGLAND RIVER BASINS COMMISSION
270 ORANGE ST NEW HAVEN CT 06511
NORTH
10 MILES
EXISTING GENERATING STATIONS
1971
LONG ISLAND SOUND
VICINITY PLAN
NEW ENGLAND RIVER BASINS COMMISSION BOUNDARY
LONG ISLAND SOUND REGIONAL STUDY AREA

TABLE 7. 1972 GENERATING FACILITIES-LONG ISLAND SOUND SERVICE AREA AND STUDY AREA

Type	LISSA Total (MW)	Study Area (MW)	Remainder in Service Area (MW)	Study Area Percent of Total
Fossil Steam	13,077	4,383	8,694	34
Nuclear Steam	1,537	662	875	43
Pumped Storage & Conv. Hydro	135	38	97	28
Combustion	3,840	426	3,414	11
Total	18,589	5,509	13,080	30

TABLE 8. LONG ISLAND SOUND SERVICE AREA GENERATING FACILITIES-1972

*Map #	Plant	Location	Ownership	Installed Capacity (KW)	Net Generation (1000 KWh)
	Connecticut				
	Fossil Steam				
1	Devon	Devon	Ct. L&P	454,000	2,313,970
2	Montville	Montville	Ct. L&P	577,400	2,378,804
3	Norwalk Harbor	Norwalk	Ct. L&P	326,400	1,950,608
	Middletown	Middletown	Hartford El. Lt.	421,996	2,565,253
	South Meadow	Hartford	Hartford El. Lt.	216,750	808,854
4	Stamford /1	Stamford	Hartford El. Lt.	-	57,149
5	English	New Haven	United Illum.	146,250	526,603
6	Steel Point	Bridgeport	United Illum.	155,500	510,571
7	Bridgeport Harbor	Bridgeport	United Illum.	660,542	4,060,805
8	Derby	Derby	United Illum.	20,000	16,286
9	North Main Street	Norwich	Norwich Mun.	14,250	4,210
10	Pierce	Wallingford	Wallingford Mun.	22,500	23,206
	Total Fossil Steam			3,015,588	15,216,319
	Nuclear Steam				
	Connecticut Yankee	Haddam Neck	Yankee At. Pwr.	600,300	4,300,320
11	Millstone Point	Waterford	Millstone Pt. Co. /2	661,500	3,165,616
	Total Nuclear Steam			1,261,800	7,465,936
	Hydroelectric				
12	Gilman	Bozrah	Bozrah L&P	250	889

Table 8 (continued)

Map #	Plant	Location	Ownership	Installed Capacity (KW)	Net Generation (1000 KWh)
	Bulls Bridge	Gaylordsville	Ct. L&P	8,400	55,478
	Robertsville	Robertsville	Ct. L&P	500	1,311
	Scotland	Scotland	Ct. L&P	2,000	9,873
	Shepaug	Southburry	Ct. L&P	37,200	184,194
13	Stevenson	Stevenson	Ct. L&P	30,500	143,103
14	Taftville	Taftville	Ct. L&P	1,760	9,191
15	Tunnel	Norwich	Ct. L&P	2,000	10,914
	Rainbow	Windsor	Farmington Rv. Pwr.	8,000	46,540
	Falls Village	Falls Village	Hartford El. Lt.	9,000	55,754
8	Derby	Derby	United Illum.	800	5
16	Second Street	Norwich	Norwich Mun.	800	5,771
17	Occum	Norwich	Norwich Mun.	800	5,393
18	Tenth Street	Norwich	Norwich Mun.	1,400	6,199
	Total Hydroelectric			103,410	534,615
	Pumped Storage				
	Rocky River	New Milford	Ct. L&P	31,000	1,934
	Total Pumped Storage			31,000	1,934
	Combustion				
	Danielson	Danielson	Ct. L&P	6,000	2,364
	Thompsonville	Thompsonville	Ct. L&P	12,000	4,447
	Tracy	Putnam	Ct. L&P	16,000	14,333
1	Devon	Devon	Ct. L&P	16,320	7,502
3	Norwalk Harbor	Norwalk	Ct. L&P	16,320	8,586
2	Montville	Montville	Ct. L&P	5,500	4,880

Table 8 (continued)

Map #	Plant	Location	Ownership	Installed Capacity (KW)	Net Generation (1000 KWh)
19	Cos Cob	Greenwich	Ct. L&P	63,750	48,600
15	Tunnel	Norwich	Ct. L&P	18,594	17,057
	Enfield	Enfield	Ct. L&P	18,594	16,250
20	Branford	Branford	Ct. L&P	18,594	19,013
	South Meadow	Hartford	Hartford El. Lt.	177,400	230,193
	Middletown	Middletown	Hartford El. Lt.	18,594	7,611
	Torrington Terminal	Torrington	Hartford El. Lt.	18,594	16,006
	Franklin Drive	Torrington	Hartford El. Lt.	18,594	18,286
7	Bridgeport Harbor	Bridgeport	United Illum.	18,594	7,730
21	South Norwalk	South Norwalk	South Norwalk Mun.	15,280	3,704
30	North Main Street	Norwich	Norwich Mun.	16,750	2,724
	Total GT/IC			475,478	429,286
	Grand Total-Connecticut /4			4,887,276	23,648,090
	New York				
	Fossil Steam				
	Waterside	Manhattan	Con. Ed.	672,250	1,444,305
	East River	Manhattan	Con. Ed.	775,652	2,366,286
	Hell Gate	Bronx	Con. Ed.	306,250	1,388,261
	Astoria	Queens	Con. Ed.	1,550,600	5,683,375
	Hudson Ave.	Brooklyn	Con. Ed.	715,000	1,041,315
	Arthur Kill	Staten Is.	Con. Ed.	911,700	3,596,337
	Ravenswood	Queens	Con. Ed.	1,827,700	8,445,864
	59th Street	Manhattan	Con. Ed.	184,500	553,565
	74th Street	Manhattan	Con. Ed.	209,000	398,864
22	Bronxville	Bronxville	Lawrence Park	1,100	3,437
23	Northport	Northport	Long Island Lt.	1,161,270	5,412,906
24	Port Jefferson	Port Jefferson	Long Island Lt.	467,000	2,647,344
25	Glenwood	Glenwood Landing	Long Island Lt.	377,272	1,428,533
	Bowline Point	Haverstraw	Con. Ed. & Assoc.	414,000 /5	853,394

Table 8 (continued)

Map #	Plant	Location	Ownership	Installed Capacity (KW)	Net Generation (1000 KWh)
	Barrett	Island Park	Long Island Lt.	375,000	2,169,125
	Far Rockaway	Far Rockaway	Long Island Lt.	113,636	574,235
	Total Fossil Steam-NY			10,061,930	38,436,432
	Nuclear Steam				
	Indian Point	Buchanan	Con. Ed.	275,000	1,127,511
	Total Nuclear Steam			275,000	1,127,511
	Combustion				
	Waterside	Manhattan	Con. Ed.	14,000	10,559
	Astoria	Queens	Con. Ed.	744,500	1,827,583
	Hudson Ave.	Brooklyn	Con. Ed.	84,596	80,204
	Ravenswood	Queens	Con. Ed.	481,800	1,049,011
	Kent Ave.	Brooklyn	Con. Ed.	28,000	29,166
	59th Street	Manhattan	Con. Ed.	34,204	36,665
	74th Street	Manhattan	Con. Ed.	37,188	46,458
	Indian Point	Buchanan	Con. Ed.	61,375	82,520
	Arthur Kill	Staten Island	Con. Ed.	16,300	22,732
	Gowanus	Brooklyn	Con. Ed.	688,000	1,636,006
26	Fisher Island	Fisher Island	Fishers Is. El.	1,800	204
22	Bronxville	Bronxville	Lawrence Park	500	1,563
	Montauk	Montauk	Long Island Lt.	6,000	785
	East Hampton	East Hampton	Long Island Lt.	6,000	1,225
	Southampton	Southampton	Long Island Lt.	11,500	2,988
27	Southold	Southold	Long Island Lt.	14,000	4,893
	West Babylon	W. Babylon	Long Island Lt.	108,724	77,254
	Barrett	Island Park	Long Island Lt.	329,994	333,591
24	Port Jefferson	Port Jefferson	Long Island Lt.	16,000	7,122
	Narrows	Brooklyn	Con. Ed.	393,120	629,833

Table 8 (continued)

Map #	Plant	Location	Ownership	Installed Capacity (KW)	Net Generation (1000 KWh)
23	Northport	Northport	Long Island Lt.	16,000	5,350
25	Glenwood	Glenwood Landing	Long Island Lt.	126,800	47,433
	East Hampton	E. Hampton	Long Island Lt.	21,250	14,574
28	Shoreham	Shoreham	Long Island Lt.	52,942	32,536
	Power Plant #1	Freeport	Freeport Mun.	13,475	15,538
	Power Plant #2	Freeport	Freeport Mun.	21,780	96,581
29	Station #1	Greenport	Greenport Mun.	8,371	12,791
	Rockville Centre	Rockville Centre	Rockville Cent. Mun.	26,316	116,155
	Total Combustion			3,364,535	6,221,320
	Grand Total-New York /4			13,701,465	45,785,263

* Numbers refer to facilities in the Study Areas as shown on Figure 3.
/1 Retired during 1972.
/2 Millstone Point Co. operates the Millstone Point plant for Ct. L&P, Hartford El. Lt., and Western Mass. El.
/3 Generation is included in the Bronxville fossil steam net generation.
/4 Totals do not reflect additional capacity installed after December 31, 1972.
/5 Con Edison's share of 621,000 KW unit.

TABLE 9. INDUSTRIAL GENERATING CAPACITY IN STUDY AREA - 1971

Type	Plant /1	Ownership	Installed Capacity (KW)	Net Generation (1000 KWh)
FS	Ansonia Bridge	Anaconda American Brass	2,100	26
FS	Versailles	Federal Paper Board Co.	4,850	18,211
FS	New Haven	Federal Paper Board Co.	7,000	20,239
FS	Bridgeport	General Electric Co.	15,000	39,681
FS	Repeat Arms	Olin Mathieson Chemical Corp.	15,000	23,573
FS	Cos Cob	PennCentral Co.	27,000	25,831
FS	Groton	Chas. Pfizer and Co.	11,000	79,569
FS	New Haven	Simkins Industries	3,500	17,656
FS	Wallingford	R. Wallace and Sons Mfg. Co.	4,200	20,811
FS	New London Submarine Base	U.S. Government	11,000	54,578
	Total Fossil Steam		100,650	300,175
H	Ansonia Bridge	Anaconda American Brass	760	2,587
H	Versailles	Federal Paper Board Co.	87	-
	Total Hydro		847	2,587
	Total Industrial		101,497	302,762

/1 All locations are in Connecticut.

1. Environmental Quality (EQ), which enhances the quality of the environment through the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.

2. National Economic Development (NED), which increases the value of the Nation's output of goods and services and improves national economic efficiency.

For this report on Power and the Environment, the tentative planning objective is:

To devise and plan a program for meeting future energy demands in the Long Island Sound region and adjoining areas with full awareness of the likely impact of the development strategy on the physical environment and on consumer costs.

To meet this tentative planning objective, generalized siting alternatives will be formulated herein and evaluated during plan formulation, and referenced to environmental, economic and social well-being criteria.

After multi-objective plan formulation and public scrutiny, the tentative planning objective stated above may be changed. It will also become more specific and be labeled as a management goal. An example of a possible management goal is to provide ______MW of nuclear power in Area 3 by 1990 and ________MW by 2020. It stands as the final recommendation of what measurable plateau can and should be reached after full consideration of all significant alternatives and side effects.

5.0 ESTIMATED FUTURE ELECTRIC POWER REQUIREMENTS

Forecasts of power consumption to 1990 may be made with a reasonable degree of accuracy and to 2020 with far less precision. In general, the principal tools used in the estimating process are the historical records of past experience, and current trends. The pattern of expanding power requirements is well established, giving consideration to those known and potential factors that would affect it in a given area. For example, the number, location, and relative requirements of future load centers are unlikely to change drastically from those presently existing.

In 1972 power requirements of the selected market area amounted to 176 million Megawatt-hours, with an associated peak demand of 31,000 Megawatts, as compared with 85 million Megawatt-hours and 16,000 Megawatts in 1960. It is estimated that this load will increase to 532 million

Megawatt-hours and 97,100 Megawatts by 1990, (see Table 10) and 2,240 million Megawatt-hours and 399,500 Megawatts by the year 2020. Estimates were derived by forecasting the needs to 1990 and then projecting these needs to the year 2020. However, projections are not straight line extrapolations but are tempered by an expected decrease in the rate of growth of demand, decreased rates of population growth, the saturation of appliance use, and increasing public pressure for conservation. All forecasts must be considered in the light of future possible public or private conservation measures which may be taken. Conservation techniques or special limits on growth could have significant effects on the needs and timing of new capacity.

Electric utilities are under increasing pressure to take into account environmental values and to give attention to many new factors in their planning decisions. One factor receiving increased attention is the raising of the quality of demand forecasts. This need has been accompanied by a recent approach to "manage the load" and to apply "energy conservation" as a means of reducing the need for additional generating sites in the future. Data gathered to date and recent studies have been inconclusive as to the effectiveness or efficiency of such operations in further reducing, to an appreciable degree, the long range demands. The recent energy crisis has precipitated a drive to conserve energy as it relates to fossil fuels, particularly oil. However, the need for total energy use will continue to grow and the present oil crunch (with its increased costs) might even accelerate the pressure for nuclear fueled electrical generation. These factors can not, at this time, be accurately predicted, nor is any attempt given in the study to evaluate these new factors. Mid-term and long-term estimates are not generally influenced by short term encounters. It is generally known that those who forecast are greatly influenced by the economic situation and technical factors at the time they make their estimates (see Sec. 7.3.1).

Projections enable planners to site generation and transmission facilities in their proper relationship to time of need. Underestimating future load requirements may have an adverse effect on the adequacy and reliability of supply, and may additionally lead to costly stop-gap expendients which would greatly increase the cost of service with no matching benefit to the environment. The degree of exactitude of load forecasting does not change the specific customer demand for power at any future point in time. The ability to satisfy power demands at all times is of paramount importance. The consequence of a low level forecast would be the inability to deliver an adequate, reliable, or economic supply for the period of time needed to build new facilities. It is not uncommon for the decision to install a generating unit at a certain site to precede the actual commitment of funds for equipment by three to five years, and the actual use on utility systems by as much as ten years. However, full consideration can be given to the environmental impact of the power plants during this time period. Corrective action, therefore, is not readily made and the resultant social and economic impact can be quite severe. The results of a high level forecast are less likely to be as critical. In this case, overestimating demands can be more readily compensated for, to some extent, by the rescheduling of future additions and/or the retirement of older, less efficient generating units.

An orderly progression in the planning of supply, due to the large lead times required for on-line service, is highly desirable. Revisions in planning methodology can develop only after the impacts of load management and energy conservation are made manifest. There can be alterations in rates, legislative impacts on use, and promotional changes in social life styles that would alter the loading pattern and amount of electrical use. In this event, and only after a thorough study of its full impact, a change can be made in the timing of the installation of new units.

Table 10 tabulates the estimated future power requirements for the market area. These have been developed and revised from prior studies of the area's requirements and reflect the lowering of population projections and a reduced compound rate of growth. Figure 4 portrays projected requirements on a logarithmic scale to the year 2020.

The market demands, represent the sum of the highest monthly peak demands for New York and New England. While New England has traditionally had a winter peak, New York has shown a summer peak during most of the 1960s and 1970s. This leads to some degree of seasonal load diversity between the two regions. However, since the magnitude is generally small and differences vary greatly from year to year, for purposes of this study, it was assumed that no future diversity will exist between the two areas and that the projected peaks will occur within the same season.

Table 11 indicates generating capacity that is scheduled and under study by the utilities operating in the service and study area. These have been identified by type and location. The year of installation shown on the table is indicative of the planning phase of utility operation. Scheduled and proposed retirements of generating units in the service area are shown on Table 12.

To provide any meaningful allocation of supply for the next twenty years, certain assumptions have to be made, if only to provide a guide to its possible magnitude and location. The Long Island Sound study area with its extensive shore line and large, and in some areas undeveloped, land areas can serve a large portion of the power market's requirements. In no way can this report define specific amounts of supply that the area's resources can support. The amount of capacity developed can be almost infinite if all "stops were pulled" or zero if every objection heeded. A reconnaissance review of the study area's water and land resources and taking into full account the vast array of technological devices available to the planner for the mitigation of a disturbed environment, reveals ample opportunity to develop capacity. The service area as well has many areas capable of supporting power plants. The Connecticut rivers and

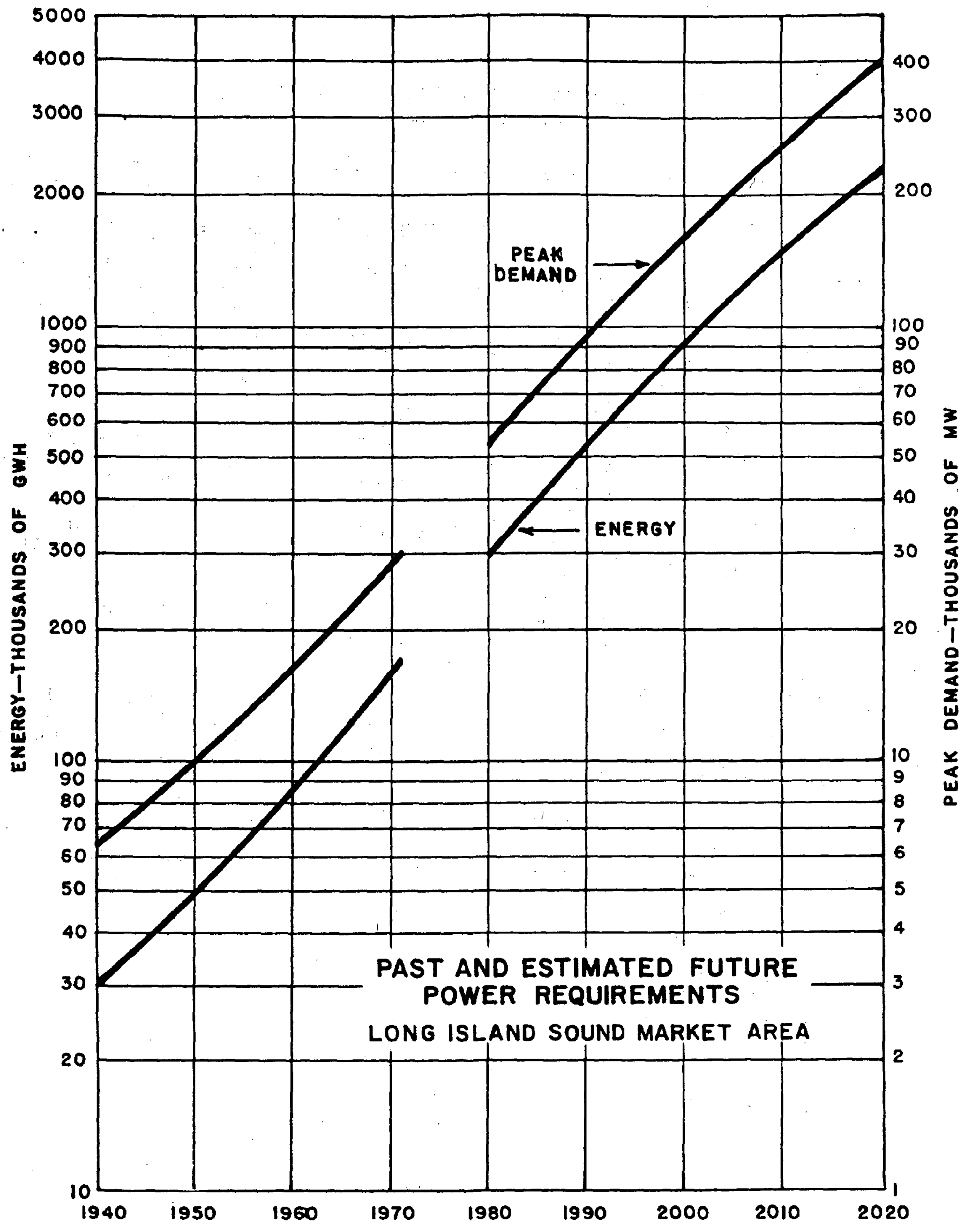
TABLE 10. ESTIMATED FUTURE POWER REQUIREMENTS - MARKET AREA

Year		Energy Requirements (1000 MWh)	Peak Demand /1 (MW)	Load Factor (%)
1980	New England	127,100	23,800	61.0
	New York	168,000	30,500	62.9
	Market	295,100	54,300	62.0
1990	New England	245,400	45,300	62.5
	New York	287,000	51,800	63.2
	Market	532,400	97,100	62.6
2000	New England	439,000	80,200	62.5
	New York	477,000	85,700	63.5
	Market	916,000	165,900	63.0
2020	New England	1,090,000	194,400	64.0
	New York	1,150,000	205,100	64.0
	Market	2,240,000	399,500	64.0

/1 Market demand is sum of coincident monthly peak demands of New York and New England.

lakes provide opportunities, as does the lower Hudson region and some areas on Long Island. It would be useless to state, at this time, any maximum of supply for any particular time period since new advances (and setbacks) will be made socially and technically which would alter such predictions. What can be done, however, is to determine under to-day's state of technology the degree of capacity allocations that most likely will be placed in the study area. Some factors involved are; past trends, projected requirements, topographic features, proximity to load, and availability of sites. The study area's share of the total capacity in the service area was about 30 percent in 1972. It is anticipated that this percentage will vary slightly in the future to about 33 percent in 1990 and perhaps to 35 percent in 2020.

The electorate of the market area will help decide the relative emphasis to be placed upon economic and environmental factors pretaining to energy supply. For the present, today's known technology and ecological values must continue to influence even long-range planning. Technological innovations, however promising and however deserving of



ENERGY—THOUSANDS OF GWH
PEAK DEMAND—THOUSANDS OF MW
PEAK DEMAND
ENERGY
PAST AND ESTIMATED FUTURE
POWER REQUIREMENTS
LONG ISLAND SOUND MARKET AREA
5000
4000
3000
2000
1000
900
800
700
600
500
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80
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3
2
1
1940
1950
1960
1970
1980
1990
2000
2010
2020

FIGURE 4

TABLE 11. GENERATING CAPACITY - SCHEDULED AND UNDER STUDY
LONG ISLAND SOUND SERVICE AREA

Plant	Location	Type	Capacity /1	Year of Install.	Owner
Middletown #4	Middletown, CT	FS	375.4	1973	Northeast Util.
*Coke Works #1	New Haven, CT	FS	445.0	1975	United Illum.
Astoria #6	Astoria, NY	FS	800.0	1975	Con. Ed.
*Northport #4	Northport, NY	FS	387.1	1977	Long Island Lt.
Bowline #2	Haverstraw, NY	FS	621.0	1974	Con. Ed. et al.
Roseton #1,2	Roseton, NY	FS	1,143.0	1974	Con. Ed. et al.
	Total	FS	3,771.5		
*Shoreham	Shoreham, NY	N	820.0	1978	Long Island Lt.
*Millstone #2	Waterford, CT	N	860.7	1974	Northeast Util.
*Millstone #3	Waterford, CT	N	1,150.0	1979	Northeast Util.
Indian Pt. #2	Buchanan, NY	N	1,069.1	1973	Con. Ed.
Indian Pt. #3	Buchanan, NY	N	1,069.1	1975	Con. Ed.
Jamesport #1	Jamesport, NY	N	1,150.0	1981	Long Island Lt.
Jamesport #2	Jamesport, NY	N	1,150.0	1983	Long Island Lt.
	Total	N	7,268.9		
Cornwall #1-8	Cornwall, NY	PS	2,000.0	1980	Con. Ed.
	Total	PS	2,000.0		
Freeport	Freeport, NY	GT	18.0	1973	Freeport Mun.
Holbrook #1-5	Holbrook, NY	GT	260.0	1974	Long Island Lt.
*Glenwood	Glenwood, NY	GT	270.0	1976	Long Island Lt.
Freeport	Freeport, NY	GT	22.0	1978	Freeport Mun.
Holbrook #6-10	Holbrook, NY	GT	270.0	1975	Long Island Lt.
	Total		840.0		

/1 Megawatts
* Plant located in study area

FS - Fossil Steam
N - Nuclear
PS - Pumped Storage
GT - Gas Turbine

TABLE 12. SCHEDULED AND PROPOSED RETIREMENTS OF GENERATING UNITS LONG ISLAND SOUND SERVICE AREA

Plant & Unit	Location	Type	Capacity /1	Year of Retirement	Owner
Hell Gate #1,2,3,9	Bronx, NY	FS	511.3	1974	Consolidated Edison
East River #1,4,5	NY, NY	FS	263.2	1973	Consolidated Edison
East River #5,6	NY, NY	FS	312.5	1980	Consolidated Edison
59th St. #7	NY, NY	FS	35.0	1973	Consolidated Edison
Hudson Ave. #2,3,5,6	Brooklyn, NY	FS	320.0	1975	Consolidated Edison
Waterside #10-13	NY, NY	FS	140.0	1975	Consolidated Edison
59th St. #8	NY, NY	FS	35.0	1976	Consolidated Edison
Hudson Ave. #7,8	Brooklyn, NY	FS	320.0	1977	Consolidated Edison
74th St. #3	NY, NY	FS	30.0	1978	Consolidated Edison
Waterside #4-7	NY, NY	FS	272.3	1979	Consolidated Edison
Waterside #8,9,14,15	NY, NY	FS	260.0	1982	Consolidated Edison

/1 Megawatts
FS - Fossil Steam

research commitment, cannot in prudence be relied on to provide for base load generation or to form the energy supply for the next two decades. New forms of energy generation can be assumed within limits to be available by 2000. The requirements for peaking capacity (generally hydroelectric, pumped storage and gas turbine units), intermediate capacity, older steam units, and base load units will remain and it is assumed that their relative share of the energy produced will not change. Accordingly, the main thrust in the period of study to the year 1990 will be the siting of large base load generating units, and large clusters of combustion turbine modules. For this reason, an urgent need exists to acquire and reserve the sites necessary for this added generating capacity. The siting situation is less critical for peaking and intermediate units due to their lesser demands on land and water. It is possible that new modifications will allow considerably more latitude in the location of this capacity than is presently available.

Three possible levels of power supply, Columns A, B & C, for the market area for 1990 are shown on Table 13. The specifics of Table 13 are fully discussed in Section 7.1. Included in the future capacity requirement of the market area is an allowance for reserves to provide for capacity on scheduled or forced outage and for possible errors in load forecasting. For study purposes, a value of 25 percent reserves has been carried through for each benchmark year, and is believed to be reasonable and conservative in light of existing knowledge.

TABLE 13. 1990 ESTIMATED POWER SUPPLY-LONG ISLAND SOUND SERVICE AREA
(Megawatts)

	1990A /1	1990B /1	1990C /1
Market Area Demand	97100	97100	97100
Reserve Requirements	24300	24300	24300
Total Required Supply	121400	121400	121400
Existing Capacity-LISSA (1972)	18589	18589	18589
Net Additional Capacity-LISSA (1972-1980)	11901	9895	15610
Total Capacity Available-LISSA (1980)	30490	28484	34199
Scheduled Capacity Additions-LISSA (1980-90)			
Fossil	-	-	-
Nuclear	2300	2300	2300
Gas Turbine Int. Combust.	-	-	-
Hydroelectric	-	-	-
Pumped Storage	-	-	-
Scheduled Capacity Retirements-LISSA			
Fossil	260	260	260
Nuclear	-	-	-
Gas Turbine, Int. Combust.	-	-	-
Hydroelectric	-	-	-
Pumped Storage	-	-	-
Capacity Additions Under Study-LISSA			
Fossil	9100	8300	10700
Nuclear	9000	8000	11000
Gas Turbine Int. Combust.	5600	4800	6400
Hydroelectric	-	-	-
Pumped Storage	-	-	-
Additional Retirements-LISSA /2			
Fossil	1000	1598	620
Total Capacity Available in LISSA	55230	50026	63719
% of Market	45.5	41.2	52.5

/2 1,000 megawatts assumed for 1990A, 35 year retirement for 1990B, 40 year retirement for 1990C.

/1 Column A represents continuation of past supply patterns.
Column B assumes the area will become an importer.
Column C assumes the area will become an exporter.

6.0 - TYPES OF GENERATING FACILITIES

Under normal system operation, generating facilities can be generally classified by their operating characteristics. These are base load, intermediate, and peak load operation. There are no hard and fast rules as to the amounts of each form of generation required for system use. Under existing patterns of electric energy utilization, however, certain generalities can be stated. In the market area in 1972, it is estimated that about 70 percent of the installed capacity was used as base load.

Capacity must be available to serve all portions of the system load from base to peak. In the past, before loads had reached their present levels of magnitude, utilities usually depended on their older, less efficient, thermal units and hydroelectric capacity to serve the peak portions of the load. As new capacity was placed in service on the base of the load, existing units moved progressively towards the peaking portion.

Optimum utilization of large thermal units requires their operation at high load factors over their lifetime, perhaps in the order of 70 to 80 percent. Power system planners resort to other prime mover types for peaking and reserve functions that would operate only a few hundred to 2,000 hours per year. Economic justification of the high production expenses usually associated with such restricted operation is met by low investment costs, relative to base load investments, Capacity types available today for such specialized duty include combustion turbines, combined cycle, cycling steam, and pumped storage hydroelectric units.

6.1 - Base Load Generation

6.1.1 - Fossil Steam

The trend towards larger fossil steam units to realize the economies and other advantages of scale have to a major degree shaped the plans for expansion of electric power systems throughout the Nation. This trend is even more pronounced in the high load areas of the northeastern region. In the late 1950's a 300 MW generating unit was considered maximum, but now, 15 years later, units as large as 1,300 MW are scheduled for operation in the United States.

Plant sizes may increase to 5,000 MW by the year 1990 with unit sizes ranging as high as 1,500 MW. Reliability is becoming increasingly important, and advances in high pressure-temperature steam technology are tempered by the need to more thoroughly prove expected gains in efficiency. Heat rates may be further improved by increases in boiler efficiency, and better exhaust and condenser design. It is unlikely, however, that improvements in efficiency will continue at the pace set in the past.

Investment costs per kilowatt are normally expected to decrease with increasing unit size, but, in addition to inflation, the demands of the early 1970's for cleaner air, reduced thermal discharges to streams and lakes, and esthetics, are absorbing the dollars saved by building larger facilities. High stacks, better precipitators, sulfur dioxide collection processes, cooling towers, costly intake and outfall structures, and better architecture and landscaping where necessary, all add to the dollar cost of any size unit.

Current unit costs for two fossil plants of 800 MW located in the study area in 1981 dollars are estimated at $387 per kilowatt. This figure includes the cost of an offshore oil unloading dock at $22/kW. Future price levels were based on utility estimates and assumed an 8% escalation. By comparison, the cost of Northport #3 which became operational in 1972 was estimated at $211/kW for 386 MW.

6.1.2 - Nuclear Steam

Operating experience gained from the continued operation of the Yankee, Indian Point, Connecticut Yankee, and Millstone nuclear units in the Northeast and the more than 40 others in the U.S. has confirmed the basic feasibility of the water-moderated and cooled reactor design. Thus, while nuclear research and developments may demonstrate the advantage and importance of other types, such as the HTGR (High Temperature Gas Reactor), the projections presented herein are based primarily on reactors of the PWR (Pressurized Water Reactor) and BWR (Boiling Water Reactor) types until 1990 when it has been assumed fast breeder prototypes will have successfully demonstrated their advantages and operating acceptability. Additional research and development and operating experience is needed for advanced reactor types under development to demonstrate this capital and operating costs, dependability and flexibility.

Capital cost differential against nuclear units as compared to fossil-fuel units has continued. This differential should decrease as increased capital expenditures for fossil fueled units dictated by environmental considerations become necessary. Based on a 1973 report, the cost of two (paired) 1150 MW nuclear units located within the study area, based on 1981 dollars would be about $645/kW.

Table 14[/1] shows a comparative environmental profile of base load alternatives and was prepared for Northeast Utilities by Arthur D. Little, Inc. Little's recent studies have shown that nuclear generation holds a high promise for helping to meet the area's energy needs. The disadvantages of high capital costs are compensated by lower fuel costs and a greater ease in meeting air quality standards. The recent oil shortages demonstrates the requirement for large power generating units that are not dependent on extranational fossil fuels. Nuclear units presently constitute the only large base load units capable of such replacement in the Long Island Sound Service Area.

/1 Work Group Comments on Table 14

1. The indicated 75,000 tons of ore for nuclear fuel supply could be 84-90,000 tons for a 1,000 MWe reactor at 80% load factor. In addition, it appears that the indicated 150 tons of uranium metal should be about 25 tons for initial cores and 15 tons for replacement cores (as fuel delivered to the plant rather than total processed material). With respect to the 1,000 pound plutonium value, it is possible that 1,000 pounds or more might be reprocessed but only about 300 to 400 pounds would be recycled to the reactor.

Nevertheless, fossil capacity additions will probably be continued, to a limited degree, in the market area and the remainder of the non-nuclear capacity installed will consist of quick start thermal peaking, and large blocks of pumped storage. These plants will complement the nuclear generation by improving capacity factor operation, thus improving overall performance of nuclear plants.

6.2 - Peak Load Generation

Generation for peak loads differs from other forms of generation in that it is required to operate for relatively short periods. The choice of facilities to carry peak loads is wide, and is governed by overall system economics and environmental considerations.

The need to operate for only short periods provides an opportunity for cost savings. These savings may be accomplished by sacrificing fuel economy to effect a reduction in investment or by providing an energy supply source which is adequate only to operate the plant during its limited hours of required use (as in pumped storage and peaking hydro).

The balancing process is sensitive to changes in construction costs, site features, fuel costs, and load size and variability, and to the characteristics of the transmission and other generating facilities in the system. Therefore, generalizations concerning proportions of the various types of peaking generation are difficult to make. The total peaking requirement can, however, be reasonably well determined from the shape of the load curve.

It can be presumed that where physical sites for economical

/1 Work Group Comments on Table 14 (Continued)

2. The indicated transportation requirements for nuclear fuel supply are perhaps misleading; there are indeed about six truck loads per year of fuel to the reactor but this is preceded by many shipments of mine to mill (3350), mill to conversion plant (12), conversion to enrichment plant (22), enrichment to UO_2 (5), UO_2 to fuel fabrication plant (9), and followed by shipments from reactor to reprocessing as indicated, reprocessing to repository (1), and reactor to low level burial ground (45 to 55). Not all of these will necessarily pertain to U.S. areas, of course.

3. The nuclear high level waste value should be 60 to 90 cubic feet/year (see also page 60) and the low level value should be about 10,000 to 20,000 cubic feet/year (600 to 4,000 of which would be associated with reprocessing plants alone).

4. The indicated operational discharge of 2 curies per day of comparatively long lived radioactivity for nuclear may be misleading. For a 1,000 megawatt Light Water Reactor, indicated overall discharges are 0.25, 0.01, and 0.01 megacuries per year of gases, liquids, and solids respectively.

5. Site acreage can vary greatly depending on specific utility requirements and configurations (see Table 17).

TABLE 14a COMPARATIVE ENVIRONMENTAL PROFILE OF BASE-LOAD ALTERNATIVES /1

	OIL-FIRED	COAL-FIRED	NUCLEAR
A. Fuel Supply			
1. Production	Production and refining of sufficient crude oil to yield 40,000 barrels of fuel oil per day. This roughly corresponds to the fuel-oil output of a large oil refinery.	Mining of 8,000 tons of coal per day.	Mining and milling of 75,000 tons of uranium ore per year. Processing and fabrication of 150 tons of uranium metal per year. If by-product plutonium is recycled, 1000 lbs. per year of plutonium would require processing and fabrication under equilibrium conditions.
2. Transport	One supertanker delivery of crude oil every 3 or 4 weeks, or, in the case of the larger tankers now serving U.S. ports, 1 delivery every 2nd or 3rd day.	Daily unit-train delivery (105 rail carloads).	6 truckload deliveries per year.
3. Storage	Storage of a 3-month fuel-oil supply would require 20 large oil storage tanks (1 million cubic feet each) occupying 20 acres.	50-acre coal pile, assuming 2-month reserve.	Nominal.
B. Power Plant			
1. Installation	70-acre plant site (assuming cooling towers used).	250-acre plant site, (assuming cooling towers used).	500-acre plant site, mostly undeveloped.
2. Operation	Discharge of 120 billion BTU of waste heat per day; emission of 70 tons/day of sulfur or SO_2 (assuming low-sulfur fuel oil being burned), 30 tons/day of nitrogen oxides and other gaseous effluents, and 0.5 tons/day of particulates.	Discharge of 120 billion BTU of waste heat per day; emission of 150 tons/day of sulfur or SO_2 (assuming use of stack gas desulfurization system, not yet commercially available), 60 tons/day of nitrogen oxides and other gasious effluents, and 9 tons/day of particulates (assuming use of highly efficient precipators and scrubbers).	Discharge of 160 billion BTU of waste heat per day; emission of trace amounts (a few hundred-thousandths of a gram per day) of radioactive substances containing 2 curies of comparatively long-lived radioactivity. Shipment of 60 casks of spent fuel per year (60 truckloads or 10 railroad flat car-loads.
C. Waste Disposal	Minor problems.	Disposal of 1200 tons/day of fly ash and 1,600 tons/day of sulfur, based on 3.5% sulfur coal and assuming 80% stack gas desulfurization efficiency.	"Perpetual" storage of solidified high-level radioactive waste concentrates from spent fuel reprocessing, which, in calcined form and with inert kiluents, accumulate at a rate of 100 cubic feet/year. Also land burial of 200 cubic feet/year of miscellaneous low level radioactive waste materials.

/1 This exhibit lists the principal ways in which the fueling and operation of base-load power generating facilities interact with the natural environment. Some details, such as the release of modest quantities of chemicals used to prevent fouling of tube surfaces in the steam condenser portion of the turbine-generator system, are not shown. Also, the transmission and distribution of the power produced are not covered.

All quantities shown are approximations and, with the exception of site acreage, relate to a single 1150 MW unit or the equivalent.

From a report prepared by Arthur D. Little, Inc. for Northeast Utilities, A Study of Base Load Alternatives for the Northeast Utilities System - July 5, 1973.

pumped storage are available, and so long as relatively low-cost energy for pumping can be provided by essentially base-load equipment, pumped-storage will constitute a significant portion of the peaking equipment addition. It can also be presumed that combustion turbine units and other peaking devices will be employed because of their additional advantages for providing at-site run-down and start-up power for the large base load plants of the future.

6.2.1 - Hydroelectric

Conventional hydro, distinguished from pumped storage, currently accounts for about 13% of all the electrical generating capacity in the market although this proportion is declining as other types of generation are expanded. Conventional hydro may be used for either peaking or base load generation, depending on plant design, system requirements and prevailing conditions of water supply. There are only 135 megawatts of capacity in the service area, and very little possibility of future additions. Since most of the good sites have already been developed, the cost of new conventional hydroelectric development may be in excess of that for available alternatives.

Pumped storage plants have been compared with storage batteries. The comparison stems from the way the plants operate. The plant uses energy generated in steam electric plants during night time hours, or other low demand periods, to pump water into a high reservoir, where it is retained temporarily. At some later time, during periods of high demand, the stored water is released to produce hydroelectric power as it falls back to its original elevation. Due to unavoidable losses in the cycle, pumped storage plants actually consume about three kilowatt-hours of pumping energy for every two kilowatt-hours generated. The disadvantage with respect to energy is offset by low investment cost and other desirable characteristics which have made pumped storage attractive to system operations.

6.2.2 - Combustion

Internal combustion units have been used for peaking on power systems for many years. The interest in this type of peaking capacity for smaller systems has resulted primarily from the recent development of low cost, packaged, automatically operated, unattended diesel units. Diesel units, while available in capacities up to 6 MW, are usually manufactured in ratings of about 2 MW and are frequently combined in multiples to provide plants of up to approximately 10 MW capacity. Straight diesel, super-charged diesel, or dual-fuel engines are available.

On major power systems diesels are not widely used, since available sizes are too small. They are sometimes installed for the primary purpose of defering investment in transmission facilities, or to provide load protection and to assure satisfactory voltage at times of maximum peak demand. Since these units can be readily and cheaply moved, they could serve this purpose in many different locations on a system over a period of years. Such applications would ordinarily be expected in areas of relatively low load density and growth rate.

The combustion turbine unit has demonstrated its suitability as a source of economical peaking and emergency power. It is low in first cost, quick starting, rapid in loading, and readily automated. Plants with single prime movers of the simple open-cycle type are available in ratings up to about 50 megawatts. These plants are pre-engineered and pre-packaged to minimize field labor. Units in the order of 10 MW are shipped assembled, but larger ones are erected in the field on concrete slab foundations. Typically, plants are furnished with a self-contained cooling system and weatherproofed housings, and include provision for self-contained starting and remotely controlled operation.

Combustion turbine units with multiple prime movers driving single generators are now being offered by manufacturers. One design employs several jet engines equally divided on either end of the centrally located generator. Other designs using different arrangements of multiple prime movers driving single generators are also available and in service. Combustion turbines are equipped to burn either liquid petroleum fuels or natural gas, and may be installed to burn either fuel interchangeably. Most manufacturers are marketing an arrangement which permits changing between liquid and gaseous fuels while operating under load. Residual and crude oils are being considered for use, and some units are being sold with this capability.

6.3 - Water Requirements For Thermal Generation

The largest non-consumptive demand on the water resources of the market area is that of thermal electric generation. Steam electric power plants withdraw more water than any other industry and nearly all of the withdrawals are for cooling and condensing the steam used to produce electric energy. Water introduced into the boiler is converted to steam to drive the turbo-generator unit. Steam leaving the turbine at less than atmospheric pressure is passed through the condenser where it is cooled and condensed back into water. The condensate is pumped back into the boiler in a closed circuit system. Thus, the only consumptive use in the boiler-generator circuit is the feedwater make-up required to replace evaporative water losses. Losses in this circuit are quite small; the requirement for 1,000-megawatt plant operating at full load is estimated to be only 0.5 $ft.^3/s$. The major use at a steam-electric plant is the large separate flow through the condensers required to carry away the waste heat of condensation. Essentially, no water is used consumptively in the condensers, but losses do occur when condenser flows are returned to the source bodies of water at higher temperatures, or are passed through cooling towers or ponds.

Withdrawals of water for cooling at steam-electric plants currently constitute the largest non-agricultural diversion of water. Either fresh, brackish, or saline water can be used for this purpose and in some cases, sewage effluents as well. The amount of water required through the condenser depends upon the type of plant, its efficiency, and the temperature rise within the condenser. The temperature rise of cooling water in the condenser is usually in the range of 10°F to 30°F.

Nuclear plants (using current design standards) have a lower thermal efficiency than fossil plants. Since there is no significant heat loss directly to the atmosphere in nuclear plants, (about 10% in fossil plants) the unit cooling water requirement per million kilowatt-hours of electric generation becomes even greater. Currently, a large nuclear steam-electric plant at full load requires about 40 percent more condenser water for a given temperature rise than a fossil-fueled plant of equal size. Such high requirements result from the lower steam temperatures and the resultant lower operating efficiencies of nuclear plants. With continuing progress in design efficiencies it is expected that the higher nuclear water requirements will decrease in the future.

The principal types of cooling systems for steam-electric plants are (1) once-through, where cooling water is taken from a suitable source, such as rivers or cooling ponds, passed through the condensers, and returned to the source body of water; (2) wet towers, where water is recirculated through the condenser after it has been cooled in an evaporative cooling tower or other cooling system in which the heated water is exposed to circulating air; and (3) dry towers, where cooling water is contained in a closed system and its heat dissipated to the air through heat exchangers. In some cases a combination of systems may be used. The water withdrawal and consumption requirement varies widely among these systems.

6.3.1 - Once-through Cooling

Where adequate supplies of water are available and applicable water quality standards can be met, the once-through cooling system is usually adopted. Although that system is normally more economical than other systems, the number of sites available for its use for large plants is limited because of the resulting thermal impact on the water bodies. Sources of cooling water for once-through systems include flowing streams, ponds, lakes, reservoirs, estuaries and the ocean.

The primary consumptive use of cooling water is the amount of evaporation caused by the increase in water temperature as it passes through the plant's condensing unit. Generally it is estimated that under average conditions about 55 percent of the cooling achieved, in a once-through system on a large flowing stream, is due to heat dissipation in the receiving body by evaporation.

Once-through cooling using fresh water, such as cooling ponds or spray canals is almost universally ruled out in the New York portion of the Long Island Sound area because of the lack of fresh water and because of unavailable land. For example, a closed loop cooling pond for a 1000 MW unit would require about 2000 acres. Some possibilities exist for the use of fresh water cooling on the Connecticut side of the Sound either with cooling ponds or possibly utilizing river flows. Two additional types of cooling are available: brackish or estuarine, and direct salt water. The largest possibility for once-through cooling water is obviously the Sound itself.

6.3.2 - Evaporative Cooling Towers (Wet)

When neither high yield streams nor large water impoundments are available, or the water temperature regulations are so restrictive as to curtail their use, steam-electric stations can employ evaporative cooling towers. In the commonly used "wet" towers, the heated water is cooled by the circulation of air through a falling spray of water in the tower. Until recently, most towers in this country have been mechanical draft. A mechanical draft tower for a 1,000-megawatt plant may be 600 feet long, 70 feet wide, and 60 feet high. These towers will eject large quantities of warm moist air, possibly causing fog, rain, ice, and snow at various times of the year. Natural draft towers (hyperbolic in design) have a higher initial cost, but cost relatively little for operation and maintenance. Because of their greater height, heat, fog, and vapor usually do not reach the ground in bothersome quantities. For example, a 1,000-megawatt plant requires two hyperbolic towers approximately 400 feet in diameter and 400 feet high, structures not easily hidden or camouflaged.

In the wet cooling tower, the warm water may be sprayed into the air or allowed to flow onto a lattice network called "fill" upon which it is broken into droplets, which facilitate the evaporative heat transfer as air moves through the tower. The cooled water is collected in a basin under the fill from which it can be pumped back to the condenser. For power plants using wet-type cooling towers, evaporation accounts for about 90 percent of the cooling. Withdrawals from streams, reservoirs, or ground-water sources are needed to replace evaporation, spray drift losses, and "blowdown".

Wet cooling towers using seawater as makeup may be feasible if blowdown to the adjacent seawater body is permitted. With solids content of 25,000-32,000 in the seawater the blowdown from the cooling towers would be around 5% of the circulated flow. Large amounts of salt or brine would be "collected" and have to be disposed of if discharge into seawater were not allowed. The design of saltwater cooling towers, based on operating experiences in England, is now being studied by some utilities.

6.3.3 Non-Evaporative Cooling Towers (Dry)

The remaining alternative would be the use of non-evaporative, dry cooling towers. Such towers use a closed piping or radiator system to dissipate to the air the heat absorbed by the cooling water. Compared to other cooling alternatives, this device has a much lower efficiency as it depends upon the dry bulb temperature and convection of the waste heat from the water through the radiator tubing to the atmosphere. Whether of the mechanical or natural draft type, the towers would need to be increased in size or in number as compared with the evaporative cooling type. This would create further environmental and esthetic problems and would add greatly to the unit cost of the installation. An additional detriment would be the increased operating and maintenance cost plus a decided decrease in total operating efficiency. The value of a "dry" system of cooling which may outweigh the factors of esthetics, costs, and efficiency is its almost complete independence of stream flows. The cooling process would have no effect on stream temperatures, flow regulation criteria, or meteorology of the area other than thermal increases in the surrounding air. Currently,dry cooling towers are only being used on one or two small plants.

Table 15 shows a comparison of various thermal plant cooling systems. The table views each system in general terms and uses as its base the fresh water (stream) once-through system. By this means values and comparisons can be made beyond those solely associated with capital costs. The numbering system does not imply proportional relationships, ie. that a rating of 6 is six times better than a rating of 1.

Costs of cooling systems depend, in a large degree, on the design criteria and even more so on site conditions. For example, on the New York side of the Sound, almost all the sites are coast-oriented while on the Connecticut side sites may be available inland, necessitating different modes and types of cooling systems. A range of costs is presented in Table 16 for the major types of cooling devices. Because of the relatively limited number of nuclear plants for which data are available, and the lack of recent dry tower construction, the range of costs for such plants is largely estimated. For each type of system, the cost of the condenser has been excluded since it is common to all. Investment costs cover such items as land, pumps, piping, canals, ducts, intake and discharge structures, dikes, cooling towers, and appurtenant equipment.

The cost of the cooling system, including the condenser, represents a significant portion of the total costs, depending on the type of plant and degree of cooling being considered. In addition to

TABLE 15. SUMMARY OF COMPARATIVE COOLING DEVICES /1

Parameter of Comparison	Once-Through: Fresh Water (Stream)	Once-Through: Estuary-Marine (L.I. Sound)	Once-Through: Cooling Lake (Connecticut)
Initial Cost	1	2	5
Operational Cost	1	2	3
Maintenance Costs	1	3	4
Plant Efficiency	6	5	3
Esthetics	Neutral	Neutral	Good
Environmental Effects	Many	Few-Many	Few
Consumptive use at full load - 36% Eff. (Heat Rate 9500 Btu/kWh)			
Fossil $ft^3/S/1000$ MW	12.2	12.2	14.4
Nuclear $ft^3/S/1000$ MW	14.3	14.3	16.8

Parameter of Comparison	Cooling Towers: Wet-Natural Draft (Stream)	Wet-Natural Draft (Wells)	Wet Mechanical Draft (Stream)	Wet Mechanical Draft (Wells)	Dry-Natural or Mechanical Draft
Initial Cost	4	5	3	4	6
Operational Cost	3	4	4	5	6
Maintenance Costs	3	4	4	5	6
Plant Efficiency	3	2	3	2	1
Esthetics	Very Poor	Very Poor	Very Poor	Very Poor	Extremely Poor
Environmental Effects	Medium	Medium	Many	Many	Few
Consumptive use at full load - 36% Eff. (Heat Rate 9500 Btu/kWh)					
Fossil $ft^3/S/1000$ MW	20.6	20.6	20.6	20.6	0
Nuclear $ft^3/S/1000$ MW	24.2	24.2	24.2	24.2	0

/1 Based on a scale from 1 to 6, where 6 is the highest.

differences in capital costs there are operating expenses associated with each type of cooling. Cooling towers have pumping heads in the range of 35 to 55 feet greater than those required in once-through systems. This added pumping power for towers is equivalent to about one-half percent or more of the plant output. Power to drive the fans in mechanical draft cooling towers is equivalent to upwards of an additional one percent of the plant output. Annual operating and maintenance expenses, other than the cost of power for pumping and to drive fans, is equivalent to one percent or more of the investment costs of cooling towers. Also, the higher water temperature at the condenser inlet that would normally result from the use of cooling towers would produce a lower turbine efficiency. Estimates indicate a one to three percent capacity penalty chargeable against plants using wet cooling towers. Thus, the use of evaporative wet cooling towers rather than flow-through systems may increase the cost of power by as much as five percent.

TABLE 16. RANGE OF COMPARATIVE COSTS OF COOLING WATER SYSTEMS FOR STEAM-ELECTRIC PLANTS IN THE LONG ISLAND SOUND AREA

Type of System	Fossil-Fueled Plant /1	Nuclear-Fueled Plant /1
Once Through	10-15	15-20
Cooling Ponds	18-27	27-36
Wet Cooling Towers:		
Mechanical draft		
River	20-24	30-40
Wells	23-27	34-44
Natural draft		
River	24-27	36-42
Wells	28-31	39-45
Dry Cooling Towers:		
Mechanical draft	36-40	50-60
Natural draft	40-48	60-70

/1 1973 date base in $/kW

6.4 - Land Requirements for Thermal Generation

Optimum land use is always of paramount importance in regional planning. Growing electrical loads require increasing numbers of plant sites and transmission corridors. These must fit into the best possible utilization of our existing land resource to achieve an orderly balance among diverse existing and potential land uses. Power sites have to be planned many years in advance. One possible solution is a land bank system where land is set aside for future multipurpose use. The current policy of most utilities today is similar, in permitting the maximum use by others of the utility owned rights-of-way, provided such use and the manner in which it is exercised will not interfere with the owners right or endanger its facilities. This policy could apply to land held in fee easements or in the this case - the land bank. Various forms of recreation, open space, mineral production, and agricultural uses could be accommodated until the land is needed for the plant. If and when the plant is built, further development of ancillary facilities, such as cooling ponds for fishing, or beaches warmed by discharges, could be undertaken.

Movement in this direction has taken a tentative start. The State of Maryland has recently adopted a procedure for identifying and setting aside land for future power plant sites.

Land requirements for electric power generation depend upon (1) the type of plant; (2) the ultimate generating capacity; (3) whether urban or rural location; (4) on-site needs for fuel storage and handling facilities; (5) the methods of disposal of waste products such as ash; (6) the exclusion areas required for nuclear power generating plants and the general population intensity and distribution outside the exclusion zone; (7) and the choice of cooling facilities.

If the ultimate plant capacity has not been determined and the plant capacity is not limited by the amount of condensing water available or other reasons it is usually advisable to obtain a sufficient amount of land that would provide for expansion and space for unforeseen additional facilities.

The following data concerning project and powerhouse space requirements assume that the capacity will be built in rural or low population density areas, and that they will be built under present technology.

TABLE 17. LAND REQUIREMENTS FOR BASE LOAD GENERATING FACILITIES /1

Plant Fuel	No. of Acres	Remarks
Coal	900-1200	Assumes onsite coal storage and ash disposal
Nuclear	500-600	Assumes satisfaction of 10 CFR 100 /2
Oil	200-350	Assumes adequate onsite fuel storage

/1 Requirement are for 2500-3000 MW plant

/2 Criteria for evaluating the suitability of a site for a nuclear Power reactor are found in Part 100 of Title 10, Code of Federal Regulations (10 CFR 100).

6.4.1 - Powerhouse Needs

The land area required for the physical plant or powerhouse containing 3 - 500 MW units is in the range of 3 to 4 acres. For a plant containing three fossil units (approximately 3000MW) the land required would be in the range of 6 to 7 acres. These figures include the area needed for a service bay, but do not include space for equipment and facilities which might be located outside and adjacent to the powerhouse.

Technical considerations in the Long Island Sound areas are quite similar. For example, data submitted by utilities operating in the area indicate that the land requirement for one oil-fired unit (approximately 1000 MW) would be about 100 acres. Each additional unit would require 25 acres.

For a nuclear plant, assuming a shoreline site with 1000 foot set back, the first unit would require a rectangle 3000' x 4000' (275 acres). Each additional unit would add about 500 feet to the 4000' dimension. If the site was moved inland it would require a 4000' x 4000' area (370 acres). These sites would be capable of accommodating cooling towers, switchyards, etc. The maximum amount of land for a single unit with a 2500' setback distance is 5000' x 5000' (575 acres). Each additional unit would add about 500'. A minimum average exclusion area of approximately 300-400 acres has been the licensing experience to date.

6.4.2 - Ash Disposal

Coal is not presently being used at any power plant in the study area except where temporary variances have been issued. However, continuing fuel shortages may require the use of coal. A 600 MW plant with a 35 year useful life and assuming an overall average capacity factor of about 50 percent would require an ash disposal area of 60 to 80 acres with ash piled to an average depth of 25 feet. A limestone injection system for controlling SO_2 emission from a plant would require collection of spent limestone from one to two times the volume of ash produced. The ash could be trucked away for disposal elsewhere, thereby reducing the local land area required for storage.

6.4.3 - Switchyard

Minimum space requirements for switchyards at power generating stations vary with plant capacity, location and transmission voltages. Under certain conditions, there might be justification in combining plant switchyard primary substations and major switching stations. It also may be necessary to include equipment for interconnecting systems of different voltages. Where several functions are combined, the required area may be doubled or tripled. The switchyard requirement for a 3000 MW plant with 345 kV transmission would be in the range of 10-15 acres.

6.4.4 - Transmission Access

Land requirements for transmission line access to a large generating plant are usually substantial. Decreases in the amount of acreage needed may be effected by a reduction in the number of circuits through the use of higher voltage levels, or possibly by tower design changes to reduce the width of rights-of-way and yet be consistent with power system design and operating criteria.

Plants being developed near populated areas could require longer transmission line rights-of-way should it become necessary to circumvent restricted areas. Developments in the technology of high voltage cable transmission may reduce land access problems but probably not without additional investment costs.

The transmission lines connecting a 3000 MW generating plant into an existing transmission system at 500 kV or double circuit 345 kV would require rights-of-way totaling from 150 to 200 acres for each mile over which the lines are built.

6.5 - Transmission and Distribution

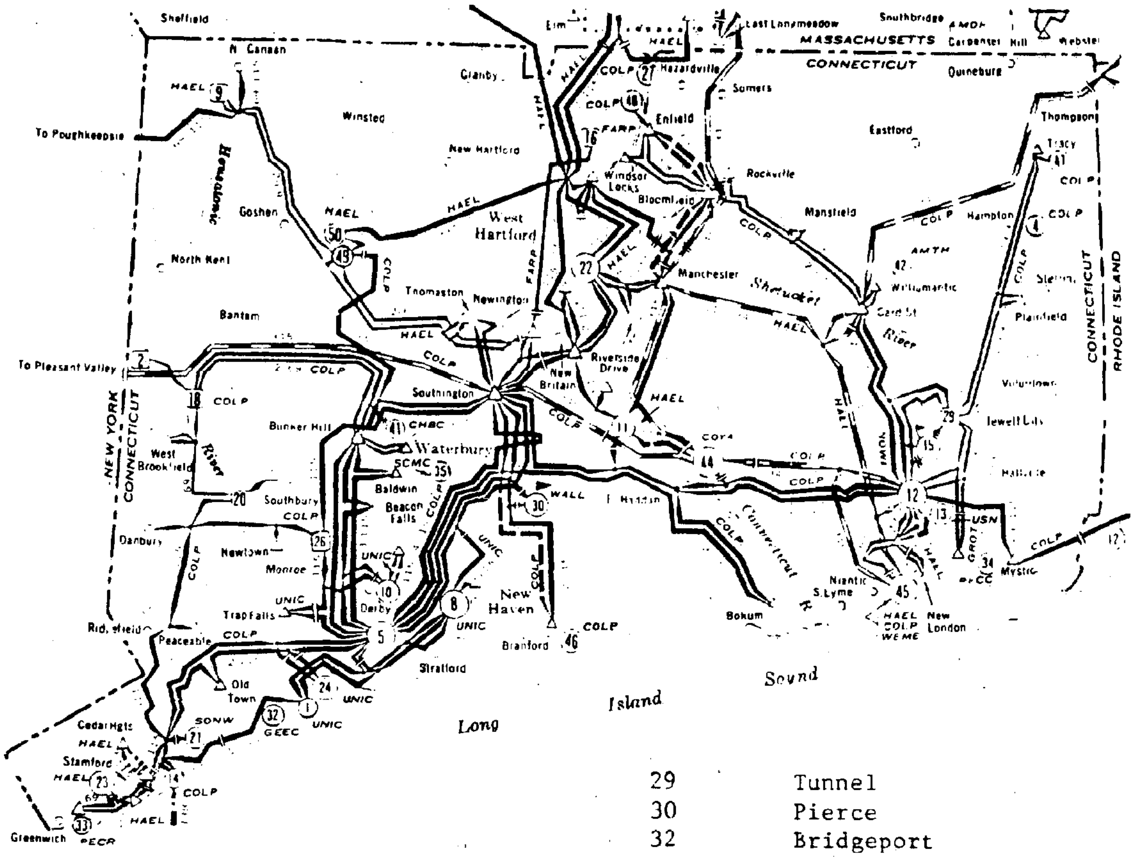
Transmission is the system component involved with conveying large blocks of electrical energy from the sources of generation to bulk power substations for ultimate distribution to the customer. The transmission system is in effect a high voltage network consisting primarily of overhead lines operating in excess of 50,000 volts. Transmission networks link virtually all sections of the country together electrically permitting the interchange of power for reliability and economic reasons. This network transmission system requires large high voltage substations situated at strategic locations to provide for the switching and control of energy transfers.

Distribution is that system component that delivers the energy from the transmission system to the customers. It includes the substations that reduce the high voltage of the transmission system to a level suitable for distribution, and the circuits that radiate from the substation to the customers.

The distribution circuits that carry power from the substations to the local load areas are known as primary circuits or feeders and generally operate at voltages between 4,000 and 40,000 volts. These circuits may be overhead or underground depending on the load density and the physical conditions of the particular area to be served. Many are constructed overhead on wood poles that may also support communication facilities and street lights. Street lighting is an important part of the distribution system.

Distribution transformers are installed in the vicinity of the customer to reduce the voltage of the primary circuit to the utilization voltage required by the customer. Secondary circuits carry the power at utilization voltage from the distribution transformers to the customers.

Figures 5 and 6 are schematic representations of electric facilities in the Long Island Sound Service Area for the Connecticut and New York portions respectively. Only principal high voltage lines are shown which provide a generalized overview of the transmission grid. Lower voltage lines as well as distribution lines are not shown because the extreme complexity of the network cannot be adopted to mapping procedures used for this study. Future transmission lines are not



Connecticut

Minimum Plant Capacity - 5 MW

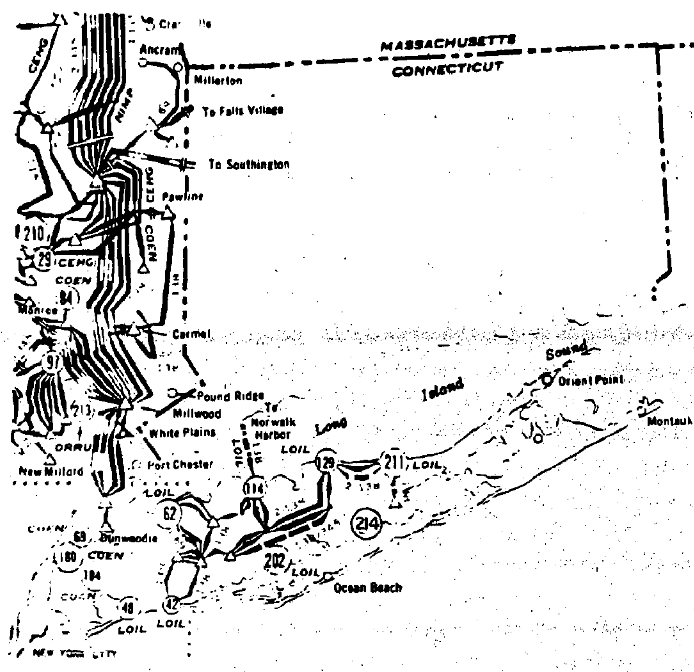
Map No.	Plant Name
1	Bridgeport Harbor
2	Bulls Bridge
4	Danielson
5	Devon
8	English
9	Falls Village
10	Derby (Housatonic)
11	Middletown
12	Montville
13	New London Submarine Base
14	Norwalk Harbor
15	Norwich
16	Rainbow
18	Rocky River
20	Shepaug
21	South Norwalk
22	South Meadow
23	Stamford
24	Steel Point
26	Stevenson
27	Thompsonville
29	Tunnel
30	Pierce
32	Bridgeport
33	Cos Cob
34	Groton
35	Main
41	Waterville
42	Wilimantic
44	Haddam Neck
45	Millstone
46	Branford
47	Tracy
48	Enfield
49	Torrington
50	Franklin Dr. (Torrington)
51	Cos Cob
52	New Haven
53	Sprague

LEGEND —·—·— Underground Cable

LONG ISLAND SOUND
REGIONAL STUDY

PRINCIPAL ELECTRIC FACILITIES
LONG ISLAND SOUND SERVICE AREA
CONNECTICUT PORTION

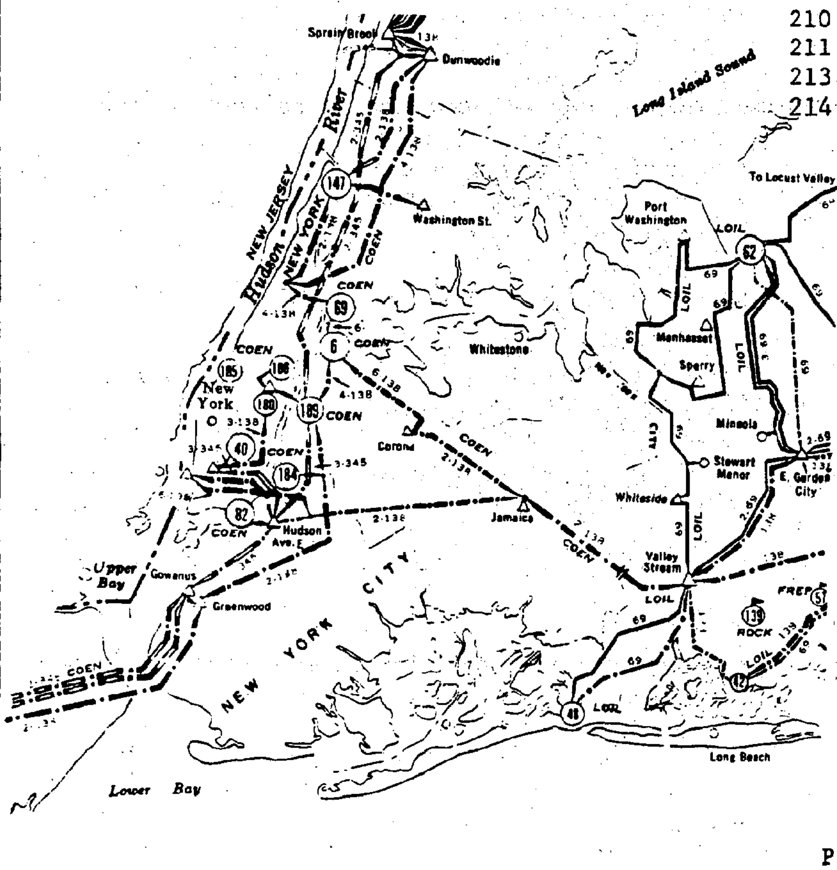
FIGURE 5



New York

Minimun Plant Capacity-25MW

Map No.	Plant Name
6	Astoria
29	Danskammer
40	East River
42	Barrett, E. F.
48	Far Rockaway No. 1 & 2
57	Freeport (2 plants)
62	Glenwood Landing 2 & 3
69	Hell Gate
82	Hudson Avenue
84	Indian Point
97	Lovett
114	Northport
129	Port Jefferson
139	Rockville Centre
147	Sherman Creek
180	Waterside No. 1 & 2
184	Kent Avenue
185	59th Street
186	74th Street
189	Ravenswood
202	West Babylon
210	Roseton
211	Shoreham
213	Bowline
214	Holbrook



LEGEND

Underground Cable

LONG ISLAND SOUND
REGIONAL STUDY

PRINCIPAL ELECTRIC FACILITIES
LONG ISLAND SOUND SERVICE AREA
NEW YORK PORTION

FIGURE 6

shown due to the uncertainties of placement and the lack of specific routing. Only after complete site investigations and routing studies are made can future transmission line locations be adequately addressed, impacts assessed, and alternatives considered.

The transmission system which serves Connecticut, indicated on Figure 5, is basically a network of 115-kV transmission lines, with an overlay of 345-kV lines added since 1964. All major generating units which have been added during the last six years have been connected directly to the 345-kV transmission system, in order to transport more efficiently their output to the load areas. The 345-kV transmission network interconnects with similar facilities in New York, Massachusetts and Rhode Island. These interconnections, several of which were recently completed, have substantially strengthened the New England transmission network and thus have improved the reliability of the power supply to Connecticut.

A primary consideration in determining the desirability of using EHV for major transmission lines is the fact that one line is the equivalent of several lower voltage transmission circuits. Thus, the same amount of power can be transported more economically and with less environmental intrusion at the higher voltage. There are now approximately 1,300 miles of 345-kV transmission lines in service in New England, including 250 miles in Connecticut.

The major transmission system that supplies the service area in New York is a highly integrated 345-kV network as shown on Figure 6. The primary voltage on Long Island is 138-kV, with over 184 circuit miles operating in 1973. The geographic location of Long Island relative to the other companies in New York greatly minimizes the effect of Long Island's generating plant locations on the state's bulk power transmission system. Electrically and geographically, Long Island is at the easterly end of the grid system and unlike the other system members, power does not flow directly through the system but only to or from it. In the future additional interconnections will be required to integrate more fully Long Island with the Power Pool. An example of inter-pool coordination is the 138-kV line between Long Island and Connecticut across the sound.

As of January 1972, over 360 miles of 345-kV lines were scheduled or proposed in Connecticut from 1972 through 1981. The exact amount and locations will depend on the extent to which new regional interconnections are made and on the location of proposed new nuclear and fossil plants in the area.

The proposed transmission facilities for the New York portion of the service area are generally in conformance with a coordinated long range program for optimum development of 345 kV. The 345-kV bulk power transmission grid will connect generation installations proposed for eastern Long Island in the 1980's with load centers in western Long Island and from there to the other New York systems through interconnections. In the intervening years transmission facilities which will be constructed at 345 kV will operate at 138 kV, the present operating voltage of the systems on Long Island. In general, routes for proposed overhead facilities, will utilize existing rights-of-way or those of the Long Island Railroad; underground installations will be on existing rights-of-way or in public streets.

Historically, the development of electric power systems has been based on the concept of using high-voltage overhead lines for bulk power transmission. The use of underground cable for this purpose has generally been limited to the short lengths required in extremely congested areas. Two principal reasons are (1) as transmission voltages have risen over the years, the technology for overhead lines has been available, while the technology for underground cables of equivalent capability has generally lagged, and (2) the cost of underground transmission has been, and remains, much higher than for equivalent aerial circuits.

The highest voltage ac underground transmission cable currently in service is 345-kilovolts, and the most extensive system is that of the Consolidated Edison Company in the New York City area.

A major difficulty of underground alternating current transmission lines results from a continuous flow of so-called "charging current" between the conductor and the sheath. Its magnitude increases with voltage and varies inversely with the thickness of the insulation and directly with the length of the cable. At 345,000 volts, utilizing commercially available cable, practically all of the current-carrying capability of the uncompensated underground conductor is utilized by this charging current in a distance of about 26 miles. Therefore, no capability is left for useful current to be transmitted, unless very expensive and bulky compensation equipment is installed.

Underground lines have the further disadvantage of poor accessibility. According to the Advisory Committee on Underground Transmission in its 1966 report to the Federal Power Commission, overhead lines have more outages than underground per unit of length but the outages are usually shorter in duration. Because of the longer repair time for underground systems, additional facilities are sometimes installed to reduce the risk of overlapping outages. Overhead lines have greater flexibility because connections and repairs are relatively simple and they can be converted to higher voltage if necessary. Underground systems cannot easily be altered, but voltages can be changed if initially planned for.

On the basis of present technology, it is estimated that in suburban areas underground lines cost on the average about 6 times as much as overhead lines at 138,000 volts, and about 10 times as much as 345,000 volts. Because of lower rights-of-way costs in rural areas, the comparable figures are 8-15 times as much, respectively, for average conditions in the Northeast. The economic costs would be higher if existing overhead lines are prematurely converted to underground because the undepreciated values of the discarded facilities must be considered in the analyses. As transmission costs represent between 10 and 20 percent of the costs paid by consumers for electricity, the significance of these increases in the cost of transmission can be readily understood.

The cost of burying transmission lines depends to a large degree on the soils into which they have to be buried and the topographic features. The Long Island portion of the study area is more fortunate than its counterpart in Connecticut. The soils on the north shore of the Island are generally sandy with little rock outcrop, while on the Connecticut side large masses of rock are exposed. In order to place transmission lines underground, costly blasting would be necessary plus the removal in many cases of the overburden. Indeed, under present technology and costs, the general feasibility of any electric power project could be jeopardized by the insistance that all the associated transmission be placed underground. It is with factors such as these in mind that a Connecticut citizen board, the Power Facility Evaluation Council, has commissioned a study to determine the feasibility of eventual undergrounding of these lines, the Council wants to insure that such a requirement is econimically as well as environmentally reasonable.

Power and other utility transmission systems currently create a landscape that is a tapestry of wires caught up from time to time by steel towers or obtrusive pole structures. Transmission systems probably generate more complaints from the public than all other facilities combined./1 Concealment of transmission towers and lines is virtually impossible, but much can be done to render them less intrusive and more attractive. Regardless of the general scheme employed in the layout of a transmission line, the appearance of the individual towers will usually be of a major concern. They cannot always be placed out of view, or effectively blended into the surroundings by landscaping or painting. Some companies have responded to this challenge by proposing completely new designs for transmission towers. They have attempted to unclutter the traditional tower and make it more graceful.

The Federal Power Commission, under Order No. 414, adopted new regulations, effective January 1, 1971, implementing procedures for the protection and enhancement of esthetic and related values in the design, location, construction, and operation of licensed hydroelectric power project works, including primary transmission facilities.

The regulations require all applications for new projects to include an exhibit showing the applicant's efforts to protect and enhance natural, historic, scenic, and recreational values in locating rights-of-way and transmission facilities. The exhibit (map, photographs or drawings) to be submitted with applications for licenses must show measures which will be taken during construction and operation of the project to prevent or minimize damage to the environment and preserve the project's scenic values.

The Commission at the same time issued a set of guidelines designed to provide an indication of the basic principles to be applied in the planning and design of electric power transmission facilities. The guidelines seek to provide the most acceptable answers from an environmental standpoint, taking into account safety, service reliability, land-use planning, economics and technical feasibility. Compliance with these guidelines is even required by Connecticut law.

/1 Although a recent survey indicates that this may not be true
Electric Light & Power - April 1973

Many companies, state agencies, and consumer groups, have decided that the pole is preferable to any other possible configuration. The simple streamline pole has met with great public acceptance in many instances as being the least obtrusive esthetically on the environment.

It is the opinion of a great many of the industry's critics that it is not so much the structures themselves that offend esthetic sensibilities, as the rights-of-way slashes in which they are placed. In obtaining new rights-of-way, many forward-looking utilities have taken great care to insure proper placement. Attempts have been made to locate lines as far away from highways or other public gathering places as possible. Structures are generally located away from skyline ridges, to avoid using the sky as a backdrop. If ridge-top structures cannot be avoided, limited height trees planted along the ridge under the transmission line help to make the right-of-way gap less obvious.

Possibilities exist for multiple use of transmission rights-of-way formally and informally for the development of trails for hikers, motorcyclists, horseback riders, and snowmobiles, which might interconnect in a regional trail system for the Long Island Sound Study Region. This may help make overhead lines more acceptable to the public.

6.6 - Esthetics

There are many esthetic considerations associated with the siting, construction, and operation of generating stations. For example, coal piles, coal handling equipment, oil storage tank farms, and stacks add to the normal problems of a large industrial structure at fossil-fueled generating stations. Not only do coal piles contribute to an unsightly overall appearance, but they are frequently involved in water pollution. Nuclear plant pose the problem of large containment vessel structures and hydro plants often intrude on scenic areas, or entail competitive use of water that may preclude other esthetic developments. Gas turbine and internal combustion plants are beset with noise and fume problems.

Esthetics and environmental effects, until recently, were often reviewed as an afterthought rather than as a prime consideration. Recent concern with environmental factors has led to a vast change in site selection and design concepts. These are more adequately addressed in the planning report, "Shoreline Appearance and Design", produced by the National Park Service and Roy Mann Associates, Inc. for the study.

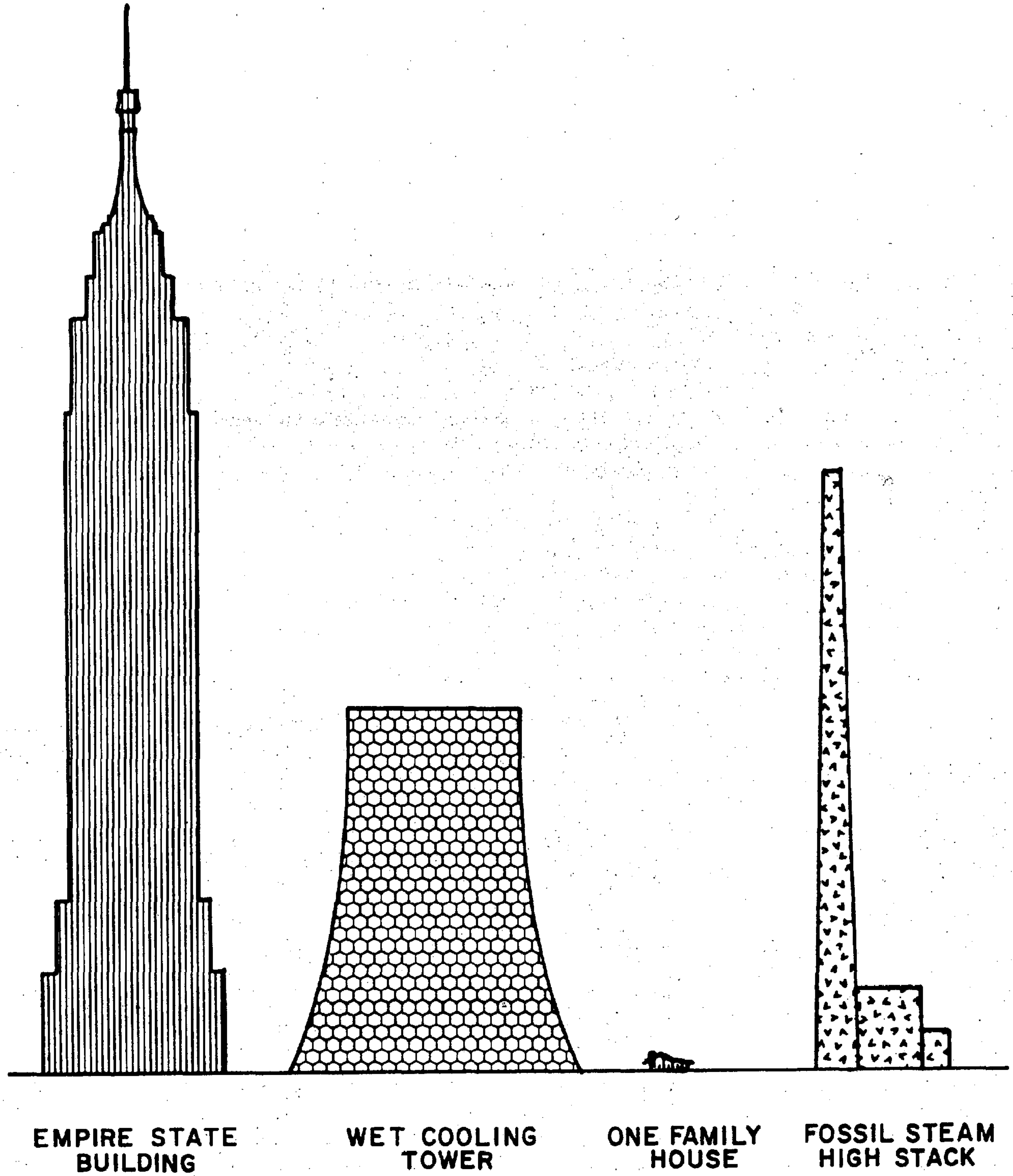
Other problems that tend to limit the number of sites esthetically suitable for fossil-fuel electric plants are the fuel storage and ash disposal areas with their attendant structures and associated transportation facilities. The space requirements for these facilities aggravates the problem of concealment.

In many cases cooling towers must be employed for thermal power plants located on inland and estuarine waters. These towers present difficult esthetic problems. If mechanical draft towers are used, the structures may be several hundred feet long and 60 feet high, see Figure 7. Forced draft towers emit vapor into the air that may create fog banks, snow, rain, sleet, or ground ice, under certain atmospheric conditions. The plumes from these giant hyperbolic towers present less of an esthetic or environmental problem than those from the forced draft systems, but this may prove an under-compensation for their enormous size. In both cases local noise conditions can constitute a major nuisance.

6.7 - Environmental Considerations

Along with the factors traditionally included in plant site investigations such as economics, area-capacity requirements, possible transmission requirements, availability and condition of land, and availability of cooling water, the utilities must give increasing consideration to water and air pollution as well as to the physical appearance of the plant itself. Area considerations for power plant siting vary widely and reflect the specific needs for fuel storage, cooling devices, type of prime mover, and many other factors. As these additional requirements tend to eliminate a number of otherwise potential sites, it is evident that only a few sites will meet all of the economic, esthetic and ecologic requirements that are desired. Controls on costs for power generation have frequently influenced the degree of environmental protection achieved in the past. With increasing emphasis on environmental and ecological protection, however, the Federal Government, some state governments, utility industry and some research institutes, have ongoing programs attempting to assess environmental benefits and to minimize the conflicting environmental problems of various interests and still maintain a reasonable balance in cost of electric power.

Connecticut, for example, has established the Power Facility Evaluation Council, a nine-man citizen board which must certify the siting of all new generating and transmission facilities within the state. Environmental compatibility and public need must be demonstrated before the facility can be certified, as well as reasonable economic cost. In this manner the public becomes more involved in the tradeoffs of the decision-making. New York State established a five-man board on electric generation siting and the environment to provide for the expeditious resolution of all matters concerning the location of major steam electric generating facilities. The board has the sole power to issue a certificate of environmental compatibility and public need. The certificate will be issued under a single proceeding to which access will be open to citizens, groups, municipalities, and other public agencies to enable them to participate in the general decision making process.



COMPARATIVE SIZES OF MAJOR POWER PLANT STRUCTURES WITH FAMILIAR BUILDINGS

FIGURE 7

6.7.1 - Thermal Effects

Control of the effects of the discharge of heated waste waters poses a major problem of increasing importance in connection with siting of new steam power plants. The thermal discharge standards for estuarine and saline waters are included in the I-2 (Water Quality) work group inventory report, and will be further discussed in their management plans.

There is no doubt that changes in aquatic temperature caused by additions of waste heat from power plant condenser cooling water can cause changes in the ecology of the area. There are many factors that must be considered before we can predict what the changes will be.

First it is important to realize that the relationship of temperature changes to biological organisms is extremely complex and complicated by the myriad variables that combine to form the environment within which the organism lives, grows, and reproduces. Also, how these variable factors interact is not well understood. Their effects must be studied and isolated prior to any reasonable assurance of predictability. The concerns over heated discharges are intensified by the substantial changes in temperature in the aquatic environment that occur normally from natural and seasonal causes. Careful design and control are required to avoid unacceptable changes in the environment caused by heated discharges. One of the most pronounced effects of heated discharge is upon aquatic animal and plant life. In general, bio-chemical processes, including the rate of oxygen utilization by aquatic species, double for each 10°C rise in temperature up to 30°C to 35°C, but as water temperatures rise, the water holds less dissolved oxygen. Thus, as temperatures rise a double phenomenon occurs, i.e., potential supplies of dissolved oxygen decrease, while the need for same increases.

Nevertheless, the thermal effect of plant effluents can have varied repercussions. On the plus side of the ledger, an increase in temperature can result in more rapid development of eggs, faster growth of larvae, fingerlings, or juvenile and larger fish of a given age or class. The temperatures at which maximum development takes place varies with species and at each stage of the life cycle. Over a period of several generations the composition of species in affected areas of streams, reservoir, lakes, or estuaries may change if the local temperature patterns are changed. While this may also occur naturally, the process may be accelerated by heat loading.

An increase in temperature may also be responsible for making the waters more desirable for swimming and associated contact sports if the waters are normally so cold as to preclude such use. If the water is already warm, however, further increases can reduce the esthetic and recreational value.

Should the temperature increase of the receiving body go beyond a certain point, aquatic life can be adversely affected. Fish hatch can be reduced and greater mortalities in the development stages can occur. A change in temperature also has a number of indirect effects. There is a potential for fish kills when a plant has to suddenly shut down, during periods of cold weather, when fishes attracted by the warm water of the "mixing zone" may be subjected to a sudden drop in local water temperature. Fish kills of this nature have been reported. Even where a temperature change is not directly damaging to the development of desirable species, and increase is often found to facilitate the more rapid development of less desirable or undesirable species. While fish are generally available in discharge areas, it is often found that an increase in temperature results in a loss of the more desirable cold water sport species since their thermal and oxygen thresholds are often exceeded. A warmer temperature is also considered to increase the occurrence of disease in fish populations.

Fish are affected to various degrees by thermal additions, sometimes beneficially and sometimes detrimentally. Several sub-lethal effects of elevated water temperature are very important to consider when evaluating the extent of impact on fish from heated water discharges. The data that are available provide guidelines as to what the critical temperatures of a water body are with respect to the existing biota. The generalizations that are made can be applied to similar water bodies, but thus far the temperature problems must be determined for each site where waste heat is being produced and discharged.

A particular problem exists with migratory species, since changes in temperature are apparently important as a stimulator of migratory activity. Premature migration, avoidance reactions to changes that occur near a water discharge, viability of eggs or sperm, or the availability of appropriate food when the eggs hatch, are probably more important in the preservation of migratory species than the direct lethal effects of the discharge.

Any increase in temperature from cooling water discharges will result in increased evaporation and an increase in the concentration of the minerals present. While not ordinarily of sufficient magnitude to constitute a problem, if the water is subject to a number of cooling cycles and evaporative cooling devices, a measurable loss of water and an increase in solids may result. This phenomenon is generally confined to cooling ponds and small bodies of water, and would not occur in a large body of water such as Long Island Sound.

The food chains associated with the species of most importance or interest have not been defined well enough to establish the critical temperatures for the links within the food chain. The sub-lethal temperatures and their related physiological effects aré as nearly important to the survival of a given fish species as the lethal temperatures for that species.

Plankton forms the base of most aquatic food chains and, depending on the species, temperature elevation, and length of exposure may or may not be affected by the heated discharge. In some thermal effluent areas, algae may thrive, occasionally to the point of being a nuisance.

In recognition of the need for more precise information on the characteristics and proper usage of Long Island Sound, Northeast Utilities, Long Island Lighting Company, United Illuminating Company and Consolidated Edison Company of New York formed the Long Island Sound Study Group and cooperated in sponsoring the Long Island Sound Scoping Study. One of the group's recommendations was a model with the capability of predicting the temperature changes in Long Island Sound as a whole due to discharge of Waste heat from electrical generating stations.

Results of the model indicated that the increase in electrical generating capacity projected for 1978 is reflected in a rise of a few hundredths of degree for most of the average temperatures, in the Sound.

6.7.2 - Impingement

The intake of large quantities of cooling water into a power plant introduces several environmental concerns, one of which is impingement. Impingement refers to the entrapment of marine organisms against trash collection screens by the intake water forced across the screen. Impinged organisms and trash are then washed from the screen and returned to the water through a discharge system, or in most newer plants are collected and hauled to landfills. Injury and/or death of large quantities of fish impinged on power plant intake screens can occur. Some power plants on Long Island Sound have had some impingement problems, and documented fish kills of over one million fish have occurred./1 Others, such as Northport have had very low impingement. Impingement can be so severe that a plant could be forced to shut-down for lack of cooling water. The routine removal of small numbers of fish through impingement can have cumulative impact which may affect local or migratory populations.

From an environmental standpoint, the design and placement of power plant intake structures require detailed evaluation. EPA's development document encourages a case-by-case review of intake criteria, rather than setting detailed requirements. It recognizes that what may work in one situation (e.g. $<$ 0.5 fps intake velocity) may not work in another. Individual site specific studies are recommended to determine the best intake designs for a particular location, so that particularly productive areas may be avoided (offshore waters can be more attractive than inshore waters to many fishes and their larvae) and diversion devices which are effective for important indigenous species can be designed.

Although many biological effects of impingement are difficult to assess the problem is well recognized. It might be noted that a number of intake studies are presently underway, seeking to find the best methods to prevent ingestion of a wide range of species since, ultimately, it is the effect of

/1 An estimated 2 million young menhaden were killed in August of 1971 at the Northeast Utilities Company plant at Waterford, Connecticut the intake on the population structure of the waterbody which is most important. If populations are not seen to be altered by an intake, then a certain level of power plant predation may be acceptable.

Although many biological effects of impingement are difficult to assess, the problem is well recognized. Substantial changes have occurred in intake structure design recently in an effort to minimize impingement losses.

6.7.3 - Entrainment

Entrainment is the passage of relatively small organisms, including eggs and larvae of fishes, through the condenser cooling system of power plants. Complicated by thermal and chemical additions into the cooling system, the mechanical effects of entrainment on the indigenous population of a local area often result in the death of organisms. Physical damage can occur to entrained organisms by mechanical and hydrodynamic forces imposed by screens, pumps, condenser tubes, and siphon sealing pits. Larval and post-larval fishes are particularly sensitive to the non-thermal components of the cooling process. Resultant mortalities are rendered more significant because reproduction and recruitment rates for fishes are estimated in months and years, whereas flushing rates for receiving waters are measured in hours or days.

Entrainment mortality of plankton could introduce great quantities of nutrient materials into receiving waters which, in combination with thermal additions, may select for the growth of nuisance algae, particularly during periods of high water temperature in summer. Dispersion and deposition of organic particulates can also change the benthic community near the plant discharge, often in combination with altered circulation patterns. The entrainment problem may be significant where large volumes of water are passed through a power plant, as in the case of high volume dilution pumping used to reduce thermal and chemical stress, unless the intake has been located in an area or zone, little utilized by larval stages.

Utilities on Long Island Sound are attempting to evaluate the isolated and combined effects of entrainment. Unfortunately, biologists have not yet perfected methods to predict or properly determine all of the impacts of entrainment. It is noteworthy, however, that concerned Federal and State agencies are directing their attention towards the evaluation and maintenance of balanced indigenous populations of organisms near power plant operations.

6.7.4 - Waste Heat Utilization

Studies are under way to find practical ways of utilizing waste heat, before it enters the cooling water, before the heated cooling water is discharged to the receiving water, or in the receiving water. Possible uses include space heating, air conditioning and refrigeration, desalination of water (with power as by-product), industrial processes, extended periods of navigation in icelocked areas, improvements in irrigation agriculture, and advances in aquaculture.

Waste heat is now being used in several instances to heat buildings. In some cases relatively low pressure or exhaust steam from thermal generating plants is used in industrial processes. However, on a national scale such uses of waste heat would account for only a very small proportion of the total available supply. Very few industrial processes can efficiently use energy of such low quality. In some cases it might be beneficial from an overall community standpoint to reduce the efficiency of a power plant in order to supply economical heat to nearby users. This would represent a trade-off between electric power and steam use which could be optimized at the local level.

Agriculture is a potential user of waste heat. Irrigation with heated water could promote faster seed germination and growth and extend the growing season. Hot houses could be used to grow tropical or subtropical crops in the more temperate regions of the country. Specialized, high income crops could be produced on a year round basis. However, such problems as soil adaptability, crop resistance to heat, and parasites, would have to be solved before large-scale use of heated water fromcrop production could become common practice.

Another potential use of condenser discharge water is aquaculture. Marine and freshwater organisms may be cultured and grown in channels or ponds fed with heated water. For example, it may be possible to grow commercially valuable oysters in areas where they cannot normally reproduce or survive due to low water temperatures. Studies are being made of the possibility of increasing lobster production in Maine with the use of waste heat. Waste heat from the Northport steam electric plant operated by Long Island Lighting Company is being used in an attempt to increase oyster and clam production. Consideration is being given to a similar technique at Millstone Nuclear plant in Connecticut; and in the Puget Sound region of Washington State to promote the spawning and growth of oysters, crabs, and mussels. Proposals have been made in Wisconsin to use waste heat to warm sport fish hatchery waters and increase growth rates. The University of Miami's Institute of Marine Science is conducting an experiment in shrimp farming at Florida Power and Light Company's Turkey Point plant.

Some other uses of low grade energy derived from heated discharge water await further studies and developments. These would include airport defogging, waste water and sewage treatment processes, and algae-plankton farming for food production.

A report "An Opportunity for Future, Integrated Water Supply-Power Plant Cooling Waste Water Treatment and Disposal", one in a series of studies has been undertaken in connection with the Northeastern United States Water Supply Study authorized under Public Law 89-298. This report evaluates the technical feasibility of integrating water supply with power plant cooling and wastewater management, with particular emphasis placed on heat transfer to wastewater treatment processes and land disposal of heated wastewater effluent for the purpose of effluent renovation and managing groundwater reservoirs. Alternative methods of beneficially utilizing the waste heat from the power generating facility are also identified and analyzed. Preliminary determination of water supply and environmental quality impacts and economic costs and benefits of integrated management systems are presented in the study. A project possibly in Suffolk County to demonstrate technical feasibility and impacts of a joint management system is recommended.

6.7.5 - Atmospheric Effects

Air pollution control is a vital element in the siting of generating plants because a substantial portion of emissions from stationary sources is attributed to the electric power industry--primarily in the form of particulate matter and sulfur and nitrous oxides--in and near major population centers. The projected power needs of the region, the long economic life of power plants, and the trend toward larger unit size, all underscore the importance of including air pollution control as a major siting criterion in planning future plants. As new plants are built and older plants are gradually replaced, cognizance of air pollution control requirements in the location and design phase represents a major step toward meeting regional air pollution control objectives.

When fossil fuels are burned, chemical oxidation occurs as combustible elements of the fuel are converted to gaseous products and the non-combustible elements to ash. Usually more than 95 percent of the gaseous combustion products are known to be harmless at the present time (oxygen, nitrogen, carbon dioxide, and water vapor) and are not a factor in air pollution. The noxious gases (oxides of sulfur and nitrogen, and organic compounds including poly-nuclear hydro-carbons) are harmful to plants, humans, animals, and material. Controls are widely available for particulates, but there are presently no fully tested, commercially available control systems for the oxides of nitrogen and sulfur. Combustion of natural gas yields comparable quantities of the oxides of nitrogen, but has no particulate and sulfur oxide emissions. All combustion control parameters being equal the combustion of natural gas produces less NOx emission rates than the combustion of oil.

Oxides of sulfur are one of the major factors contributing to air pollution. Sulfur dioxide may, upon discharge, convert to sulfur trioxide, and the latter to sulfuric acid mist, which may cause extensive damage to human and vegetable life, as well as to property. Sulfur oxides in combination with other pollutants, e.g., particulates, have been shown to exhibit synergistic effects several times more severe than comparable exposure to either pollutant alone. Extensive research efforts are under way to develop economical control processes for industrial units.

Nitric oxide, though not a toxic gas when isolated, oxidizes in the atmosphere to nitrogen dioxide, a lung irritant. Under the action of sunlight, nitrogen dioxide dissociates into nitric oxide and atomic oxygen. Some of the latter then combines with molecular oxygen to form ozone, a highly irritating gas and a health hazard. The nitrogen dioxide combines with various hydrocarbons, forming various organic nitrogen compounds. Gaseous emissions from coal combustion include oxygenated organic compounds (such as aldehydes, carbon monoxide, hydrocarbons), as well as the oxides of sulfur and nitrogen.

Particulate emissions from coal-fired units consist primarily of carbon, silica, alumina, and iron oxide in the flyash. All but the smallest of the submicron particles of flyash can be removed by control equipment before flue gases are discharged.

Health and nuisance aspects of a fossil-fired plant normally increase in direct proportion to the population. Population centers in the immediate vicinity of a plant may present air quality problems related to dust from handling coal or flyash as well as from stack emissions. Air quality considerations related to population should take into account both existing and expected future developments and populations in the area of concern.

Agriculture and forestry are primarily affected by emissions of sulfur dioxide. Plant tolerance levels are reasonably well known, and proper planning and design can assure that they will not be exceeded.

There are three general approaches to the control of sulfur oxides and/or particulate emissions arising from fuel combustion: fuel changes, stack gas cleaning, and improvements in precombustion removal of sulfur compounds.

Fuel changes include both fuel substitution and fuel switching. The latter is defined as the replacement of one fuel with another of the same type, an example being the substitution of low-sulfur coal for high-sulfur coal. Fuel substitution is defined as the replacement of one fuel with another of a different type (e.g., substituting coal for oil or natural gas).

Stack gas cleaning is applicable to the control of both sulfur oxides and particulate emissions, but currently it is widely applied only in control of particulates. However, EPA requirements and the success with a protype flue gas scrubbing system at Everett, Mass. may have significant bearing.

There are inherent limitations on the usefulness of mechanical treatment because 40 to 80 percent of the sulfur in coal is organic. Organic sulfur is chemically bound to the coal in a complex structure, so detailed treatment is necessary. Research projects such as for solvent refined coal indicate possibilities of removing as much as 70% of the sulfur, although the final product may still contain slightly more than 1% sulfur on a weight basis.

6.7.6 - Radiological Effects

A rem is a unit used to measure radioactivity effect on man. A millirem is one thousandth of a rem. The Environmental Protection Agency has recommended that the whole body dose restriction to any person at the site boundary be limited to 5 millirems of radiation per year.

The development of nuclear reactor technology in the United States has been characterized by an overriding concern for the health and safety of the public. Its overall safety record has been excellent. According to Atomic Energy Commission statistics, no member of the general public has received a radiation exposure in excess of prescribed standards nor have accidents of any type affecting the general public occurred, in any civilian nuclear power plant in the United States.

During their operation nuclear power plants are permitted to release, under well controlled and carefully monitored conditions, low level radioactivity. Experience with licensed operating power reactors shows that such levels of radio-activity are only a small percentage of release levels permitted under A.E.C. regulations. Typical nuclear power plant off-site dose design objective is one percent of A.E.C. regulations and operating reports from plants in the field show an order of magnitude of about 1 millirem per year.

Nuclear reactor technology has been developing in the United States for more than 25 years. During this time the knowledge necessary to protect public health and safety has advanced with the technology. Protection of public health and safety in the design, construction, and operation of reactors is a statutory responsibility of the A.E.C. under the Atomic Energy Act of 1954, and the Commission considers this in all its activities. In carrying out this responsibility, the A.E.C. devotes special attention to assuring that radioactive wastes produced at nuclear power reactors and other facilities are carefully managed and that releases of radioactivity into the environment are within government regulations.

The management of radioactive waste material in the growing nuclear energy industry can be classified into two general categories: the treatment and disposal of materials with low levels of radioactivity, i.e., the low activity gaseous, liquid, and solid wastes produced by reactors and other nuclear facilities such as fuel fabrication plants; and the treatment and permanent storage of much smaller volumes of wastes with high levels of radioactivity.

The high level wastes of the latter category are by-products from the reprocessing of used fuel elements for nuclear reactors. These high level fuel reprocessing wastes have a higher hazard potential than the former category. The two types are unfortunately misunderstood by much of the public. For example, 60-90 cubic feet per year of solidified high level waste is produced by a 1000 MW plant, and 0.1 acres of solidified low level waste.

Neither the reprocessing of used fuel nor the disposal of high-level wastes is conducted at the sites of nuclear power stations. After the used fuel is removed from the reactor, it is securely packaged and shipped to the reprocessing plant./1 After reprocessing, the high-level wastes are concentrated and safely stored in tanks under controlled conditions at the site of the reprocessing plant. Only a few reprocessing plants will be required within the next decade to handle the used fuel from civilian nuclear power plants. As with the power reactors themselves, the A.E.C. carefully regulates the operation of such plants.

More than 20 years of experience has shown that underground tank storage is a safe and practical means of interim handling of high-level wastes. Tank storage, however, does not provide a long term solution to the problem. Accordingly, using technology developed by the A.E.C., these liquid wastes are to be further concentrated, changed into solid form, and transferred to a Federal site,which will be capable of providing long term or permanent isolation of wastes from man's environment.

Technology developed for the treatment and storage of radioactive wastes produced at presently operating power reactors has been sufficient to date for the expanding industry. These treatment systems include short-term storage of liquid wastes, evaporation, demineralization, and filteration of liquids and gases, and compression of solid wastes. They also include chemical treatments to concentrate radio-active materials, and immobilization of radioactive solids and liquids in concrete or other materials. On-going research seeks to develop a more permanent solution to waste storage.

6.7.7 - Nuclear Reactor Safety

Recognizing the impossibility of providing, herein, an in-depth analysis of nuclear reactor safety, the following discussion merely highlights the basic problems. Nuclear reactor safety problems are complicated by the fact that there are many ways in which such complex systems can fail, although their individual and joint probability of occurrence is extremely low. There are also differences of opinion as to the credibility of postulated events and the need to take action to protect against them. The objective is to reduce this hazard to levels as low as possible--much lower than those which society faces (often without realizing it) everyday. Highly important is the siting criteria which controls the placing of reactors with respect to population density so as to minimize population exposures during normal operation (to a small fraction of permissible levels) and during any reactor accidents.

/1 The Buffalo,New York reprocessing plant serves the Northeast.

The first rationale is building the plant in such a way that the possibility of accidents is minimized. This involves highest standards of quality assurance and design of redundant control systems to shut the nuclear reaction down; design of pressure vessel and piping systems to minimize the chance of failure; design for earthquake and other natural phenomena; minimizing the possibility of failures that disable two or more systems which are designed to be independent of each other; and enclosing the reactor system in containment structures to essentially isolate from the public the consequences of any accident.

A major factor which makes reactor safety unique is the existence of radioactive fission products which are generated as a by-product of heat-generating nuclear fission. These fission products are not only biologically hazardous, but continue to generate heat (at a decreasing rate) by radioactive decay after the reactor is shut down. There is no way of shutting off this decay heat generation. It must be removed by active cooling systems to avoid excessive temperatures and possible melting of fuel in the reactor core, either by the normal cooling system or backup emergency cooling systems (ECCS) which are provided. In case of loss of primary coolant, the emergency core cooling system must operate to prevent fuel failures, core meltdown, and excessive release of fission products.

In addition to the ECCS, other safety systems are provided to mitigate the consequences of an "accident". A containment vessel which encloses the nuclear plant is provided to contain any fission products which might escape from the primary system. In some designs, spray systems reduce the pressure in the containment vessel after an accident by promoting steam condensation and reduce possibility of leakage. These sprays, which may contain chemical additives, also reduce the airborne inventory of fisson products--primarily by reacting with radio-iodine, the major radiological hazard in certain reactor accidents. Recirculating filters also remove contaminants from the containment vessel air to reduce the amount available for leakage to the environment.

Should an accident occur, there must be no undue hazard to the health and safety of the public. Accident sequences and response of reactor systems cannot always be precisely predicted. Accordingly, AEC licensing of a nuclear power plant is based on a very conservative design approach coupled with consideration and intensive analysis of many hypothetically assumed failures in a plant and their credible consequences.

The accident environment within a containment vessel may be hostile to the operation of equipment required to maintain cooling to the reactor. Plants are carefully designed so that as many critical items of the emergency cooling equipment as possible (such as pumps and valves) are external to the containment vessel and can be maintained. The emergency core cooling system is designed to flood the core in the event of a loss-of-coolant accident. This controversial subject was evaluated by an AEC

Task Force which made the interim recommendation in 1971, that existing reactors be operated in a mode and power level to limit the temperature of the fuel during an accident, that older plants be retrofitted with adequate emergency core cooling systems, and that newer plants be built with the capability of backfitting as may be required.

The AEC recently issued new regulations governing emergency core-cooling systems in light-water reactors and a method for analyzing acceptability of these systems in order to ensure their adequacy in all reasonably hypothesized ECCS situations. A record of 22,380 pages and 125 days of hearings was put into these changes from the 1971 interim criteria. Among the changes are: (1) The calculated maximum temperature of the Zircaloy cladding surrounding the fuel should not exceed 2,200F (instead of 2,300F) and a calculated limit is set on local oxidation; and (2) limitations on clad swelling rupture to minimize adverse effects on core flow and heat transfer, plus modification of hot channel flow factors. These changes, plus the interim acceptance criteria and other regulations regarding reactor accidents are considered to be conservative evaluations and should provide reasonable assurance that, with regard to emergency cooling, LWRs of current design can be operated without undue risk to the health and safety of the public.

Reactors are designed for at least a 30 year life; depending on economics, future technology and other factors this might extend to a useful life up to 40 to 50 years. Current AEC regulations require discussion of decommissioning plans and impacts at the time of preparing environmental impact statements before construction permits are issued. In general, experience with decommissioning of several small reactors to date indicates the availability of a wide range of acceptable measures that may be taken, depending on circumstances, ranging from (a) simply removing fuel, establishing an exclusion area and long-term surveillance to (b) removing fuel, removing all superstructure and contaminated equipment, and rehabilitating the ground area. Detailed consideration of the degree of dismantlement, abandonment, rehabilitation, salvage and reuse of equipment and sites may be deferred until near the end of useful life and established on a case-by-case basis so as to strike a proper balance appropriate to the then current conditions. Decommissioning of any non-reactor nuclear facilities with shorter lives (such as fuel processing facilities with possibly a 20 year life) would be evaluated in the same way as for reactors.

7.0 EVALUATION OF ALTERNATIVE MEASURES

To meet the objective of providing for future energy demands there are three catagories of alternatives that might be considered. The amount of generating capacity supplied within the service area to meet market area requirements can be varied. Another option would be to place the determined capacity in various generalized locations. These can be classified as urban, rural, inland, coastal, etc. and even further divided as cluster or scatter site developments. The third category can be viewed as a non-site oriented alternative that would include: not meeting the market area needs; reducing the overall demand for power; and the development of individual (non-central) power sources.

7.1 Vary the Amount of Generating Capacity Within the Service Area

The specific placement of future generating capacity readily lends itself to a strict analysis of economic/environmental effects. Any large generating facility increases the value of the nation's output of goods and services and improves national economic efficiency. With additional costs, the mitigation of detrimental environmental effects can be accomplished by the application of quality control facilities. Increased capital and annual costs will reduce the net national efficiency but increase the environmental quality.

The alternatives between EQ and NED are not basic to the choice of build vs. not build, but rather the choice of where and how the facilities are to be provided. To fully answer the question of "where", a region-wide and in-depth survey would be required that demands the essentials and details of an environmental impact statement. The "how" can be equally addressed only by a detailed analysis of trade-offs between costs and benefits as related to specific technologically acceptable devices.

Although such determinations are beyond the scope of this study, there still remains a large area of alternative decisions that can be made prior to the definitive calculations that would proceed the start of construction. It is these alternatives that this report will consider. Within certain time frames and specific service areas, additions to capacity can be projected that would supply power for each individual utility. However with present day interconnections the projected capacity supply, at any given point in time, can be varied from less than to more than required. In effect a service area can be an importer, exporter or self-sufficient.

NED, which maximizes and increases the value of the nation's goods and services and improves national economic efficiency, is best served by a regional power supply that chooses as a means of producing power those locations that offer the best potential for lowest cost and most efficient operation. This requires the use of water and related land resources of the service area to the extent of restricting its use for other purposes. It entails the use of relatively large expanses of industrial zoned land, possible thermal loading of water bodies, a degree of contamination of air and water discharges, increased transportation and access facilities, transmission needs, esthetic impacts, local community disruptions, effects on wildlife and recreational facilities, cultural impacts, and safety measures. Since the service area appears to be fortunate in having a very good potential for siting of generating units in the region under present technology it is assumed that maximizing the service power producing potential would serve to increase NED, ie: the service area would be an exporter of power.

EQ, which enhances the quality of the environment through management conservation, preservation,creation, restoration or improvement of the quality of natural and cultural resources and ecological systems, would be best served by a power supply system that would place the fewest demands on the resources of the area. These demands, partially enumerated above, would be eliminated by restricting power placement in the service area. EQ would be achieved but at the sacrifice of reliability, efficiency of operation, economic costs and increased impact on adjacent areas, ie: the service area would be an importer of power.

The best and most obvious choice for a program is to select those elements of each objective that serve to reduce their impacts on the environment and maximize their social and economic values. An analysis of a variety of factors that are involved in general power plant siting have been evaluated against each other for each option (export, import, and a composite that approaches self-sufficiency). The parameters used encompass a broad range of power generation demands.

Demand Factors

	Overall Evaluation		
	Import	Export	Composite
L.I. Sound Crossings	Fair	Fair	Good
Rights-of-Way	Fair	Fair	Good
Land Requirements	Good	Poor	Fair
Thermal Discharges	Good	Poor	Fair
Fuel Handling	Good	Poor	Fair
Air Discharges-Nuclear	Good	Good	Good
-Fossil	Good	Poor	Fair
Esthetics	Good	Poor	Fair
Reliability	Poor	Fair	Good
Tax Base	Poor	Good	Fair
Cost of Power	Poor	Fair	Fair
Extra-Regional Dependancy	Fair	Good	Good
Employment	Poor	Good	Fair

It appears that a composite program is the most likely course and, in fact, this has been the route invariably taken by major utility systems and governmental agencies. There is some amount of flexibility in the planning of supply so that each system can make the best use of its available sites and in scoping the size of new installations. The patterns developed over past decades by the various utilities in the service area appear to be the most conducive in providing a balance between meeting their requirements without being overly dependent on outside sources or overextending their capacity to generate. It can be assumed that this format will continue in the future.

In keeping with the requirements of the study, Table 13 presents three possible patterns of future power supply composition. Each of the tabulations represents an attempt to project levels of capacity that would satisfy the service area and market area requirements. The three levels of capacity allocation assumed for placement in LISSA have been designated as A, B, and C. The first, Series A, assumes that the service area would continue supplying the market at the same level as in the past. At this level it is further assumed, from past correlating data, that the service area has sufficient generating capacity to supply its own requirements. This is not to say that every operating system operates in a closed, self-supplied pattern. Both anticipated and unexpected variations in daily and seasonal loading patterns are met by interchanges of power. Still further complicating the concept of demand/supply relationships is the practice of utility sharing of large units, so that they may reap the benefits of the economics of scale as well as eliminate the steady proliferation of numerous small-scale installations.

The second assumption, series B, is that the service area would have a lower level of participation in the larger market area capacity requirements. This would, in effect, relegate the utilities that serve this area to the position of being net importers of energy. On a daily and seasonal basis there would still be an interchange of energy. At times of high demand and unexpected outages, a lowering of reliability may be caused by the dependence on capacity that may be committed for use outside the area.

Conversely, the third assumption, series C, is that the service area, with its extensive shoreline and adequate water supplies would become a net exporter of power. In this case a much higher level of capacity would serve utility systems located outside the service area by either multi-sharing of units or direct energy sales during times of high market area demands.

Under the three capacity levels future retirements are varied. Obviously, the removal of older units would have a beneficial effect on the environment but would also necessitate the replacement of these units. Retirement for the "C" series is taken at the relatively high period of 40 years. Amortization of capital investment is usually at a 35-year period and this is used for the "B" series. There is no hard and fast rule, however, as to the actual removal from service. For example, over 1,000 MW in existence in the New England area had been installed prior to 1930, with many units dating back to 1920. While retired units are sometimes considered in studies as replaced in kind, such a simplified assumption is inappropriate for the near future where some scheduling of retirements is available or can be readily postulated. Capacity taken out of service may be replaced by an alternative prime mover type and/or in a different location. For the period from 1972 to 1990, 1,000 megawatts is considered to be the "average" additional retirement under the "A" series.

Scheduled capacity additions for the Long Island Sound service area are generating plants or unit additions that are presented in utility reports to the Federal Power Commission as either under construction, authorized for construction, or in the planning stage.

Capacity additions designated as "under study" are generating plants or unit additions that have merely undergone preliminary reconnaissance analysis that indicate possible locations, magnitudes, and unit types.

7.2 Alternative Capacity Locations

There are four major areas that can be considered as appropriate for considerations of power plant site selection. These are: (1) the more efficient (or intensive) use of existing power sites; (2) urban sites; (3) rural sites; and (4) offshore sites. Within the broad catagories outlined above the possibilities of site selection can vary in degrees of intensity of use. The alternatives are not mutually exclusive. Under the limits of alternatives to supply that are outlined under Section 6.1, total capacity can be varied in magnitude for each of the location options.

The requirements of electrical demand have placed a heavy burden on the area's natural resources. Competition for these resources has put the power facility at a disadvantage due to its high use of water and land. The same features that attract the power planner also attract the industrial and general land developer. The increasing use of waterfront and coastal locations for recreation purposes had led to an even greater pressure for an evenhanded approach to satisfy industrial, commercial, and residential land and water resource needs. One prime objective in overall planning for the Long Island Sound Study must be to see that the rapidly dwindling supply of appropriate sites is used to the greatest advantage.

One of the most economically attractive aspects of power planning is the "economy-of-scale" factor -- the decrease in unit electrical cost with increasing plant size. All power generating units influence their surroundings, but large units exert a more significant local influence. Their impact is not only on the environment, but on the economy and social structure of the LIS area as well. The following is a discussion of the proposed alternative capacity options. The specifics of each type of power facility and their requirements have been discussed in Section 6.0.

7.2.1 More Efficient Use of Existing Power Sites

This option is usually the most acceptable solution to power plant siting. Unfortunately, increasing the rating of existing sites cannot meet the service area's total future needs. Providing more capacity at current facilities can be done in two ways. Where land is available for the addition of future units, the total capacity of the site can be increased without the concurrent increase in supportive facilities. For example, transmission appurtenances, disposal facilities, unit sizes and types, rights-of-way, and many of the environmental reserach problems have already been addressed in the construction of the prior units. Not having to duplicate geological studies, historical and cultural studies, access routes, and the like, eliminate lengthy delays and help bring the unit on line expeditiously.

In the other case, an existing unit can be retired from service and the site reused for a larger more efficient unit. In many cases, reuse of the site requires demolition of existing stacks, clearance of appurtenant structures and costly site restoration. However, these older sites with proper architectonics can be upgraded to meet standards and should be reused wherever possible.

7.2.2 Urban Siting (Fossil)

Under present day restrictions, urban siting of power plants are confined to fossil fired units. Urban placement can be further classified under two headings - coastal and inland. Each, in turn, can utilize condenser cooling facilities that are classified as once-through or cooling towers. A comprehensive analysis of this Section is given in Section 7.2.5.

7.2.3 Rural Siting (Nuclear)

This option is considered to encompass the installation of nuclear fueled facilities although fossil fired units can also be accommodated. As in urban siting, classification can be coastal and inland with cooling devices of once-through design or cooling towers. A comprehensive analysis of this Section is given in Section 7.2.5.

7.2.4 Offshore Siting

As a relatively new concept of power plant siting, this alternative can be judged under two modes - natural islands and artificial sites. Problems associated with general siting parameters seem to be carried over to natural islands. Recently, plans for offshore power installations have met with public resistance since many land and water features in offshore locations are as controversial as those onshore. Artificial islands have been seriously proposed and it can be assumed that most major technical problems are capable of solution. Almost all land siting deficiencies can be over-come by this siting procedure but esthetic, water quality, and ecological problems will require further examination.

7.2.5 General Site Evaluation

It is necessary for long range planning to select potential sites that provide the utilities the greatest amount of flexibility in developing an expansion plan. Based upon a number of vital considerations the planner is faced with selecting a sufficient number of sites to accommodate the capacity necessary to meet the anticipated demand. These sites, however, should, during the long-range planning phase of the siting process, be subject to detailed evaluation. The driving force for the commitment of power plant sites can no longer be principally an economic one. Equally important with the availability of an inexpensive site and its requisite technical attributes, such as abundance of cooling water and adequate transportation, is compatibility of such site development with current and probable future environmentally and societally accepted land use in the area. Economic considerations are not the only governing factors, since the expected environmental impacts are also highly relevant to ultimate utilization of the site.

A method for the evaluation of power plant sites in specific areas may utilize a ranking procedure. This will encompass weighted impacts of different effects combined to yield a generalized measure of an area's ability to support a power plant facility. This procedure utilizes four types of area siting; inland and rural, inland urban, coastal rural, and coastal urban.

For the purpose of this study, five major factors are considered to influence the placement of a major facility. These are land, water, air, access, and social factors. They have been evaluated under economic and environmental impacts. Similar techniques have been developed by utilities./1 It should be clearly indicated that only very general evaluations of potential sites have been made for the study to show how the projected demands could be met and that detailed site studies are required by the Federal and State licensing proceedings.

Each of the above factors were considered in detail (see generalized criteria). The generalized criteria, for both economic and environmental objectives, are subdivided into their basic components and are not necessarily in the order of their importance. The effect of each subdivision

/1 Power Engineering - March 1974, "Plant Site Evaluation Using Numerical Ratings".

may be given broad based values such as high, moderate, and low. From these, their total effect on each of the four area sitings were given a rating from 0 to 4, with zero having the least impact.

Having ranked the various areas in terms of each individual factor it is still necessary to use a weighting system. Based on a total of 10 for a multiplier, each major factor (i.e. land, water, etc.) was assigned a weight corresponding to their assumed relation to each other. The weights chosen are; land 3.0, water 2.5, air 2.0, access 1.5, and social 1.0.

The evaluation matrix, Tables 18 and 19, indicates the factor (or factors) in each area siting that are critical. The aggregate of all factors for each of the four areas indicates their relative desirability. Under present siting restrictions (10 CFR 100) nuclear power plants have not been considered for placement in urban areas.

Generalized Criteria for Rating Base Load
Power Plant Sites Under an Economic Objective

LAND FACTORS:

1. Availability
2. Cost of the land.
3. Other competitive uses.

WATER FACTORS:

1. Supply and availability.
2. Water and cooling devices needed.
3. Incremental water treatment.

AIR FACTORS:

1. Diffusion and stack costs.
2. Precipitators and control devices.
3. Fuel cost increment.

ACCESS FACTORS:

1. Fuel transportation costs.
2. Access during construction and maintenance.
3. Transmission and appurtenance costs.
4. Safety and waste disposal.

SOCIAL FACTORS:

1. Cost of labor.
2. Local tax rates.
3. Incremental plant design and landscaping needs.
4. Prevention of community disruption.

Generalized Criteria for Rating Base Load Power Plants Under an Environmental Objective

LAND FACTORS:

1. Effects on wildlife.
2. Esthetic considerations.
3. Historic and cultural impacts.

WATER FACTORS:

1. Effects on quality.
2. Competitive uses.
3. Facilities having a disruptive influence.

AIR FACTORS:

1. Effects on wildlife.
2. Human impacts.
3. Effect on modifying facilities.

ACCESS FACTORS:

1. Impact of transport facilities.
2. Effects of energy transmission.

SOCIAL FACTORS:

1. Disturbance of land patterns.
2. Recreation resources impact.
3. Health and safety.

TABLE 18. EVALUATION MATRIX - FOSSIL POWER PLANTS

	Economic					Environmental				
Category	Weighting Factors	x	Economic Overall impact	=	Rating	Weighting Factor	x	Environmental Overall impact	=	Rating
Inland - Rural										
Land	3.0		1.0		3.0	3.0		3.0		9.0
Water	2.5		3.0		7.5	2.5		3.0		7.5
Air	2.0		2.0		4.0	2.0		2.0		4.0
Access	1.5		4.0		6.0	1.5		4.0		6.0
Social	1.0		1.0		1.0	1.0		2.0		2.0
Total	10.0				21.5	10.0				28.5
Inland - Urban										
Land	3.0		2.0		6.0	3.0		1.0		3.0
Water	2.5		4.0		10.0	2.5		4.0		10.0
Air	2.0		4.0		8.0	2.0		4.0		8.0
Access	1.5		3.0		4.5	1.5		2.0		3.0
Social	1.0		3.0		3.0	1.0		1.0		1.0
Total	10.0				31.5	10.0				25.0
Coastal - Rural										
Land	3.0		3.0		9.0	3.0		4.0		12.0
Water	2.5		1.0		2.5	2.5		1.0		2.5
Air	2.0		1.0		2.0	2.0		1.0		2.0
Access	1.5		1.0		1.5	1.5		3.0		4.5
Social	1.0		2.0		2.0	1.0		4.0		4.0
Total	10.0				17.0	10.0				25.0
Coastal - Urban										
Land	3.0		4.0		12.0	3.0		2.0		6.0
Water	2.5		2.0		5.0	2.5		2.0		5.0
Air	2.0		3.0		6.0	2.0		3.0		6.0
Access	1.5		2.0		3.0	1.5		1.0		1.5
Social	1.0		4.0		4.0	1.0		3.0		3.0
Total	10.0				30.0	10.0				21.5

TABLE 19. EVALUATION MATRIX - NUCLEAR POWER PLANTS

	Economic					Environmental				
Category	Weighting Facotrs	x	Economic Overall impact	=	Rating	Weighting Factor	x	Environmental Overall impact	=	Rating
Inland - Rural										
Land	3.0		2.0		6.0	3.0		2.0		6.0
Water	2.5		4.0		10.0	2.5		3.5		8.8
Air	2.0		0.5		1.0	2.0		0.5		1.0
Access	1.5		2.0		3.0	1.5		3.0		4.5
Social	1.0		2.0		2.0	1.0		4.0		4.0
Total	10.0				22.0	10.0				24.3
Inland - Urban										
Land	3.0					3.0				
Water	2.5					2.5				
Air	2.0		NOT APPLICABLE			2.0		NOT APPLICABLE		
Access	1.5					1.5				
Social	1.0					1.0				
Total	10.0					10.0				
Coastal - Rural										
Land	3.0		3.0		9.0	3.0		3.0		9.0
Water	2.5		2.0		5.0	2.5		2.0		5.0
Air	2.0		0.0		0.0	2.0		0.0		0.0
Access	1.5		1.0		1.5	1.5		2.0		3.0
Social	1.0		3.0		3.0	1.0		3.0		3.0
Total	10.0				18.5	10.0				20.0
Coastal - Urban										
Land	3.0					3.0				
Water	2.5					2.5				
Air	2.0		NOT APPLICABLE			2.0		NOT APPLICABLE		
Access	1.5					1.5				
Social	1.0					1.0				
Total	10.0					10.0				

7.3 Non-Site Oriented

Of the three alternatives encompassed herein, the possibility of reducing demand holds the most promise for early action. The other two options, sanctioned power deficiencies and new forms of generation have legal and institutional imperfections and technical drawbacks. In all three cases these alternatives are more national than regional in scope.

7.3.1 Reducing the Demand (Conservation)

The conservation of energy is the central theme of many programs attuned to protecting natural resources and providing a better environment. It is not surprising that the continuing increases in demand for electricity have, in colliding with environmental imperatives, raised the basic question as to the acceptability of a continuing annual growth rate of about seven percent. Various devices for dampening the use of electricity have been suggested. They range from consumer education on energy conservation to the elimination of lower rates for large-use customers (including, as some suggest, the imposition of actual rate penalties) -all with the objective of slowing electrical growth and/or discouraging the use of electricity for certain purposes regarded by some as unnecessary or undesirable.

It is possible that the current sharp increases in electric power costs will result in some reshaping of rate structures. However, it would be shortsighted to view electric energy growth in terms of cost-price adjustments only, or to predetermine the rate of growth without considering the Nation's overall energy needs and supplies.

Energy conservation includes cutting down on waste; a reduction of energy demand in absolute terms, such as turning off unnecessary lights in office buildings; a reduction of energy demand in the production of electricity; a reduction of energy demand in industrial production processes, by more efficient fuel conversion; and a reduction in energy demand in consumption, such as requiring improved FHA insulation standards for single and multi-family housing and federal mortgage lending practices to enforce compliance, and the labeling of efficiency of air conditioners, and other major energy-consuming home appliances.

While conservation practices are imperative they are not the panacea to limit energy use. Growth can be slowed (a decrease in the compound rate of growth) but probably not eliminated. This would defer the installation of new power plants, not eliminate their need. On the other hand, a stimulating effect on electrical energy use could be expected if adequate supplies of natural gas are not available for household heating, or if conversion of energy in fossil fuels into central station electric energy becomes less costly than on site use of these fuels. Reduced oil imports and/or a general scarcity of fossil fuels can be a major spur on non-fossil fired electric power production to compensate for an energy lack in home heating, transportation, and industry.

The biggest imponderable with respect to future growth lies in the creativity of American inventors in terms of unidentifiable new developments both domestically oriented or in advanced industrial applications.

7.3.2 Sanctioned Power Deficiencies

Not meeting the need for power can have far reaching pernicious effects on the nation without any substantial compensating benefits. Additionally, electric power is essential in almost all environmental protective and improvement processes. It is required to achieve national goals calling for clean air, clean water, safer highways and streets, better housing, and a higher standard of living for low income groups.

7.3.3 New Forms of Generation

With continuing advances in technological innovations, this option, if properly pursued, offers the best means of providing an adequate supply of power with the least effect on environmental values. As a caveat to this approach, it should be understood that the development and supply of such new technology will, in the primary stage, create an accelerated demand on natural resources and power.

Some avenues open to development at this time that are technologically feasible or are presumed to be available in the foreseeable future are:

- Further improvements in the present method of using the heat energy in our fuels, including combined-cycles, and increased working temperatures.
- The commercial development of the fast breeder reactor.
- Commercial application of Magnetohydrodynamics (MHD).
- Development of fusion reactor technology.
- Solar energy for central station use and its application for individual use.
- Where practical at specific sites, the development of tidal power.
- Wind power.

-Fuel Cells.

- On-site methane gas generators.

There can be no doubt that the technical and scientific resources of this and other countries are well able to find satisfactory solutions to the above power generation possibilities. The great deal of time, effort, and money that will be required for a viable commercial application to be brought on-line, forces us to assume that no new forms of generation will be available to relieve our power needs before 1990. It is assumed by the benchmark year 2020, that this new source of power may account for about 20 percent of all generation.

7.3.4 Potentials for Resource Conservation

Beyond the many options previously discussed, there are certain avenues available to the planner that can affect the power generation industry. There are various new technologies and new approaches that can be used to enhance the total efficiencies of resource employment. These potential schemes are new, untried, and unsupported by the test of time. However, they do represent important considerations in a program of resource management for the Long Island Sound area.

There is a need to conserve the irretrievable resources of oil and coal. One way this can be accomplished is by combining refuse disposal and power generation. Cooperation with local agencies should be pursued to develop the practical utilization of refuse as a supplemental fuel in power plant boilers. A degree of success in other parts of the nation (St. Louis, Mo.) and in Europe indicates the feasibility of this approach to fuel conservation and refuse disposal. A plant is already being designed and constructed in Bridgeport by the Connecticut Resources Recovery Authority. The advantages of combining two resource functions to the benefit of both are obvious. Other combinations can also be followed, such as: the use of nuclear plants allied with desalting facilities; the use of power plant steam for industrial use; and the use of waste heat.

Hydroelectric plants have had a history of combining recreational pursuits with power generation. Hydroelectric and pumped-storage facilities under license from the Federal Power Commission are required to furnish and implement plans for the recreational development of project lands, where feasible. Recreation at thermal power plants, however, have been generally overlooked. A large potential exists for the development of public recreation at generating plant sites. This becomes even more attractive at coastal locations. Some efforts which have been made at developing recreation within the bounds of transmission line rights-of-way should be expanded and new approaches explored that would open up these areas to a wide range of community development.

At present, no systems in the Long Island Sound Service Area are isolated. All the systems are interconnected to at least one other utility. In order to foster the most efficient resource use, interconnections should be expanded. By this means increased reliability would be ensured, there would be better system stability, and many of the smaller utilities would enjoy the benefits and economies of a share in larger units. To heighten the effectiveness of fostering interconnections it would be desirable to provide a rational approach to the identification of future bulk power sites and their associated transmission needs. Site banks can be developed in coordination with State and local agencies who would develop standards and oversee their use during the fallow periods.

The entire gamut of primary site designation should be vigorously pursued. Administrative procedures can be developed that would reduce the time lag and by-pass the time consuming adversary processes now used. Agencies with the proper expertise can act with finality and can balance the conflicting needs for power and the preservation of the environment. The reasonable progression of facilities to meet power requirements would also be served by the above procedures. An orderly review of all siting factors and on-time delivery of energy would be beneficial as a social goal by reducing capital costs and shortages.

7.3.5 Research and Development Needs

The thrust of efforts and endeavors in research and development programs relevant to power supply that the study area has shown in the past, should be preserved. No organization, public, private, or academic, should be excluded as a possible candidate for the lead in accomplishing the needed research and development. Obviously research and development is required for the whole range of generation and transmission technology. Some of this R & D has already been undertaken by study groups in government, universities, and private industry. Cooperation and coordination is vital to avoid waste of manpower and effort. There should be compensating action by all levels of government, foundations, and utilities to qualified investigators to pursue those issues that appear to be the most critical in the regional area. One possibility is the creation of an independent Federally funded agency to coordinate the R & D programs. The agency could be established in an inter-agency format with members in Federal, State, and local government.

No attempt is made, herein, to suggest the order or priority of R & D needs because they are all germane to the Long Island Sound Study. Additionally, most programs are national and perhaps even international in scope.

8.0 TENTATIVE RECOMMENDATIONS

Develop the Composite Plan as shown in Table 13 under column 1990A and detailed on Table 20 and Figure 8, and implement the following:

PRIMARY

Self-Sufficiency - The Long Island Sound Service area should provide sufficient capacity to supply its own requirements. The Long Island Sound Study area should provide generating facilities at a slightly increasing rate from 30% to 33%.

Reliance on Nuclear Energy - Nuclear power facilities should provide all or most of the base load additions in the Service area for at least the period to 1990 or until suitable new forms of energy production become available.

SECONDARY

Energy Conservation - A State energy conservation program should be developed in each of the states to foster reductions of waste in industrial processes, to increase insulation requirements, to enforce heating and cooling limitations and to designate performance standards on electrical appliances sold within the state.

One-stop Licensing - An Inter-Agency mechanism should be established to act with finality subject to due process on power plant siting through unified one-stop procedures for Federal and State licensing requirements. In addition, administrative procedures should be substituted for the adversary process in the courts which often requires too much time while proving inadequate to cope with the complexities of the engineering and ecological problems involved.

Land Bank - Long term future sites should be identified and set aside and made available for multipurpose time-sequenced use.

Interconnections - Transmission line interconnections between utilities should be expanded especially where only emergency ties now exist.

Recreation - Opportunities for public recreation at all new plant sites should be developed and the impairment of existing recreational areas should be avoided.

Esthetics - Esthetic values should be considered and adequate attention should be given to the appearance of future power plant facilities and associated transmission lines as a part of all power plant design.

FUTURE STUDY NEEDS

Resource Conservation - Proper incentive and suitable technology

TABLE 20. SUMMARY OF TENTATIVE RECOMMENDED POWER ALTERNATIVE PROGRAMS (1973-1990) *

Measure	Sub-Region & Project Name	Fuel /1 Type	Total Site Area (Acres)	Unit Capacity (MW)	Present Capacity at Site (MW)	Additional Space Available (MW)	Water Req'd. (1000 gpm)	Evaluation Criteria: Envir.	Evaluation Criteria: Legal & Inst.	Evaluation Criteria: Social & Other	Evaluation Criteria: Economic
1. More efficient use of existing Facilities											
Unit additions	1-Millstone #2	N	500	861	662	2500	548	Good	Good	Good	Good
	1-Millstone #3	N	-	1150	662	1350	730 /2	Fair	Good	Good	Good
	1-Millstone #4	N	-	1350	662	None	860 /2	Fair	Fair	Fair	Good
	4-Bridgeport	F	N/A	500	661	390	220 /2	Fair	Fair	Fair	Fair
	6-Glenwood (GT)	GT	4	270	127	580	None	Good	Good	Good	Good
	7-Northport #4	F	120	387	1161	1450	643 /3	Fair	Good	Good	Good
Site redevelopment	5-Stamford	F	N/A	500	None	N/A	220/2	Fair	Fair	Fair	Fair
2. Urban site acquisition											
Coastal	3-Coke Works #1	F	106	445	None	500	280	Fair	Good	Good	Good
	3-Coke Works #2	F	-	500	None	None	300 /2	Fair	Fair	Good	Good
Inland	None			None				Fair	Fair	Fair	Poor
3. Rural site acquisition											
Coastal	7-Shoreham #1	N	875	850	None	4160	590	Good	Good	Good	Good
	7-Shoreham #2	N	-	1150	None	3010	730 /2	Fair	Good	Good	Good
	8-Jamesport #1	N	525	1150	None	4350	730 /2	Good	Good	Good	Good
	8-Jamesport #2	N	-	1150	None	3200	907	Fair	Good	Good	Good
	9-Eastern L.I. #1	N	N/A	1150	None	N/A	907	Good	Good	Good	Fair
Inland	None			None				Fair	Fair	Fair	Poor
4. Offshore Sites	3-Charles Island	N	14	1150	None	None	730 /2	Fair	Fair	Good	Fair
5. Reduce demand				None				Fair	Poor	Poor	Poor
6. Sanctioned power deficiencies				None				Fair	Poor	Poor	Poor
7. Exotics				None				Good	Fair	Good	Fair

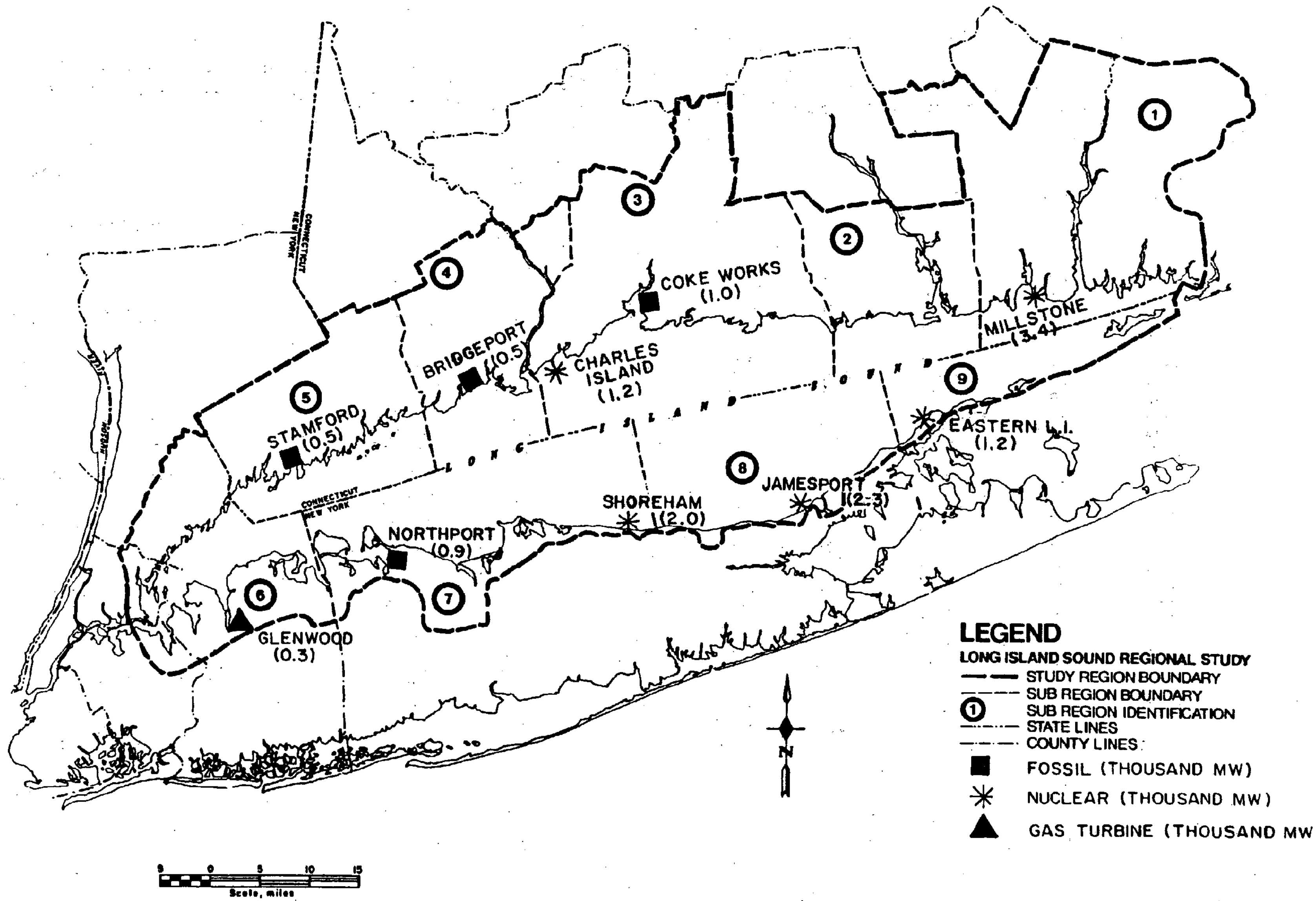
/1 F=Fossil N=Nuclear GT=Gas Turbine /2 Estimated /3 Includes total plant requirements

* All projects suggested are subject to detailed Environmental Impact Statements that may or may not recommend construction.

TABLE 21. SUMMARY OF TENTATIVE POWER ALTERNATIVE PROGRAMS (1990-2020) *

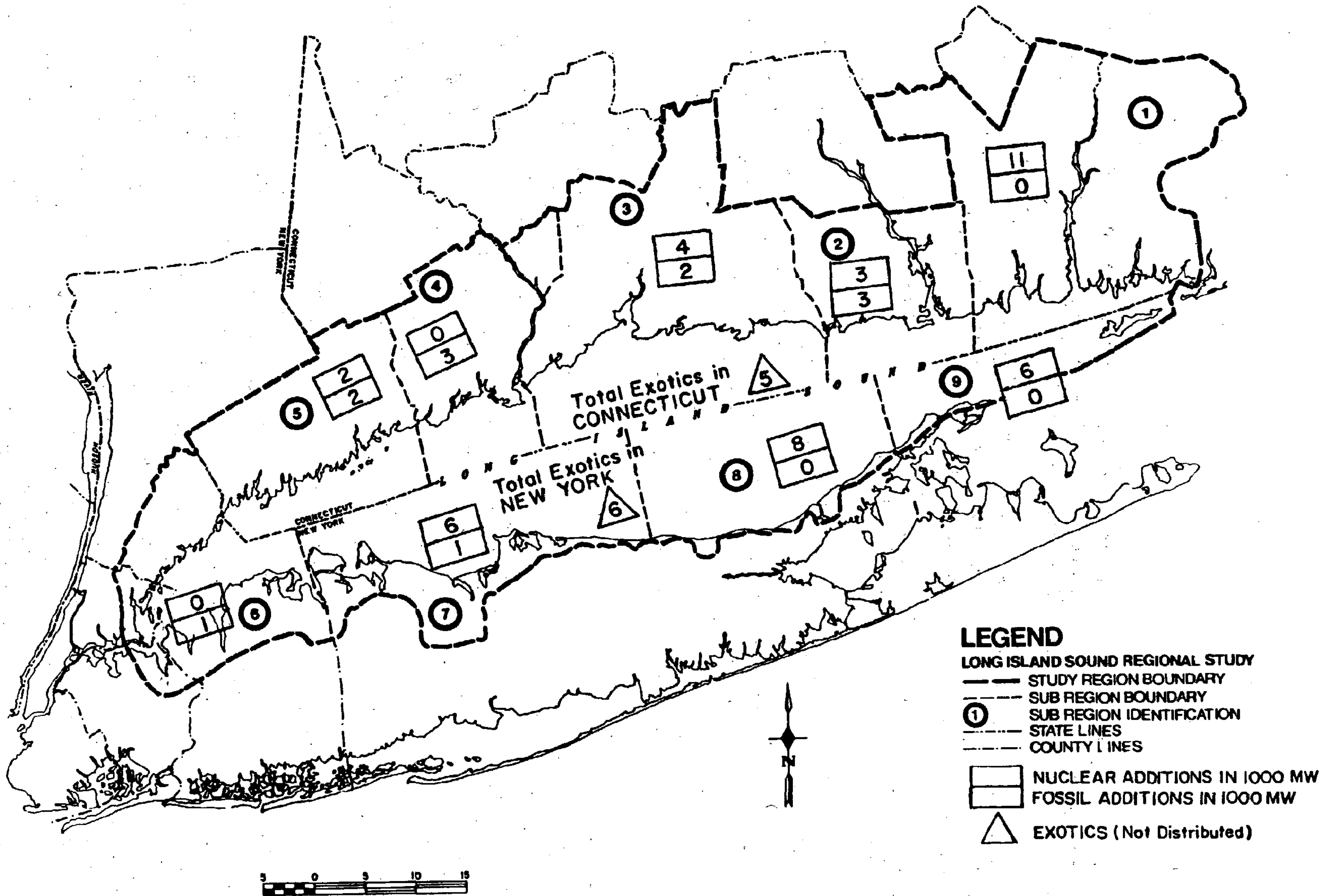
Measure	Sub-region	Fuel Type	Unit Capacity (MW)	Land Req'd. (Acres)	Water Req'd. (1000 gpm)	Evaluation Criteria: Envir.	Legal & Inst.	Social & Other	Economic
1. More efficient use of existing facilities									
Unit additions	7	Nuclear	3000	None	1460	Fair	Good	Good	Good
	8	Nuclear	2000	None	980	Fair	Good	Good	Good
	9	Nuclear	4000	None	1950	Fair	Good	Good	Fair
Site Redevelopment	1	Nuclear	3000	None	1460	Fair	Good	Good	Fair
	2	Fossil	1000	None	250	Fair	Good	Fair	Fair
	4	Fossil	1000	None	250	Fair	Good	Fair	Fair
	5	Fossil	1000	None	250	Fair	Good	Fair	Fair
2. Urban site acquisition									
Coastal	2	Fossil	2000	150	500	Fair	Good	Fair	Good
	2	Nuclear	1000	150	450	Good	Fair	Fair	Good
	3	Nuclear	1000	150	450	Good	Fair	Fair	Good
	7	Nuclear	3000	300	1460	Good	Fair	Fair	Good
Inland	3	Fossil	2000	150	500	Fair	Good	Fair	Fair
	4	Fossil	2000	150	500	Fair	Good	Fair	Fair
	7	Fossil	1000	100	500	Fair	Good	Fair	Fair
3. Rural site acquisition									
Coastal	1	Nuclear	3000	300	1460	Good	Good	Good	Good
	8	Nuclear	3000	300	1460	Good	Good	Good	Good
	9	Nuclear	2000	200	980	Good	Good	Good	Fair
Inland	1	Nuclear	2000	300	980	Fair	Good	Good	Fair
	2	Nuclear	2000	300	980	Fair	Good	Good	Fair
	3	Nuclear	3000	400	1460	Fair	Good	Good	Fair
	5	Fossil	1000	100	500	Fair	Good	Good	Fair
	6	Fossil	1000	100	500	Poor	Good	Good	Fair
4. Offshore sites									
Artificial	1	Nuclear	3000	15-30	1460	Fair	Fair	Good	Fair
	5	Nuclear	2000	15-30	980	Fair	Fair	Good	Fair
	8	Nuclear	3000	15-30	1460	Fair	Fair	Good	Fair
5. Reduce demand			None			Fair	Poor	Poor	Poor
6. Sanctioned power deficiencies			None			Fair	Poor	Poor	Poor
7. Exotics	1-5	-	5000	-	-	Good	Fair	Good	Fair
	6-9	-	6000	-	-	Good	Fair	Good	Fair

* This summary represents a "first look" analysis of possible plant locations based on a geographic approach and a balanced use of natural resources, and is not meant to suggest actual construction.



CAPACITY ADDITIONS
1973-1990

FIGURE 8



CAPACITY ADDITIONS
1990-2020

FIGURE 9

should be provided to allow public utilities to develop, with the cooperation and support of State and local agencies, a practical means of using refuse as a fuel for power production.

Multipurpose Land Use - The prospects for combining power plants with industrial and residential use of waste heat, desalting plants and use of sewage effluent for cooling should be considered.

Undergrounding - The technology to place all transmission lines including EHV underground should be developed.

Research and Development - The following research should be implemented: the further reduction of sulfur dioxide, oxides of nitrogen, and particulate matter in fossil-fuel stack gas; better understanding of tolerances of the aquatic ecosystem; accelerate development of the breeder reactor and nuclear fusion technology; economic studies to foster better understanding of the economic impact of higher energy prices, price elasticity, non-price effects on demand, and the environmental effects of shifts in consumption.

9.0 PROGRAM EVALUATION

A general evaluation of the environmental, economic and social impacts of the recommended 1990 and 2020 programs can be addressed primarily to the projected supply allocations in the study area. The supply projections set forth in Table 20 and 21 follow from the various evaluations developed in this single purpose report. A composite program determined the relative amount of generation the study area would be required to provide to meet a reasonable share of the service and market area's requirements. Further analysis of the alternative means to provide for 1990 show that the supply appears to favor the use of existing sites and the development of rural coastal sites. For 2020 with allocations admittedly nebulous, it appears to be most advantageous to again make the most use of existing and more rural sites.

The use of study area resources for the proposed power generation will provide that area, as well as the service and market area, with the electrical energy they need to progress economically and without undue disruptions to the general environment. It is not possible to assign a benefit or cost in dollar values for the program presented herein. There are numerous externalities and tradeoffs that can not be adequately formulated within the scope of this study. It is possible, however, to give an indication of the magnitude of capital costs necessary to provide the generating facilities for the Long Island Sound Study area. If we assume an average construction cost of $500 per kilowatt, regardless of unit types, based on 1974 dollars, the 1990 program would exceed $5 billion. If we assume a cost of $500 per kilowatt for the program after 1990, where the expected components of the power supply would require higher capital cost facilities, the costs would exceed $30 billion.

Suffice it to say that contrary to the notion that our use of energy must necessarily despoil nature, our future wise use of energy in abundant quantities may even have environmental benefits. A fully dependable supply of power is, and will continue to be of utmost importance in correcting past environmental abuses and sustaining future needs in the fields of waste water treatment, non-polluting transportation, solid waste disposal, and other applications vital to a clean environment.

The recommendations presented, if implemented as appropriate chronologically and spatially, would reinforce the objective of supplying adequate and reliable sources of electrical energy, assure the least likely impact on the physical environment, and provide for the social well-being of the region's inhabitants.

10.0 FINAL RECOMMENDATIONS

The preceeding recommendations have not necessarily been approved by the New England River Basins Commission. At the time of this report's publication, the draft main report of the Long Island Sound Regional Study is undergoing public review and comment for consideration in the final document. The FINAL RECOMMENDATIONS on "Power and the Environment" are therefore to be found only in the final version of the Study's main report--to be published inthe Spring of 1975.

APPENDIX A

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APPENDIX B

GLOSSARY

BLOWDOWN - The periodic release of circulating condenser water in evaporative cooling towers to remove solids that have accumulated in the cooling tower from the addition of chemicals to the source water.

BRITISH THERMAL UNIT (Btu) - The quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit at or near 39.2°F.

CAPABILITY - The maximum load which a generator, turbine, transmission circuit, station or system can supply under specified conditions for a given time interval, without exceeding approved limits of temperature and stress.

CAPACITY - The load for which a generator, turbine transformer, transmission circuit, apparatus, station, or system is rated. Capacity is also used synonymously with capability.

Dependable Capacity - the load-carrying ability of a station or system under adverse conditions for the time interval and period specified when related to the characteristics of the load to be supplied. Dependable capacity of a system includes net firm power purchases.

Installed Capacity - the total of the capacities as shown by the nameplates of similar kinds of apparatus such as generating units, turbines, transformers, or other equipment in a station or system.

Peaking Capacity - generating equipment normally operated only during the hours of highest daily, weekly, or seasonal loads. Some generating equipment may be operated at certain times as peaking capacity and at other times to serve loads on a round-the-clock basis.

Reserve Generating Capacity - extra generating capacity available to meet unanticipated demands for power or to generate power in the event of loss of generation resulting from scheduled or unscheduled outages of regularly used generating capacity.

Reserve System Capacity - the difference between dependable capacity of the system, including net firm power purchases, and the actual or anticipated peak load for a specified period.

DEMAND - The rate at which electric energy is delivered to or by a system, part of a system, or piece of equipment, expressed in kilowatts or other suitable unit, at a given instant or averaged over any designated period of time.

Coincident Demand - any demand that occurs simultaneously with any other demand; also the sum of any set of coincident demands.

Instantaneous Demand - the demand at any instant, usually determined from the readings of indicating or recording instruments.

Maximum Demand - the greatest of a particular type of demand occurring within a specified period.

DEMAND INTERVAL - The period of time during which the electric energy flow is averaged in determining demand, such as 60-minute, 30-minute, or instantaneous.

DISTRIBUTION - That portion of an electric system used to deliver electric energy from points on the transmission or bulk power system to the consumers.

DIVERSITY, LOAD - The difference between the peak of coincident and noncoincident demands of two or more individual loads.

Seasonal Diversity - load diversity between two (or more) electric systems which occurs when their annual peak loads are in different seasons of the year.

ENERGY - That which does or is capable of doing work. It is measured in terms of the work it is capable of doing; electric energy is usually measured in kilowatt-hours.

Economy Energy - electric energy produced from a source in one system and substituted for energy that could have been produced by a less economical source in another system.

Interchange Energy - electric energy received by one electric utility system usually in exchange for energy delivered to the other system at another time or place. Interchange energy is to be distinguished from a direct purchase or sale, although accumulated energy balances are sometimes settled for in cash.

Net Energy for System - the electric energy requirements of a system, including losses, defined as: (1) net generation of the system, plus (2) energy received from others, less (3) energy delivered to other systems for resale.

Off-peak Energy - electric energy supplied during periods of relatively low system demands as specified by the supplier.

EXTRA HIGH VOLTAGE, OR EHV - A term applied to voltage levels of transmission lines which are higher than the voltage levels commonly used. At present, the electric industry generally considers EHV to be any voltage greater than 230,000 volts.

FACTOR

Load Factor - the ratio of the average load over a designated period to the peak-load occurring in that period; for example, the annual Load Factor in % = $\frac{\text{Energy for system}}{\text{Peak Demand x 8760 hr/yr}}$ x 100

HEAT RATE - A measure of generating station thermal efficiency, generally expressed as Btu per net kilowatt-hour. It is computed by dividing the total Btu content of the fuel burned (or of heat released from a nuclear reactor) by the resulting net kilowatt-hours generated.

INTERCONNECTION - A tie permitting a flow of energy between the facilities of two electric systems.

Emergency Interconnection - an interconnection established to meet an emergency need.

KILOWATTS - (KW) - A unit of power equal to 1000 watts.

KILOWATT HOUR - (Kwh) - A unit of work or energy equal to that expended by one kilowatt in one hour.

LOAD - The amount of electric power delivered at a given point.
Base Load - the minimum load in a stated period of time
Peak Load - the maximum load in a stated period of time

MEGAWATT - (MW) - 1000 Kilowatts

PLANT (STATION)

Base Load Plant - a power plant which is normally operated to carry base load and which, consequently, operates essentially at a constant load.

Fossil-Fuel Plant - an electric power plant utilizing fossil fuel, coal, lignite, oil, or natural gas, as its source of energy.

Hydroelectric Plant - an electric power plant utilizing falling water for the motive force of its prime movers.

Nuclear Power Plant - an electric generating station utilizing the energy from a nuclear reactor as the source of power.

Peak Load Plant - a power plant which is normally operated to provide power during maximum load periods.

Power Plant (Generating Station) - a generating station at which are located prime movers, electric generators, and auxiliary equipment for producing electric energy.

Pumped Storage Plant - a power plant utilizing an arrangement whereby electric energy is generated for peak load use by utilizing water pumped into a storage reservoir usually during off peak periods. A pumped storage plant may also be used to provide reserve generating capacity.

PRIME MOVER - The engine, turbine, water wheel, or similar machine which drives an electric generator.

RESERVE

System Required Reserve - the system reserve capacity needed as standby to insure an adequate standard of service.

SERVICE AREA - Territory in which a utility system is required or has the right to supply or make available electric service to ultimate consumers.

THERMAL - A term used to identify a type of electric generating station or power plant, or the capacity or capability thereof, in which the source of energy for the prime mover is heat.

TRANSMISSION - The movement or transfer of electric energy in bulk. Ordinarily the transmission movement is considered to end when the energy is transformed for distribution to ultimate consumers.

Transmission Line Capacity - the maximum continuous rating of a transmission line. The rating may be limited by thermal considerations, capacity of associated equipment, voltage regulation, system stability or other factors.

Transmission System - an interconnected group of electric transmission lines and associated equipment for the movement or transfer of electric energy in bulk between points of supply and points at which it is transformed for delivery to ultimate consumers, or is delivered to electric systems of others.

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LONG ISLAND SOUND REGIONAL STUDY
As of the date of this report

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State of Connecticut	Richard Dowd
Conn. Coastal Zone Management Committee	Senator George L. Gunther
Connecticut Department of Finance and Control	Horace Brown
State of New York	John A. Finck
Interstate Sanitation Commission	Thomas R. Glenn
Tri-State Regional Planning Commission	Richard DeTurk
Atomic Energy Commission	Walter Belter
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Department of Commerce	Russell T. Norris
Department of Housing and Urban Development	Sheldon Gilbert
Department of the Interior	William Patterson
Department of Transportation	Capt. Royal E. Grover, Jr.
Environmental Protection Agency	William M. Newman
Federal Power Commission	Martin Inwald
Nassau-Suffolk Regional Planning Board	Lee E. Koppelman
Citizen Advisory Committee	Roger Shope
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Tri-State Regional Planning Commission	Robert Leighton
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Primary responsibility for these planning reports rests with the chair agency indicated above. The other agencies and individuals listed participated either in an active, a review, or an advisory role, but their listing here does not necessarily imply an endorsement of the report in whole or in part.