Section I Surface Water Quality

1.0 INTRODUCTION

The surface waters of Long Island can be divided into those existing as freshwater flowing across the surface as streams and rivers, and those which comprise the surrounding marine waters. Areas where the waters of Long Island Sound and the Atlantic Ocean mix with, and are noticeably diluted by the freshwater streams, are classified as estuaries. The amount of freshwater inflow, the rate at which the fresh and saline waters mix and the amount of flushing on each tidal cycle determine the relative salinity levels in each bay and the concentration and rate of loss of pollutants carried into them by the streams and subsurface groundwater. In general, because of the wider connection with Long Island Sound and the tidal flushing that takes place, North Shore bays generally demonstrate narrow salinity variations, and their biological and chemical characteristics reflect the quality of the adjacent Sound waters. On the other hand, the South Shore bays are relatively shallow, receive large amounts of freshwater via streams and subsurface flow and have only a few small restrictive inlets to allow mixing of the ocean and bay waters. Consequently, they experience greater salinity ranges, show wide geographical variations in biological and chemical characteristics and have prolonged flushing times. Nutrients or pollutants introduced into these systems will remain for longer periods of time than in North Shore bays.

The physical forces that drive the mixing processes in the North and South Shore bays are also different. In general, tidal mixing is dominant in North Shore bays, whereas a combination of mixing due to tides and wind-driven water currents generally predominates along the South Shore.

As mentioned above, the degree of mixing and the flushing rate determine the salinity levels within a bay system. The salinity of estuarine waters is a major controlling factor of biological processes within the bays, from the type of species of plankton, benthic organisms and fish that can survive to the rate of growth of shellfish and marsh grasses. Since salinity is affected by the proportions of fresh and ocean waters; it can be altered by changes in rainfall, groundwater elevations, stream discharge, inlet characteristics and flushing rates. Consequently, changes in these factors will result in changes in the biological and chemical characteristics of the system.

Just as increased mixing and tidal exchange can increase salinity in an estuarine system, these same processes will generally lead to increased dispersion and loss of pollutants introduced into the bays.

The major components of any ecosystem, whether terrestial or marine, can be divided into four parts:

1. The *abiotic* component, which comprises the non-living factors such as temperature, salinity, oxygen levels, nutrient concentrations, etc.;
2. The *decomposer transformer* component, comprised of bacteria and fungi not capable of carrying out photosynthesis and which, through biochemical processes, breaks down complex organic compounds into simple molecules such as carbon dioxide, water and inorganic nutrients;
3. The *autotrophic* component, which includes all organisms capable of carrying out photosynthesis; that is, using energy from the sun, carbon dioxide, water and inorganic nutrients to produce complex organic compounds; and
4. The *heterotrophic* component, which is made up of all other living organisms that cannot carry out photosynthesis and that require complex pre-formed organic compounds to survive.

These four components will be present in each ecosystem but the types

of organisms that characterize them will differ from system to system. For example, the main autotrophic component of eastern terrestrial Long Island is characterized by scrub oak and pine trees, whereas the main autotrophs of the marine ecosystem are floating and attached algae and marine grasses.

Each species exists and carries on a basic function, which is the transfer of energy from one organism to another. Organisms that receive their energy from the same source, whether they are the same species or not, are on the same trophic or energy level. For example, clams, oysters and mussels are all filter feeders relying on plankton and organic particulate matter for their nutrition, and are therefore on the same trophic level. A highly simplified example of the trophic levels and energy cycling along a salt marsh on Long Island is shown in Figure 1–1. It is obvious that changes in any one component can have both qualitative and quantitative effects on other components. It is because of this that any evalutaion of wastewater treatment alternatives, which will impact one or more of these factors, must be considered in light of their effect on the entire system. It is the intent of the 208 Study to define possible adverse effects from various alternative management schemes and to minimize them as much as possible in the light of existing and newly generated information as outlined in the following sections.

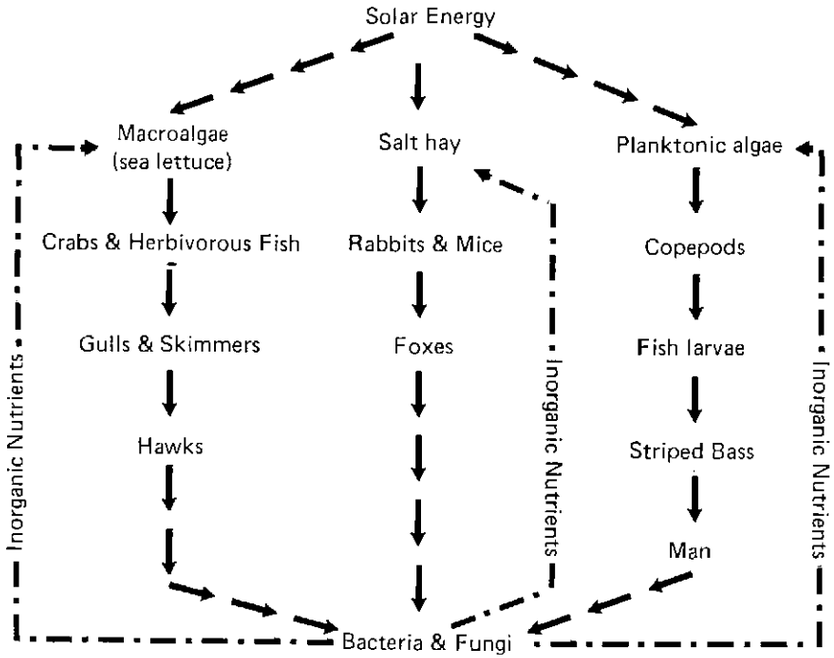


FIGURE 1–1 *Illustration of a Simple Saltmarsh-Estuarine Ecosystem on Long Island.*

1.1 SURFACE WATER QUALITY STUDIES

The surface water quality program of the 208 Study has involved:

1. Collection and inventory of all existing data on marine surface waters of Long Island.
2. Statistical analyses, reduction and identification of shortfalls in existing data.
3. Design of field sampling programs to update historical data and fill in data gaps.
4. Design, calibration and verification of mathematical models capable of representing existing water quality and predicting future changes that may be expected to occur under varying wastewater treatment regimes.

The basis of any scientific study is the detailed gathering and analysis of all existing information concerning the topic under investigation. Tetra Tech, Inc., the prime marine water quality consultant, has amassed data containing more than 400,000 observations on the physical, chemical and biological characteristics of Long Island waters. These data were analyzed as to completeness, length of record and accuracy for each bay system and data gaps identified. Based on these analyses, water quality reports were prepared (see bibliography) and field sampling programs designed to fill in missing data and to calibrate and verify the mathematical models. An example of the procedures used in developing the data base is shown in Figure 1–2.

One of the significant components of the Long Island 208 Study centers on the development and use of appropriate mathematical models. The wastewater management plan for this area ultimately depends on the ability to quantify a preference for one set of structural and non-structural alternatives over another. In the process of doing so, it is necessary to understand in numerical terms just what the impact of these alternatives may be on ground and surface waters in terms of both the changes in movement and quality that result from the options used. The modeling efforts are directed to this end by providing flexible tools to evaluate and predict such impacts without engaging in prohibitive or even impossible trials on the actual water bodies themselves; that is, modeling is a surrogate for reality in which certain basic interrelationships in the real world are captured by mathematical statements. By manipulating these statements one simulates, as it were, the events that actually take place. The models are therefore a conceptual shorthand for organizing the complex interactions which occur between the water bodies and the stresses placed on them. It is possible in this way to carry out "what if" experiments on nature by replacing the actual driving forces (as well as initial and boundary conditions) by altered ones, which presumably would represent new structural and non-structural options. That we can simulate these changes without having to engage in physical alterations is one of the great virtues of models. Also we can look into the future by tracking present conditions to see what eventual effects they may produce on water movement and quality. Finally, one can generate alterations in initial and boundary conditions to find the "best" future scenario.

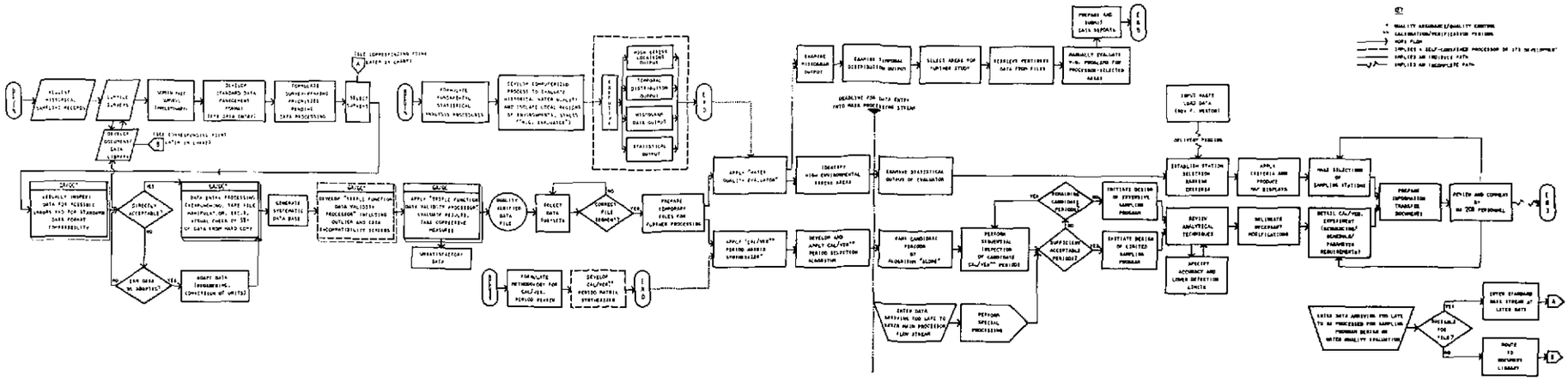


FIGURE 1–2 *Data Evaluation Procedure.*

Water quality modeling for the study involved both two-dimensional estuary and one-dimensional river models. The following parameters are included in both types of models:

- –Conservative substances (such as salinity)
- –Total nitrogen
- –Total phosphorus
- –Total coliform bacteria
- –Fecal coliform bacteria
- –Carbonaceous biochemical oxygen demand (CBOD)
- –Nitrogenous biochemical oxygen demand (NBOD)
- –Dissolved oxygen
- –Temperature

The two dimensional estuary models include three different programs—dynamic estuary, steady-state estuary and time-dependent estuary. The dynamic estuary model uses changing tidal conditions to simulate the hydrodynamics of flow in the estuary. This model is useful for studying short term (one to three days) changes in water quality due to variations in tide stage. The steady-state estuary model takes changes in water mixing and dispersion of the materials under consideration to represent daily average conditions that would prevail if all inputs to the system are kept constant. This model is appropriate for comparing alternative management schemes under typical conditions. The time-dependent estuary model uses dispersion coefficients for the parameters being studied, similar to the steady-state model. However, the boundary conditions and waste load inputs are varied to compute average conditions as a function of time, for example, to determine the effects of a storm. This model is useful when simulations over time (greater than three days) are of interest.

The water quality river models are virtually identical to the steady-state estuarine model except that the movement of water is calculated in one direction only (downstream).

Each of the models represents the estuarine systems as a network of nodes connected by links (See Figure 1–3) where each node represents a

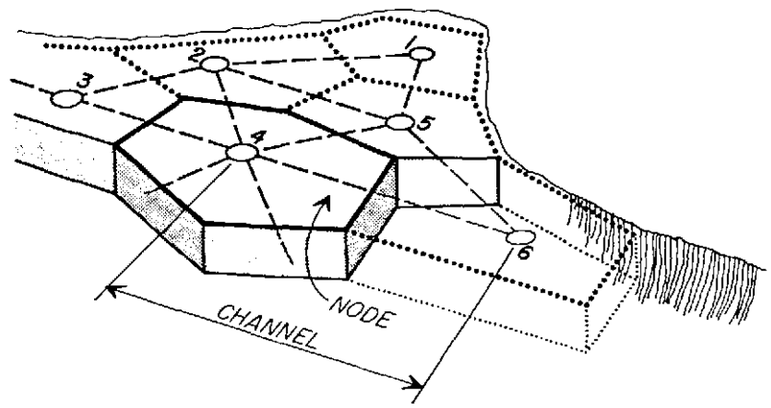


FIGURE 1–3 *Diagram of Link Node System for Bay and Estuarine Models.*

discrete unit of the water body characterized by its surface area, depth and volume. The nodes are interconnected by channels or links characterized by length, width, cross-sectional area, depth, slope and bottom friction. Water masses are modeled as flowing between the nodes along these links resulting in changes in the water quality parameters under study. The reader is directed to Section Seven, outlining the detailed conceptual and mathematical frameworks of the models, for further information.

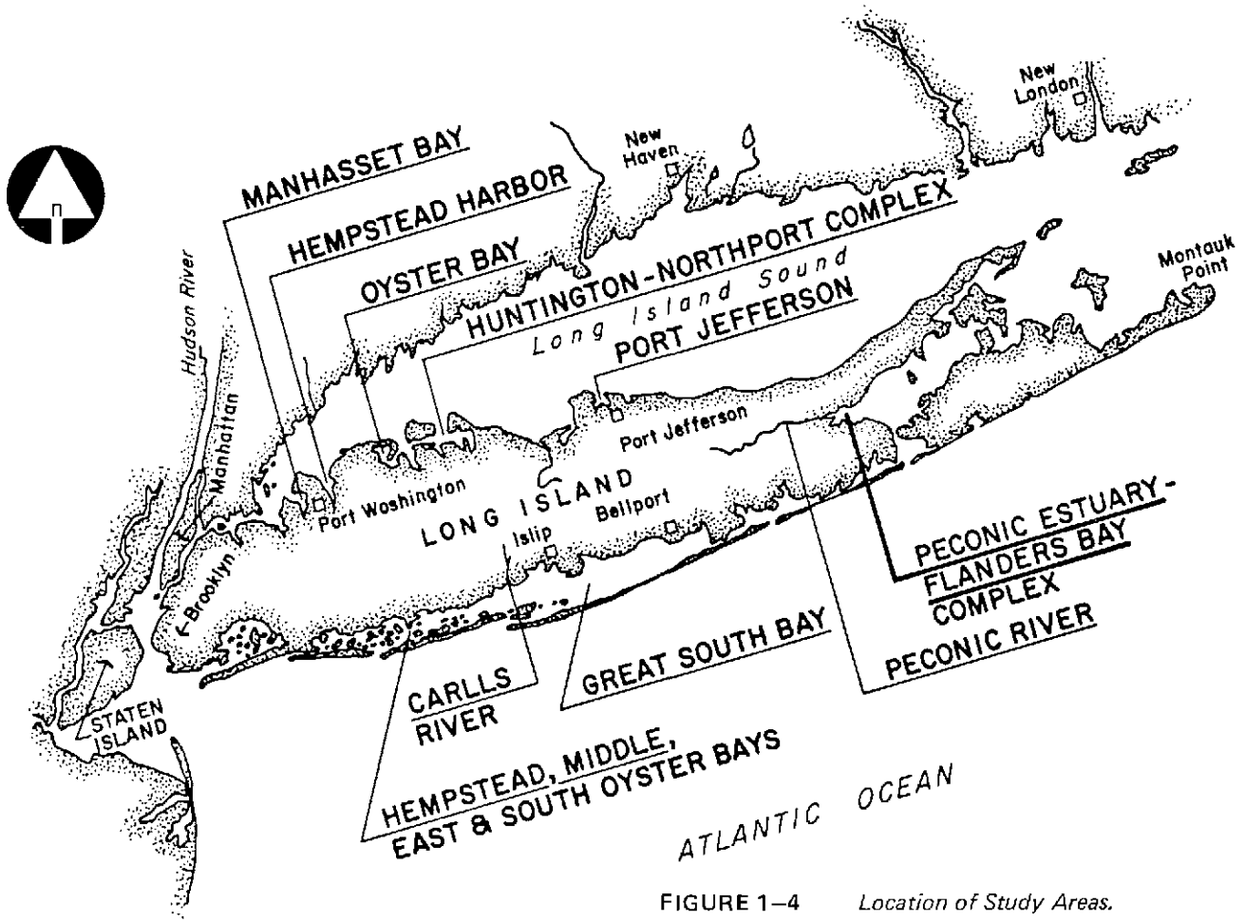
Detailed modeling and data collection is being carried out for the following marine surface waters (Figure 1–4):

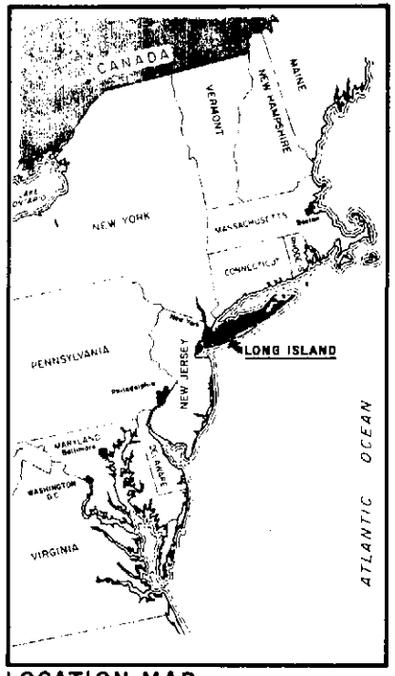
South Shore Bays
–Great South Bay
–Hempstead, Middle, East and South Oyster Bays

North Shore Bays
–Manhasset Bay Complex
–Hempstead Bay Complex
–Port Jefferson
–Peconic Estuary–Flanders Bay
–Huntington–Northport Complex

Rivers
–Carlls River
–Peconic River

In addition to water quality modeling, non-modeling water quality reports are also being prepared for the following areas (Figure 5):
–Western Long Island Sound including Little Neck Bay





LOCATION MAP

GRAPHIC SCALE: Nautical Miles

10 5 0 10

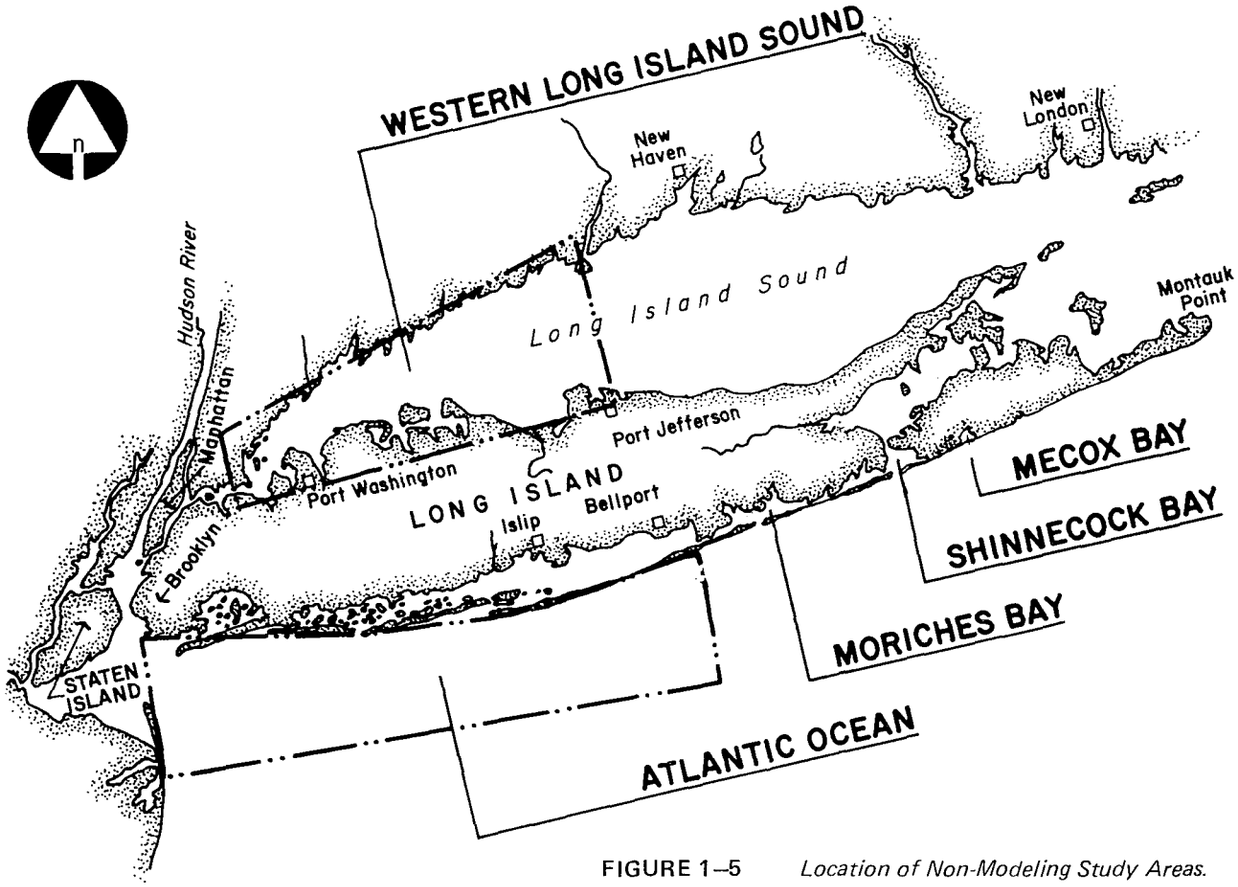
FIGURE 1–4 *Location of Study Areas.*

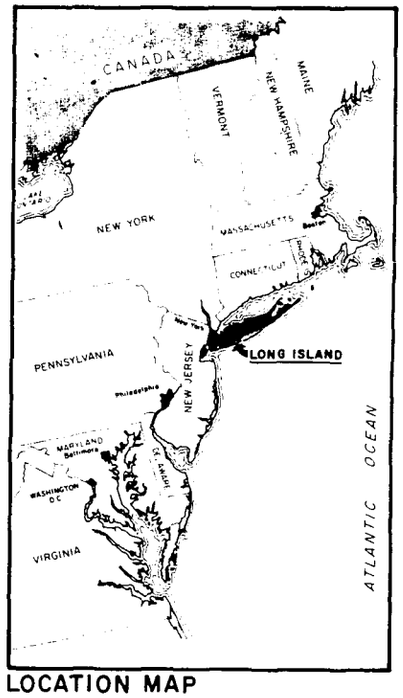
—Cold Spring Harbor and Smithtown Bay
—Nearshore Atlantic Ocean
—Moriches Bay
—Shinnecock Bay
—Mecox Bay

An example of the type of sampling program required to calibrate and verify the models is shown in Figure 1—6. For the Great South Bay Complex alone, six survey vessels with technical personnel were required to sample 42 stations on each of four days. Station locations for each bay system are shown in Figures 1—7 through 1—13b. The reader is referred to the individual technical reports listed in the bibliography for more detailed information on each bay.

At each station, water samples were obtained and analyzed for temperature, salinity, dissolved oxygen, dissolved and total phosphorus, nitrate, ammonia, total nitrogen, chlorophyll pigments and total fecal coliform organisms. Additional information was also recorded for water depth, transparency, wind speed and direction, bottom sediment type and tide stage. The latter information, when combined with temperature and salinity, allows calibration of the hydrodynamic portions of the models. The output of this part of the model is then used in determining the water quality parameters.

Dissolved oxygen is an important biochemical parameter since it is indicative of the relative rates of organic production by marine plants and respiration by bacteria and other marine animals. Depressed oxygen levels are often associated with areas receiving organic waste material, such as that derived from treatment plants. High concentrations of phytoplankton may also lead to low oxygen values due to respiration during evening hours. Severely depressed oxygen levels can lead to large-scale mortalities in organisms unable to migrate from the areas, especially benthic animals such as





LOCATION MAP

GRAPHIC SCALE: Nautical Miles

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FIGURE 1—5 *Location of Non-Modeling Study Areas.*

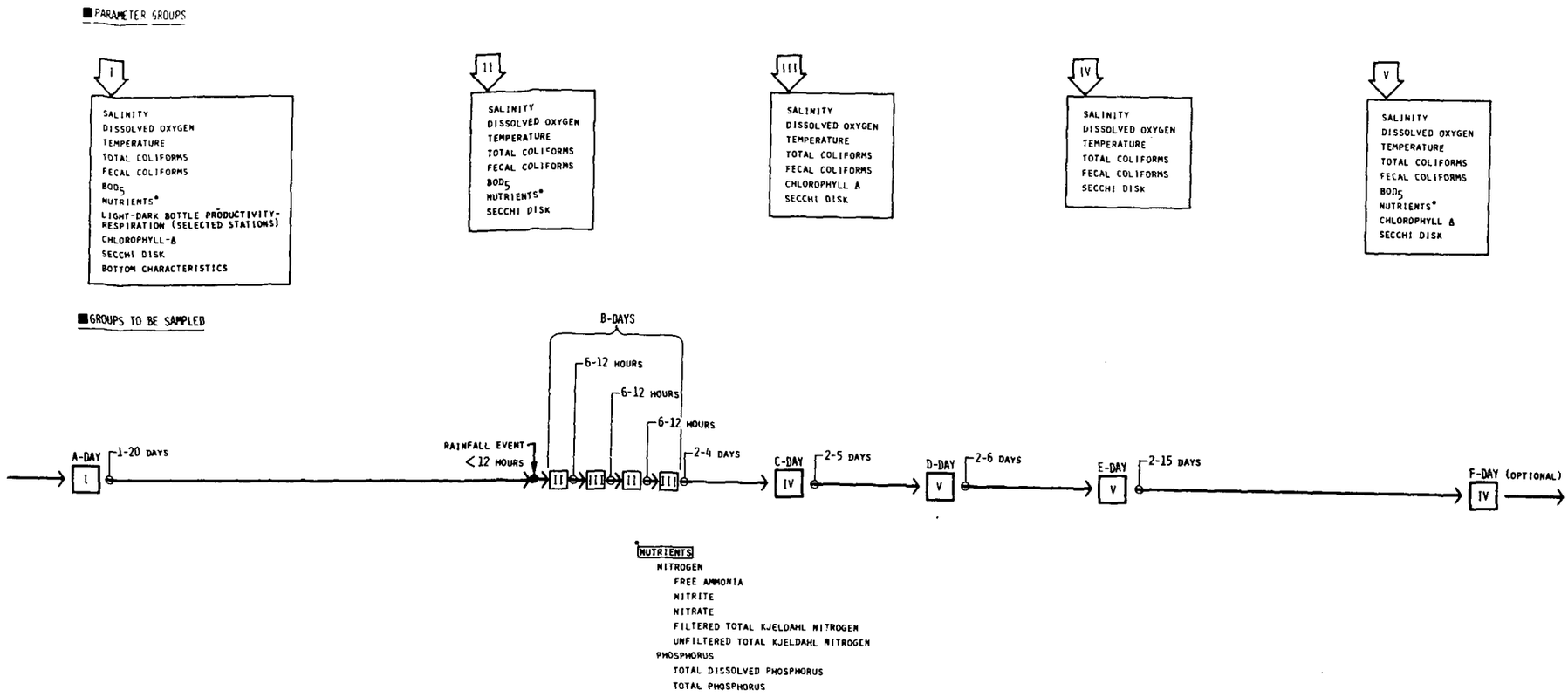


FIGURE 1–6 *Parameter Sampling Schedule.*

clams and oysters.

Dissolved nitrogen and phosphorous are essential plant nutrients. However, elevated concentrations or abnormal ratios of the two nutrients can lead to "bloom" conditions or changes in the normal species composition of the phytoplankton. If these algal blooms grow large enough because of abundant nutrients, they can contribute to the oxygen demand by their respiration and decomposition.

Chlorophyll pigment concentrations are used as indicators of the amount or standing crop of phytoplankton. In some cases, it is possible to correlate chlorophyll and nutrient concentrations and thus make decisions regarding the amount of nutrients that can be allowed to enter a system from sewage treatment plants or other sources.

Total and fecal coliform organisms are bacteria which have long been used as indicators of fecal pollution. The non-fecal coliforms are found normally in the environment and can be derived from a variety of sources, such as stormwater run-off and decomposing organic matter. Fecal coliforms, on the other hand, are found only in the intestines of warm-blooded animals and as such have been used to indicate fecal pollution. They are harmless in themselves but are statistically correlated to the possible presence of pathogenic bacteria.

An example of the type of output obtained from the models is shown in Figure 1–14 for a transect across Port Jefferson Harbor. The curves indicate the effects of discharging 15 million gallons per day at node 1 (head of harbor), node 9 (center of harbor) and node 18 (mouth of harbor). The increase in both nitrogen and phosphorus is easily seen when discharge takes place at the head of the harbor. Model predictions such as these are extremely valuable when considering not only treatment plant size, but also the location of the discharge point. The structural and non-structural wastewater treatment alternatives that were considered in each of the modeling efforts are more fully detailed in an interim report to be published.

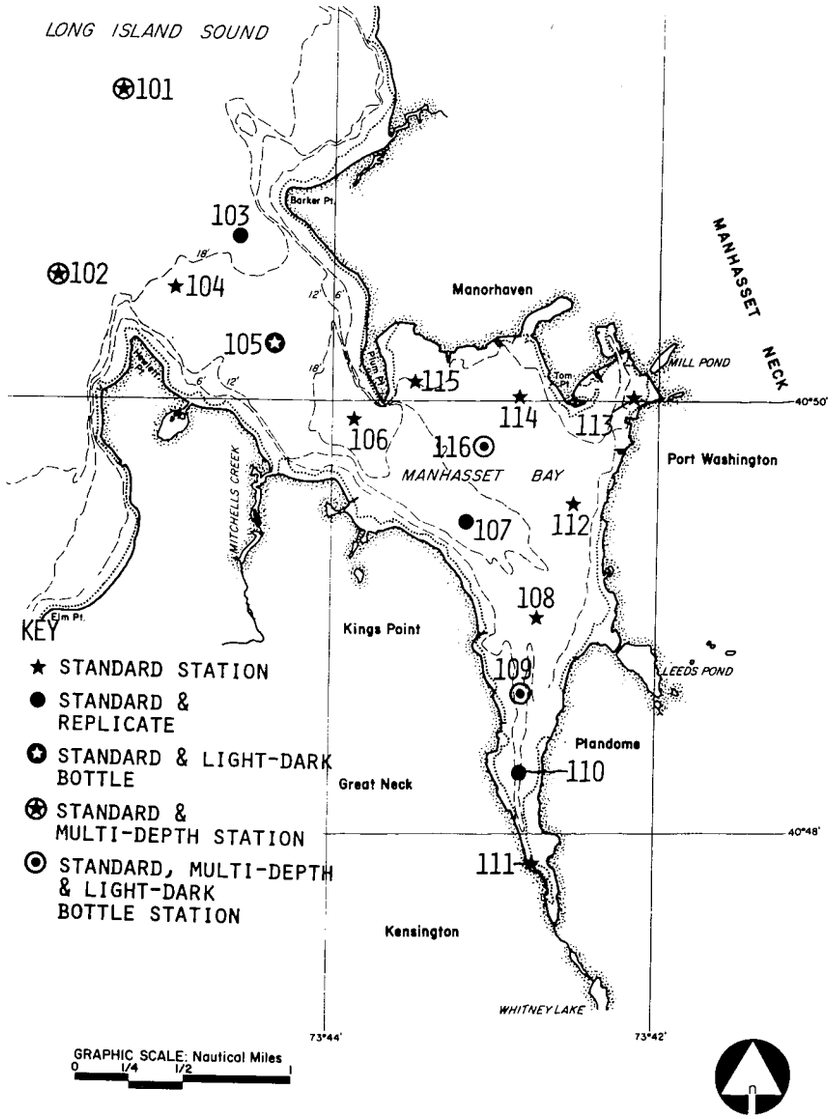


FIGURE 1–7 *Manhasset Bay Sampling Station Locations.*

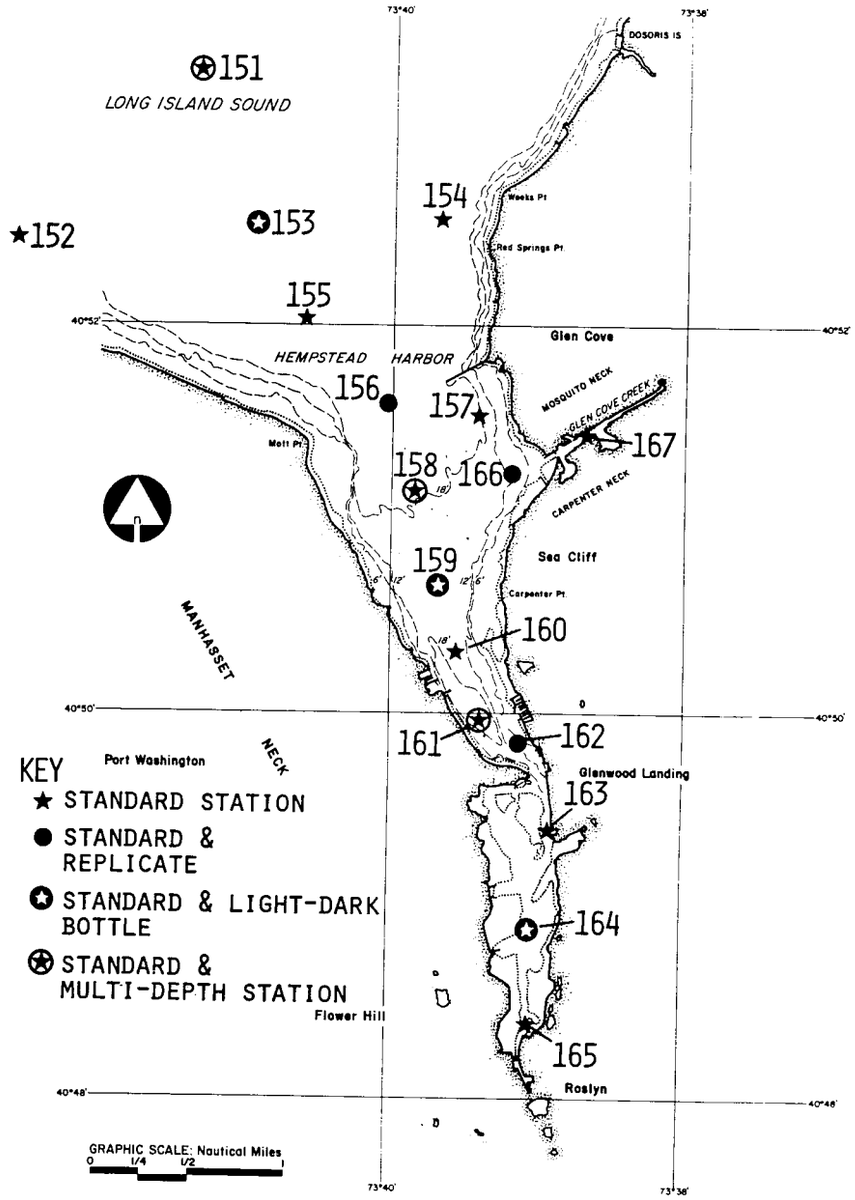


FIGURE 1–8 *Hempstead Harbor Sampling Station Locations.*

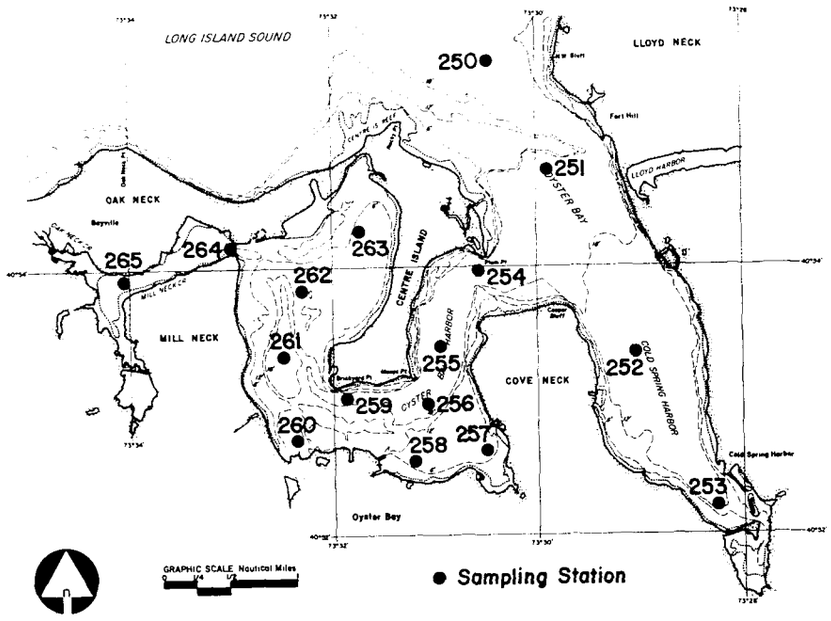


FIGURE 1–9 *Oyster Bay Sampling Station Locations.*

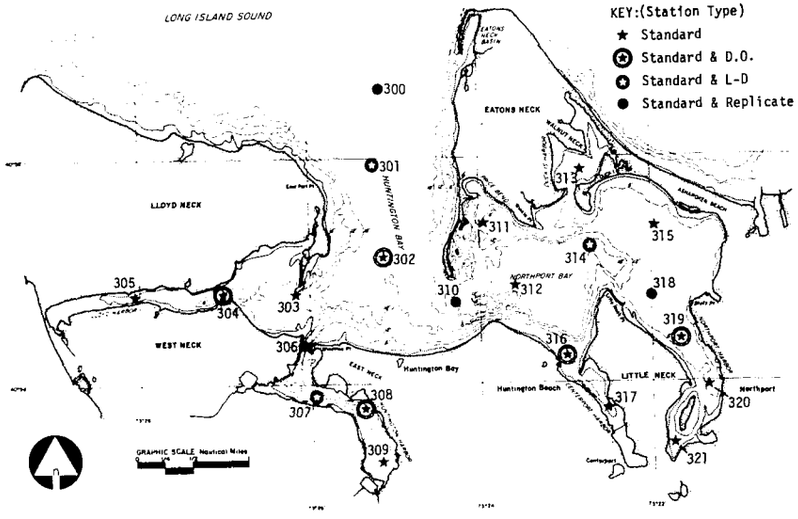


FIGURE 1–10 *Huntington-Northport Complex Sampling Station Locations.*

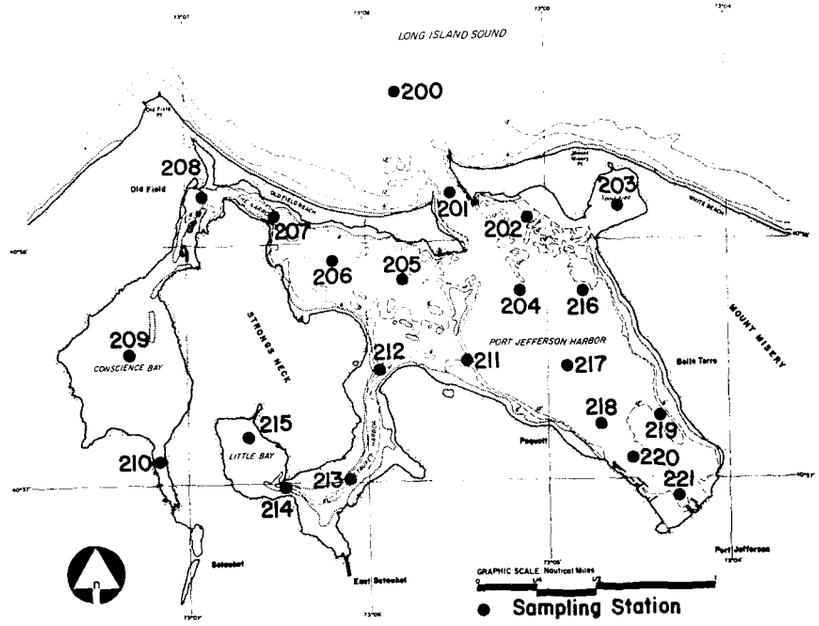


FIGURE 1–11 *Port Jefferson Sampling Station Locations.*

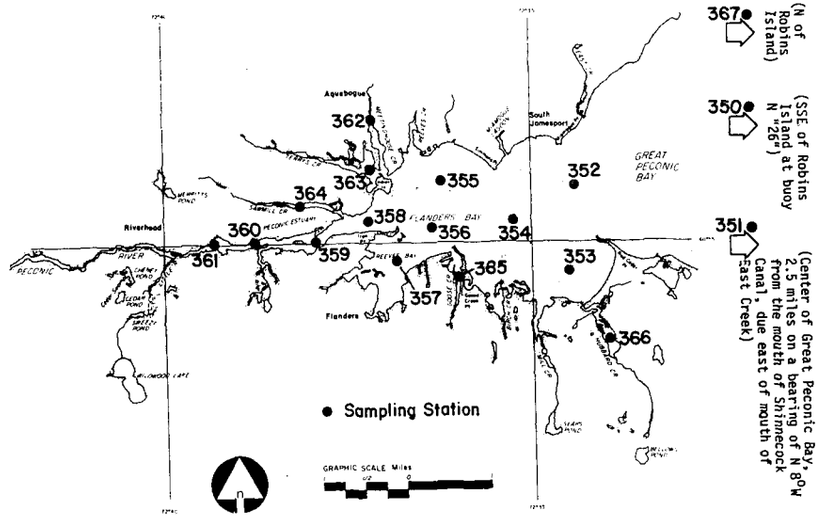


FIGURE 1–12a *Peconic Estuary-Flanders Bay Sampling Station Locations.*

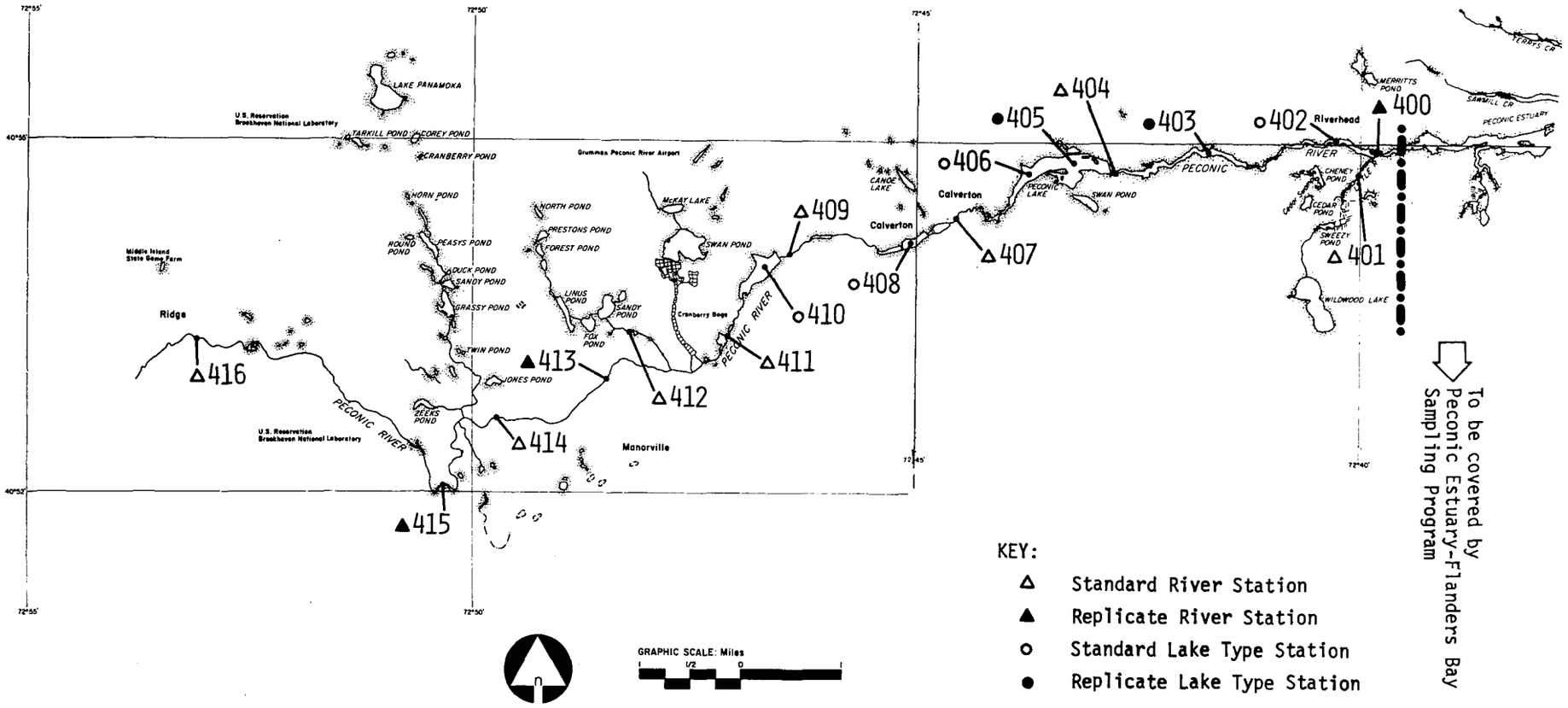


FIGURE 1–12b *Peconic River Sampling Station Locations.*

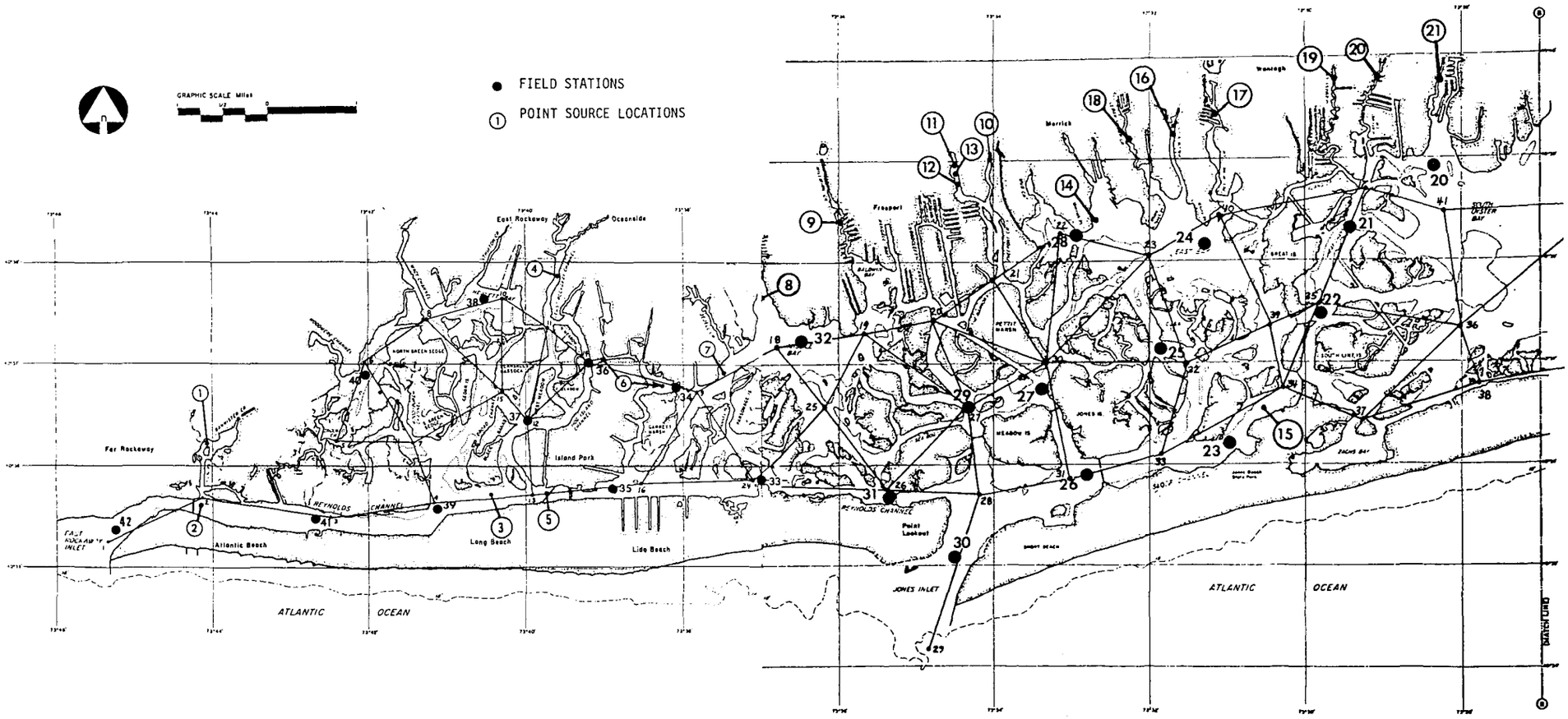


FIGURE 1–13a *Southshore Bays Sampling Station Locations.*

1.2 POINT SOURCE LOAD INVENTORY

In addition to water quality parameters for each receiving body of water, the quantity and quality of all existing point sources have also been fed into the models. The advantage of the modeling exercise is to be able to show how a variety of future conditions such as upgrading existing plants, increasing flow rates or moving plants to different areas will affect water quality by merely changing a few input cards to the computer program.

R.F. Weston has inventoried 411 potential point sources of pollution in the bi-county area. These include 124 domestic (private and municipal) wastewater treatment plants (excluding private septic tanks or cesspools), 170 industrial waste facilities, 29 duck farms, 75 coin-operated laundromats and 13 incinerators. Of the total 124 domestic plants, 22 representative facilities were visited and evaluated in regard to discharge outfall location, potential impact on water quality, service area, service population, operational data, anticipated future flows, potential for plant expansion, effluent limitations, general plant operation, design limitation, infiltration/inflow problems and sludge handling methods. Eleven representative industries, three incinerators and one duck farm were also visited and evaluated with regard to the types and volumes of wastewater generated and treatment methods employed. The reader is directed to "Domestic and Industrial Point Source Inventory and Evaluation, May 1976" prepared by R.F. Weston for detailed information on individual sources.

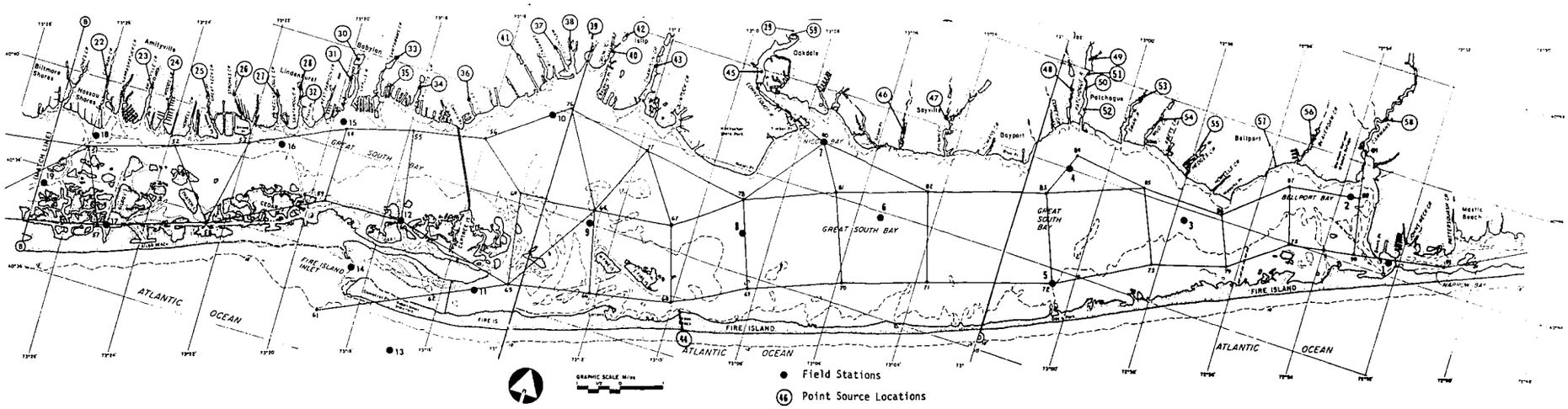


FIGURE 1–13b *Southshore Bays Sampling Station Locations.*

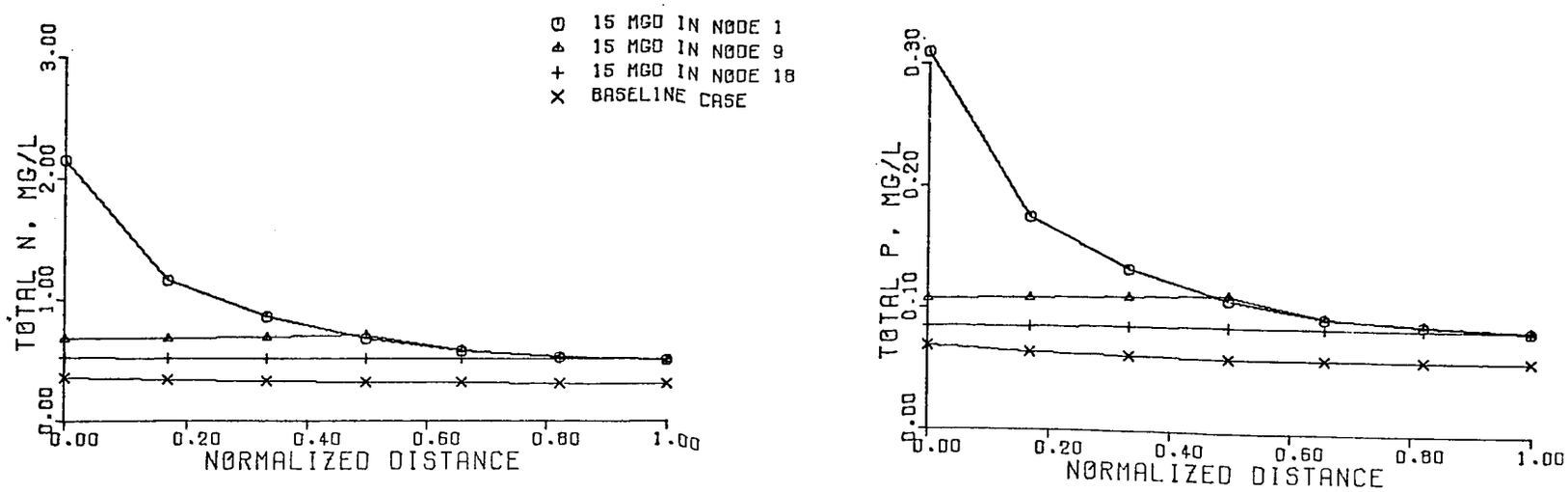


FIGURE 1–14 *Example of Model Output—Transect Across Port Jefferson Harbor Showing 15 Million Gallons Per Day Discharge at Three Outfall Locations.*

1.3 NON-POINT SOURCE POLLUTION

A major source of pollution for both surface and groundwaters has only recently been recognized. Non-point source stormwater run-off may contribute as much as 90% of the total pollutant load entering surface waters. Domestic pets and farm animals contribute large amounts of coliform bacteria, organics and nutrient wastes. Lawns, recreational areas such as golf courses and agricultural lands are sources of herbicides, pesticides and fertilizers. Roadways contribute tars, silt, hydrocarbons and heavy metals such as lead, zinc and nickel.

In contrast to flowing streams and point sources of pollution, such as wastewater discharges, non-point source pollutants enter surface water under highly variable conditions depending on duration and intensity of precipitation and the degree and type of development in an area. One objective of the 208 Study has been to identify and quantify the pollutants entering surface waters and subsurface aquifers under conditions found in the Long Island area. This information has been used as input to the water quality models and to determine the relative contributions of pollutants from point and non-point sources.

Four agencies sampled fifteen areas which are characterized by six different land uses (Table 1–1). Samples obtained were analyzed for the following constituents:

- –Biochemical oxygen demand (BOD)
- –Chemical oxygen demand (COD)
- –Total organic carbon (TOC)
- –Suspended solids, volatile solids
- – Total nitrogen, nitrate, nitrite, ammonia
- –Total phosphorus, ortho-phosphorus
- –Dissolved oxygen
- –Total coliforms
- –Fecal coliforms
- –Heavy metals

Because the volume and character of stormwater run-off is highly dependent upon the types and degree of development in an area, the land use for all of Nassau and Suffolk counties had to be determined before non-point source pollution loadings could be calculated. The Nassau-Suffolk Regional Planning Board constructed a network of grids, each approximately one square mile, covering all of the bi-county area. Percentages of land in residential, industrial, agricultural and open space use were assigned for each grid square. Aggregations of squares within each drainage basin then allowed correlation of land use with the stormwater run-off characteristics obtained from the field sampling program.

Computer analysis of the data provided plots of each pollutant entering the streams over the course of each storm as well as the calculations of load factors for each pollutant based on land area. These load factors have been used to obtain stormwater loadings for each bay in relation to the amount of precipitation and for assigning overall yearly loads to surface and groundwater. Table 1–2 lists a summary of average load factors for each of the areas sampled. A number of conclusions can be drawn from this table that are applicable to the Long Island area:

1. There are no appreciable differences in both BOD and suspended solids in run-off from different land uses. That is, all land uses have consistent load factors for both parameters.
2. There is no real difference between medium and low density residential areas with respect to total nitrogen and phosphorus loadings (nutrients); there are no major differences between roads and industrial areas for total nitrogen and phosphorus; residential load factors for nutrients are an order of magnitude higher than loadings for roads and industrial areas.
3. There is no significant difference between low and medium density residential areas with respect to both total and fecal coliforms.
4. The industrial areas have consistently high values for heavy metals. Medium density residential areas exhibit elevated load values.
5. In the first six categories of pollutants, no differences can be discerned between medium and low density residential land uses in terms of run-off characteristics.

Table 1–1

NON-POINT SOURCE SAMPLING LOCATIONS AND LAND USE CLASSIFICATION

Area	Land Use
Valley Stream	Medium density residential
Massapequa Creek	Medium density residential
Cedar Swamp Creek	Mixed land use
Mill Neck Creek	Low density residential
Wildwood	Agricultural
Miller Place	Low density residential
Sagaponic	Agricultural
Baldwin	Medium density residential
Lake Success	Low density residential
Swan River	Mixed land use
Sampawams Creek	Medium density residential
Penataquit Creek	Medium density residential
Heartland Industrial Park	Industrial
Long Island Expressway	Major roads
West Branch Browns River	Medium density residential

1.4 TOTAL ANNUAL LOADS FROM POINT AND NON-POINT SOURCES

Data obtained from the point source and non-point source inventories has been calculated for each drainage basin in the Nassau-Suffolk region. The reader is directed to reports prepared by R. F. Weston listed in the bibliography for detailed discussion of the data and methodology involved. Figure 1–15 shows the individual drainage basins and areas contributing surface run-off directly to streams and salt water bodies, while Table 1–3 lists the total pounds of six pollutants contributed to surface water from each basin per year and the percentage of each pollutant as represented by point

Table 1–2

LOAD FACTORS FOR LAND USES IN THE NASSAU-SUFFOLK REGION[1]

Parameter	Land Use	Average Load Factor Lbs. of Pollutant Per (Acre) (Inch)	Number of Storms Sampled	Standard Deviation	High/Low
BOD	Medium Density Residential	.36	6	.24	.64–.056
	Low Density Residential	(2)	–	–	–
	Roads	.32	4	.24	.67–.16
	Industrial	.35	1	–	.35
SS	Medium Density Residential	3.3	10	4.5	14.7–.3
	Low Density Residential	2.9	3	–	6.5–2.0
	Roads	4.6	4	6.5	14.2–.67
	Industrial	(3)	–	(3)	(3)
TN	Medium Density Residential	.23	12	.25	.79–.002
	Low Density Residential	.14	3	–	.27–.008
	Roads	.06	4	.03	.10–.03
	Industrial	.06	1	–	.06
TP	Medium Density Residential	.091	13	.29	1.04–.00
	Low Density Residential	.018	3	–	0.45–.002
	Roads	.005	4	.004	.01–.002
	Industrial	.007	1	–	.007
F. Coli[4]	Medium Density Residential	1.02×10^{10}	12	1.6×10^{10}	4.9×10^{10}–1.3×10^{7}
	Low Density Residential	4.2×10^{10}	2	–	7.6×10^{10}–$.72 \times 10^{10}$
	Roads	(5)	–	–	–
	Industrial	3.40×10^{6}	1	–	3.4×10^{6}
T. Coli[4]	Medium Density Residential	6.2×10^{10}	12	11.0×10^{10}	35.9×10^{10}–6.5×10^{7}
	Low Density Residential	7.3×10^{10}	2	–	13.3×10^{10}–1.4×10^{10}
	Roads	(5)	–	–	–
	Industrial	2.18×10^{7}	1	–	2.18×10^{7}
Lead	Medium Density Residential	0.024	12	0.03	0.063–0.000
	Low Density Residential	0.006	3	–	0.010–0.000
	Roads	0.008	4	–	0.018–0.000
	Industrial	0.01	–	–	0.01
Chromiun	Medium Density Residential	0.002	9	.002	.007–0.000
	Low Density Residential	0.000	1	–	0.000
	Roads	0.001	4	–	0.001–0.0
	Industrial	0.105	1	–	0.105
Copper	Medium Density Residential	0.009	11	0.02	0.067–0.000
	Low Density Residential	0.003	2	–	0.003–0.002
	Roads	0.011	4	0.009	0.024–0.002
	Industrial	0.014	1	–	0.014
Nickel	Medium Density Residential	0.003	11	0.003	0.008–0.000
	Low Density Residential	0.001	2	–	0.001–0.001
	Roads	0.001	2	–	0.001–0.001
	Industrial	0.064	1	–	0.064

[1] High density residential and open space were not sampled. Agriculture was sampled and no appreciable runoff resulted.
[2] Neither BOD nor TOC was sampled in a low density area.
[3] SS was not sampled in this land use category.
[4] Units are MPN/(acre) (inch)
[5] Coliforms were not analyzed in this land use.

source, dry-weather stream flow and wet-weather run-off. Long term data on dry-weather stream flow were not available for all areas and are indicated in the Table by the letters NA.

The following conclusions can be drawn from Table 1–3.

Nassau County

1. With reference to BOD, it is quite apparent that except for drainage basin N5, point sources dominate the pollutant contributions. They range from 74 percent of the total loads in N6 to 94 percent in N1. The only exception is N5 where run-off contributes 70 percent of the total load. The influence of the wastewater treatment plant at Bay Park in N1 is readily apparent in Table 3 since point sources contribute 94 percent of BOD,

2. *Suspended solids behave opposite to BOD, i.e., run-off contributes* more than point sources. Loadings of suspended solids from wet-weather run-off range from 62 to 94 percent of the total annual load from basins N2 to N6 and in only one case, basin N1, do point sources dominate the total load. Again, the impact of Bay Park with its large discharge is readily apparent in N1.

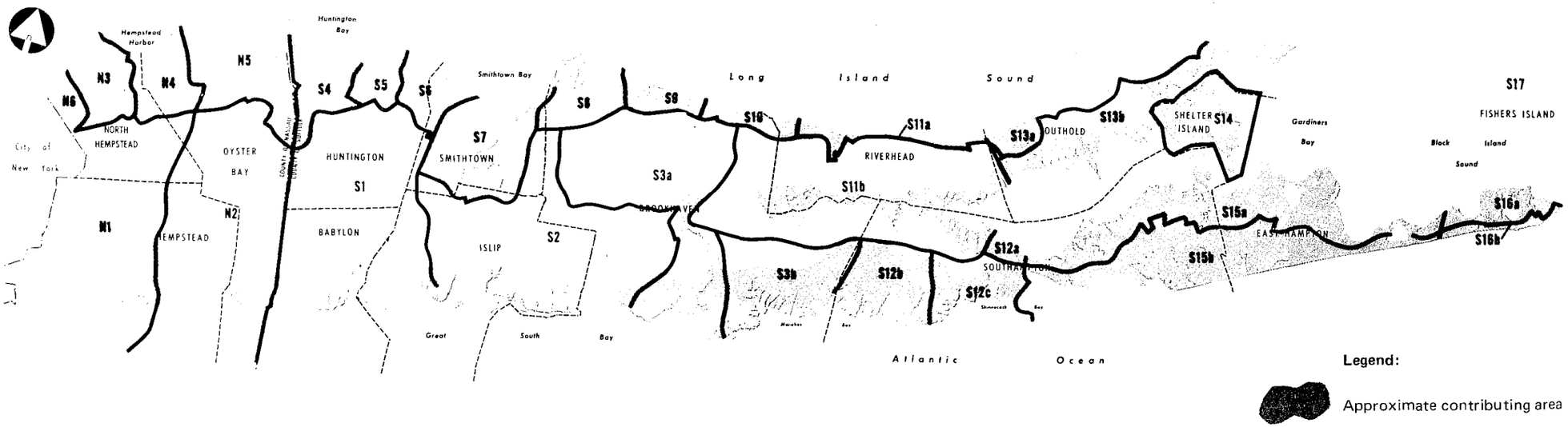
3. Total nitrogen appears to be dominated by point sources. The point sources account for between 48 and 95 percent of the total load in each drainage basin. It should be noted that in drainage basin N1, when stream effects are included, only two percent of total nitrogen is accounted for by the base flow in the streams, while over 95 percent is attributed to point sources. This could reflect the influence of Bay Park. In drainage basin N2, the streams' influence increases to 36 percent, compared to 54 percent for the point sources. The point source percentages reflect the influence of the Cedar Creek Plant. The point source contribution will increase as the Cedar Creek Plant flow increases in the future.

4. Total phosphorus appears to be dominated by point sources in all the basins except for N5; they account for 65 to 93 percent of the total load in each of the basins except N5. The percentage contributed by stream flow in N1 and N2 is only one percent.

5. Fecal coliform load is clearly dominated by run-off rather than point sources. The clear domination of run-off appears in five out of the six Nassau County basins (N2 through N6) and ranges from 72 to 99 percent. Even in basin N1 with the influence of Bay Park, run-off contributes an almost equal amount of coliform as the point sources. Equally important is the zero dry weather contribution from streams indicating dry weather flow is not a major problem.

6. Total coliform is given as a total number rather than a percentage because only six out of 127 treatment plants, in both Nassau and Suffolk, measure and record total coliform. Because complete data does not exist, percentages cannot be compared without distorting the results. However, the results would be similar to fecal coliform, *i.e.,* domination by run-off.

7. By reviewing results by drainage basins, the following conclusions can be drawn: in drainage basin N1, which would correspond to the most heavily populated basins, as well as the most urbanized, domination by point



Legend:

Approximate contributing area

N1, N2, N3... Drainage Basins
S1, S2, S3.....

FIGURE 1–15 *Areas Contributing Surface Runoff Directly to Streams and Saltwater Bodies.*

sources is apparent in all parameters. This is due to the effluent from Bay Park and some of the other treatment plants that discharge in this drainage basin. Drainage basin N5, which is the most rural basin, shows the exact opposite, *i.e.,* the total pollutional load from each of the parameters is dominated by run-off rather than by point sources.

Suffolk County

1. The total loads of the six parameters are almost always dominated by run-off, primarily due to the fact that there are not many large treatment systems in Suffolk County. Only in small drainage basins with a large point source would there be a significant percentage of contribution from point sources (such as in drainage basins S11B, S3 and S4).

2. There is a significant difference between Nassau and Suffolk Counties in terms of which sources contribute the major portion of the total load. In Nassau, point source contributions dominate in most basins. However, in Suffolk, run-off contributes more pollutant material than the point sources. The one exception, in Nassau, is fecal coliform which is predominantly derived from run-off. Between 47 and 100 percent of the fecal coliform load comes from run-off in all drainage basins. In Suffolk County, run-off accounts for between 86 and 100 percent of fecal coliform loads to surface water.

3. Pollutant loadings are substantial in terms of total pounds per year, especially with respect to suspended solids.

4. The major portions of the pollutant loads originated in the western drainage basins, S1 through S8. Assuming impact on water quality is proportional to loads, pollution control efforts should focus on these basins.

1.5 WATER QUALITY AND ALTERNATIVE EVALUATIONS

Using information derived from historical data searches, the marine field sampling programs and point and non-point source loadings, a series of modeling studies were carried out to predict water quality characteristics and to evaluate proposed structural alternatives for certain bay systems. Table 1–4 is a compilation of all water quality data generated in the 208 Study. The values were derived from verified steady-state numerical models where possible. In the case of non-modeled systems, data was obtained from the water quality assessments based on historical data as prepared by Tetra Tech, Inc. Since each bay system undergoes large seasonal variations in chemical and biological processes, only data from the months of July through September were used. This insures that changes due to temperature variations would be minimized. It should also be remembered that the nomenclature used to describe the South Shore bays is artificial in that all bays between Hempstead Bay and eastern Great South Bay are actually one large bay complex. The data for Great South Bay in Table 1–4 has been broken down into three geographical areas: western Great South Bay from the Nassau-Suffolk County line east to the Captree Bridge; central Great South Bay from the Captree Bridge east to Nicolls Bay; and eastern Great South Bay from Nicolls Bay east to Smith's Point. Several conclusions may be drawn from this information:

1. Tidal ranges for all North Shore bays are significantly greater than for the Peconic-Flanders or the South Shore bays.

2. The salinity range for individual North Shore bays is generally much narrower than for the South Shore bay complex. This is mainly due to longer flushing times and greater freshwater input in South Shore bays compared to those of the North Shore.

3. Dissolved oxygen values vary widely between bays. Only Hempstead Bay and Middle Bay showed steady-state values below the state standard of 5.0 milligrams per liter for SB waters. This does not mean that other areas have not or will not experience values below the standard. The values in Table 4 are tidally-averaged, steady-state and as such do not show variations due to changes in seasonal or diurnal respiration and photosynthesis. For example, dissolved oxygen values in Great South Bay are generally above 100% saturation but may fall as low as 30% saturation during the night in summer months.

4. Biochemical oxygen demand values are generally higher for the North Shore Bays than for South Shore Bays. The high North Shore values are generally attributed to Long Island Sound water, which receives loadings from the East River. If the effects of algal respiration are added to the values for South Shore bays, the values for bays east of Middle Bay would increase significantly, bringing them in line with Hempstead and North Shore bays.

5. Nutrient values are generally higher in North Shore areas than in the south bay system. Again, this most likely reflects the effects of enriched Long Island Sound water.

6. Nitrogen/phosphorus (N/P) ratios are calculated based on total values for both constituents except where noted. In the latter case, only data on ammonia, nitrate and phosphate were available. In general, nearshore ocean values for N/P ratios are generally about 10:1. Values lower than this are generally associated with changes in species composition and algal blooms characterized by chlorophyll a levels higher than 20 milligrams per liter.

A comparision of N/P ratios and chlorophyll a values illustrates this point. N/P ratios in the North Shore bays are generally below 10:1 and show elevated chlorophyll values whereas the South Shore bays generally have N/P ratios higher than 10:1 and chlorophyll values below 20 milligrams per liter. Exceptions are seen in Hempstead Harbor and in the central and eastern portions of Great South Bay where upper chlorophyll values exceed twenty. This is most likely due to the increased nitrogen loadings from streams in the South bay areas.

7. The total coliform standard for shellfishing areas is 70 MPN per 100 milliliters (log = 1.85). In general, coliform levels in the North Shore bays bracket this value and indeed all or part of each bay has been closed to shellfishing. The western South Shore bays are generally above the 70 MPN per 100 milliliters standard. However, it should be noted that the transect used in modeling the South Shore bays runs along the north shore of these bays, and is therefore closer to point and non-point sources of pollution. Areas of central and eastern Great South Bay are generally below the 70 MPN standard.

Table 1–3

APPROXIMATE PERCENTAGES OF THE TOTAL POLLUTANT LOADS TO SURFACE WATERS CONTRIBUTED BY POINT SOURCES, DRY-WEATHER STREAM FLOW AND WET-WEATHER NON-POINT SOURCES (1975)

	BOD			SS			TN			
Drainage Basin	Lbs/Yr Total	% Run-off[3]	% Pt. Source[3]	Lbs/Yr Total	% Run-off[3]	% Pt. Source[3]	Lbs/Yr Total	% Run-off	% Stream	% Pt. Source
N-1	4,530,000	6	94	9,500,000	22	78	5,880,000	3	2	95
N-2	1,540,000	20	80	3,400,000	71	29	1,830,000	10	36	54
N-3	699,000	18	82	1,480,000	64	36	645,000	10	NA	90
N-4	1,650,000	10	90	1,960,000	62	38	701,000	12	NA	88
N-5	368,000	70	30	2,000,000	94	6	199,000	52	NA	48
N-6	164,000	26	74	447,000	76	24	110,000	21	NA	79
Nassau Total[2]	**8,951,000**			**18,787,000**			**9,365,000**			
S-1	300,000	97	3	2,240,000	99	1	964,000	16	83	1
S-2	485,000	72	28	2,750,000	98	2	707,000	27	70	3
S-3	329,000	53	47	1,550,000	89	11	180,000	51	49	0
S-4	358,000	55	45	1,690,000	90	10	171,000	52	NA	48
S-5	111,000	92	8	780,000	99	1	69,000	66	NA	34
S-6	104,000	100	–	727,000	100	–	46,000	100	NA	–
S-7	327,000	98	2	2,380,000	99	1	213,000	74	NA	26
S-8	433,000	32	68	1,210,000	84	16	136,000	52	NA	48
S-9	62,000	100	–	510,000	100	–	35,000	100	NA	–
S-10	49,000	100	–	305,000	100	–	23,000	100	NA	–
S-11A	8,500	100	–	57,000	100	–	4,100	100	NA	–
S-11B	472,000	18	82	826,000	44	56	84,000	36	NA	64
S-12A	6,000	100	–	51,000	91	9	2,900	100	NA	–
S-12B	127,000	67	33	483,000	95	5	32,000	100	NA	–
S-12C	45,000	100	–	359,000	100	–	23,000	100	NA	–
S-13A	11,000	100	–	87,000	100	–	5,400	100	NA	–
S-13B	324,000	14	86	424,000	85	15	88,000	26	NA	74
S-14	15,000	100	–	108,000	100	–	6,700	100	NA	–
S-15A	67,000	100	–	477,000	100	–	32,000	100	NA	–
S-15B	24,000	100	–	867,000	100	–	55,000	100	NA	–
S-16A	24,000	100	–	164,000	100	–	11,000	100	NA	–
S-16B	8,200	78	22	42,000	95	5	4,100	64	NA	36
Suffolk Total[2]	**3,690,000**			**18,087,000**			**2,892,000**			
Total[2]	**12,641,000**			**36,874,000**			**12,257,000**			

1 Reflects runoff loading only
2 Rounded total
3 Percent of partial loading; dry weather stream flow not included.

Note: NA = Not Applicable

	TP				F. Coli			T. Coli	
Lbs/Yr Total	% Run-off	% Stream	% Pt. Source	MPN/Yr Total	% Run-off	% Stream	% Pt. Source	MPN/Yr Total[1]	Drainage Basin
866,000	6	1	93	1.6×10^{16}	47	0	53	4.1×10^{16}	N-1
202,000	34	1	65	1.1×10^{16}	72	1	27	4.7×10^{16}	N-2
115,000	16	NA	84	3.5×10^{15}	90	NA	10	2.1×10^{16}	N-3
89,000	27	NA	73	9.9×10^{15}	95	NA	5	2.7×10^{16}	N-4
34,000	58	NA	42	2.4×10^{16}	99	NA	1	4.6×10^{16}	N-5
27,000	29	NA	71	2.1×10^{15}	98	NA	2	7.1×10^{15}	N-6
1,333,000				**6.6×10^{16}**				**1.9×10^{17}**	**Nassau Total[2]**
76,000	80	20	–	8.0×10^{15}	98	1	1	4.4×10^{16}	S-1
146,000	47	49	4	1.2×10^{16}	98	1	1	5.4×10^{16}	S-2
35,200	87	13	–	8.5×10^{15}	100	0	0	2.86×10^{16}	S-3
40,000	58	NA	42	1.5×10^{16}	99	NA	1	3.5×10^{16}	S-4
16,000	72	NA	28	7.8×10^{15}	99	NA	1	1.8×10^{16}	S-5
12,000	100	NA	–	6.7×10^{15}	100	NA	–	1.6×10^{16}	S-6
60,000	83	NA	17	1.6×10^{16}	99	NA	1	5.0×10^{16}	S-7
42,000	57	NA	43	5.8×10^{15}	99	NA	1	2.1×10^{16}	S-8
13,000	100	NA	–	2.5×10^{15}	100	NA	–	1.0×10^{16}	S-9
8,000	100	NA	–	1.3×10^{15}	100	NA	–	6.0×10^{15}	S-10
1,400	100	NA	–	3.1×10^{14}	100	NA	–	1.2×10^{15}	S-11A
33,000	25	NA	75	4.9×10^{15}	99	NA	1	5.6×10^{15}	S-11B
800	100	NA	–	4.0×10^{14}	100	NA	–	1.0×10^{15}	S-12A
7,500	100	NA	–	4.6×10^{15}	100	NA	–	1.1×10^{16}	S-12B
7,600	100	NA	–	2.4×10^{15}	100	NA	–	7.6×10^{15}	S-12C
1,600	100	NA	–	7.2×10^{14}	100	NA	–	1.9×10^{15}	S-13A
11,000	69	NA	31	2.8×10^{15}	98	NA	2	7.8×10^{15}	S-13B
1,800	100	NA	–	2.4×10^{15}	100	NA	–	2.4×10^{15}	S-14
10,000	100	NA	–	3.3×10^{15}	100	NA	–	1.0×10^{16}	S-15A
16,000	100	NA	–	7.4×10^{15}	100	NA	–	1.9×10^{16}	S-15B
3,700	100	NA	–	1.0×10^{15}	100	NA	–	3.4×10^{15}	S-16A
700	100	NA	–	4.0×10^{14}	86	NA	14	8.80×10^{14}	S-16B
543,000				**1.1×10^{17}**				**3.5×10^{17}**	**Suffollk Total[2]**
1,876,000				**1.8×10^{17}**				**5.4×10^{17}**	**Total[2]**

Table 1–4

COMPILATION OF WATER QUALITY DATA DERIVED FROM NUMERICAL MODELS AND HISTORICAL DATA

		North Shore							South Shore	
	Units	Western Long Island Sound	Manhasset Bay	Hempstead Harbor	Oyster Bay	Huntington–Lloyd Complex	Northport–Centerport Complex	Port Jefferson	Peconic–Flanders System	Hempstead Bay
Tidal Range	ft.	6	7.3	8.6	7.3	7.1	7.1	6.6	2.7	2.0–4.0
Salinity	ppt.	24–26	21–26	23–26	24–26	25–28	24–27	26–27	15–27	30–31
Temperature	°C.	19–21	14–19	20–24	19–25	21–23	21–23	21–23	20–22	20–23
Diss. O_2	mg/L.	5.5–8.5	8–12	7–9	8–9	8–10	8–10	7–9	8–10	5–9
BOD_5	mg/L.	2.0–4.0	0.5–3.5	1.5–4.5	0.2–0.9	1.3–2.0	ND*	1.5–1.8	0.2–1.3	0.7–1.1
T. Phos.	mg/L.	0.12–0.15 (PO_4)	0.08–0.39	0.19–0.35	0.12–0.14	0.12–0.16	0.12–0.18	0.04–0.05	0.06–0.16	0.04–0.11
T. Nit.	mg/L.	0.24–0.45 ($NH_4 + NO_3$)	0.13–2.03	0.93–2.43	0.33–0.45	0.32–0.41	0.34–0.78	0.30–0.37	0.31–0.88	0.25–0.73
N/P	atoms	1–3	3–11	10–15	6–7	5–6	6–9	15–16	11–12	13–15
Chl a	mg/L.	10–30	3–51	10–220	10–30	2–28	ND	2–18	5–370	2–15
T. coli.	log	1.15–3.70	0.3–5.8	0.5–1.9	–1.4 to 0.3	0.19–2.25	–1.1 to 1.5	3.1–4.22	0.38–2.25	2.2–2.7
F. coli.	log	0.55–3.5	–0.3 to 5.8	0.0–2.88	–1.35 to –0.19	–0.4 to 1.3	–1.3 to 0.4	2.99–4.22	0.38–2.25	1.4–1.5

		South Shore								
	Units	Middle Bay	East Bay	South Oyster Bay	Great South Bay West	Great South Bay Central	Great South Bay East	Mecox Bay	Moriches Bay	Shinnecock Bay
Tidal Range	ft.	2.5–3.5	2.0–3.0	1.2–2.0	1.0–3.0	0.6–1.0	0.4–0.8	2.0 variable	1.5	2.0
Salinity	ppt.	29–31	29–31	30–31	29–31	26–30	22–27	6–30	25–31	27–32
Temperature	°C.	21–23	20–22	21–22	22–23	22–23	22–23	~20–22	22–24	22–24
Diss. O_2	mg/L.	4–6	5–6	5–7	6–8	7–10	8–10	9–13	ND	ND
BOD_5	mg/L.	0.7–0.8	0.5–0.7	0.3–0.5	0.1–0.3	ND	ND	ND	ND	ND
T. Phos.	mg/L.	0.04–0.11	0.01–0.04	0.01–0.02	0.01–0.02	0.01–0.05	0.05–0.09	0.05–0.20	0.11–0.19	0.01–0.04 (PO_4)
T. Nit.	mg/L.	0.33–0.70	0.33–0.45	0.25–0.38	0.13–0.25	0.13–1.33	1.33–1.65	0.02–1.09	0.28–1.07	0.01–0.15 (NH_4+NO_3+NO_2)
N/P	atoms	14–18	25–78	45–60	30–31	30–60	40–158	0.5–2.0 (dissolved)	5–14	ND
Chl a	mg/L.	5–17	9–12	3–6	4–8	6–28	12–25	26–49	ND	ND
T. coli.	log	2.2–2.6	2.0–2.4	1.9–2.0	1.8–1.9	1.1–2.1	1.1–1.9	0.3–3.4	0.48–3.4	0.48–3.5
F. coli.	log	1.5–1.6	1.5–2.0	1.4–1.5	1.3–1.6	0.8–2.0	0.8–1.5	ND	ND	ND

**ND = No Data*

Note: Only data for months of July through September are included in this table.

1.5.1 Structural Alternatives Examined for Long Island Surface Waters

The following section lists the point sources for each of the modeled bays, the structural alternatives proposed and results of these model evaluations where available.

Point Sources for Manhasset Bay

1. Mill Pond
2. Port Washington Sewage Treatment
3. Baxter Pond
4. Knickerbocker Drain
5. Stannard's Drain
6. Leed's Pond
7. Manhasset Valley Park Pond Creek (Whitney Lake)
8. Great Neck Sewer District STP
9. Great Neck Village STP
10. South Pond (Mann's Creek)
11. Mitchell's Creek
12. Wilson's Pond

Table 1–5

SUMMARY OF ALTERNATIVES EXAMINED FOR MANHASSET BAY COMPLEX

Wastewater Sources

Great Neck STP @ 3.5 MGD
Village of Great Neck STP @ 1.5 MGD
Kings Point–Manhasset Collection District @ 2.0 MGD
Port Washington Sewer District STP @ 4.5 MGD
Plandome–Sands Point Collection District @ 2.0 MGD
Roslyn STP @ 0.7 MGD

Treatment Type and Effluent Characteristics

	BOD_5*	T. Nit.*	T. Phos.*	T. coli.†	F. coli.†
Secondary	30	30	4	400	200
Advanced	10	3	4	400	200

Discharge Locations

Current
Mid-Bay
Long Island Sound

* *values in mg/L*
† *values in MPN/100 ml*

1.5.2 Alternative Analyses For Manhasset Bay Complex

As can be seen from Table 1–5 the number of treatment plants, the estimated future flows, the type of treatment and the outfall locations result in a very large number of possible structural alternatives for wastewater management in this area. In addition to the type of modeling efforts previously described, an entire series of "incremental load values" were calculated for each possible combination of alternatives. These will be used along with environmental analyses to determine the most cost-effective and environmentally sound management plan.

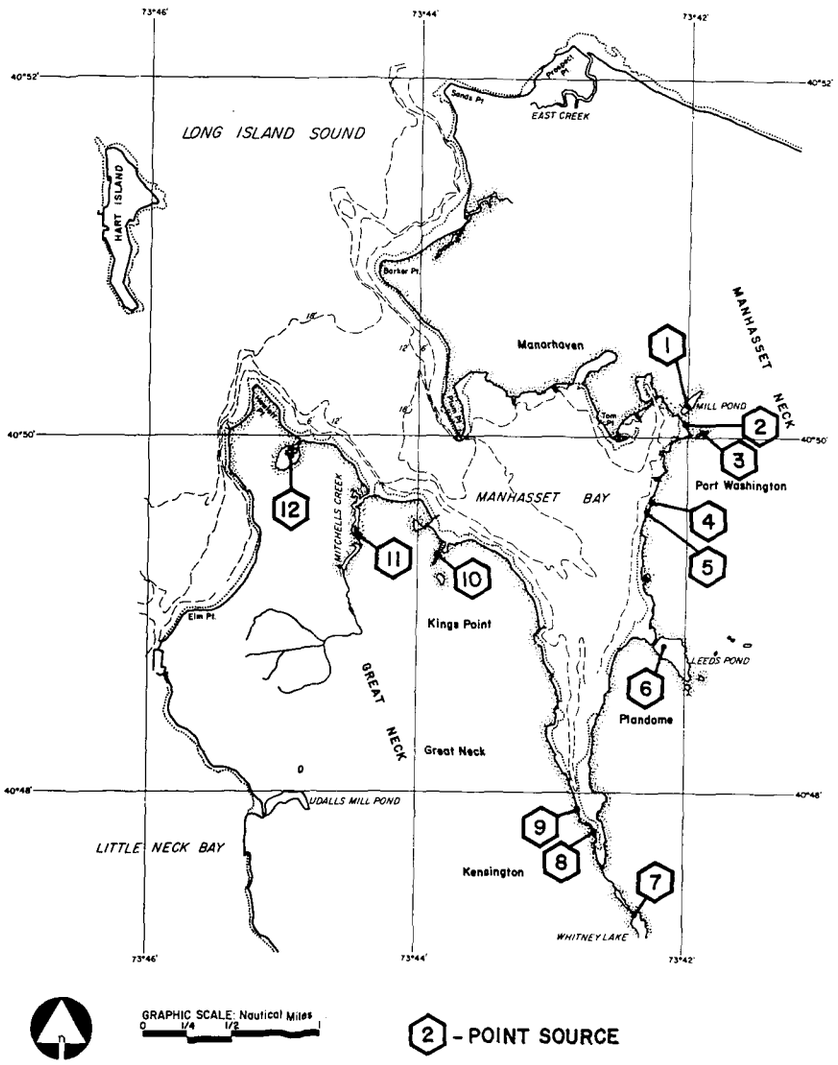


FIGURE 1–16 *Point Source Locations for Manhasset Bay.*

Point Source Locations for Hempstead Harbor

1. Cedar Swamp Creek
2. Powers Chemco
3. Glen Cove STP
4. Scudders Pond
5. N. Tappan Drain
6. S. Tappan Drain
7. Powerhouse Drain
8. Swan Club Pond
9. Drain at Swan Club
10. Drain North of Emmanuel's Pond
11. Emmanuel's Pond
12. Roslyn STP
13. Roslyn Duck Pond
14. Roslyn Viaduct (North Center, S) Pipes
15. Roslyn Incinerator
16. Drain North of Hempstead Harbor Beach

Table 1–6

SUMMARY OF ALTERNATIVES EXAMINED FOR HEMPSTEAD HARBOR

Wastewater Sources

Glen Cove @ 6.5 MGD
Sea Cliff–Roslyn Harbor Collection District @ 5.0 MGD
Oyster Bay STP @ 2.0 MGD
Unsewered Bayville and East Norwich areas @ 2.7 MGD
Port Washington Sewer District @ 4.5 MGD
Unsewered Plandome–Sands Point Collection District @ 2.0 MGD
Great Neck Sewer District @ 3.5 MGD
Unsewered King's Point area @ 2.0 MGD
Roslyn STP @ 0.7 MGD

Treatment Type and Effluent Characteristics

	BOD_5*	T. Nit.*	T. Phos.*	T. coli.†	F. coli.†
Secondary	30	30	4	400	200
Advanced	10	3	4	400	200

Discharge Locations

Current
Mid-Bay
Long Island Sound

* *values in mg/L*
† *values in MPN/100 ml*

1.5.3 Alternative Analyses for Hempstead Harbor

Because of their proximity to one another, many of the structural alternatives examined for Manhasset Bay are also possible alternatives for the Hempstead Bay complex. Again, a series of incremental values (milligrams per liter of constituent per million gallons per day or equivalent units) were calculated for the series of alternative loads, treatment type and discharge location examined. As mentioned previously, boundary conditions (water quality in western Long Island Sound) have a major influence on water quality within Long Island North Shore bays. For this reason, two sets of boundary conditions were chosen for the model runs: yearly averages and "typical worst case" conditions. In addition to these, a "zero discharge" situation (no treatment plants) was also run as a basis for comparison.

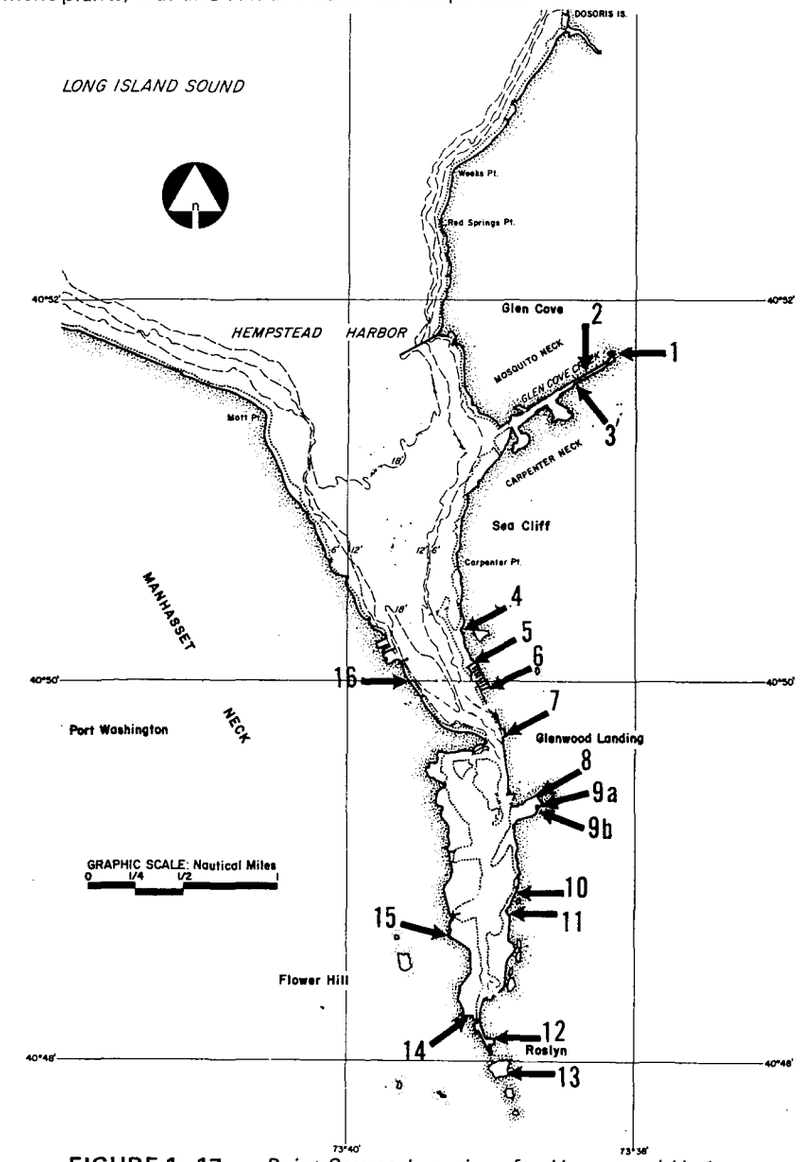


FIGURE 1–17 *Point Source Locations for Hempstead Harbor.*

Point Sources for Oyster Bay—Cold Spring Harbor

1. Oak Neck Creek
2. Mill Neck Creek—Factory Pond
3. Kentuck Pond Creek
4. Mill Pond Creek
5. Oyster Bay STP
6. Center Island STP
7. Tiffany Creek
8. Cold Spring STP
9. Cold Spring Brook

Table 1—7

SUMMARY OF ALTERNATIVES EXAMINED FOR OYSTER BAY—COLD SPRING HARBOR COMPLEX

Wastewater Sources

Oyster Bay @ 3.1 cfs
Oyster Bay with unsewered Bayville area @ 4.96 cfs
Oyster Bay with unsewered East Norwich area @ 5.43 cfs
Oyster Bay with both Bayville and East Norwich @ 7.29 cfs

Treatment Type and Effluent Characteristics

	BOD_5*	T. Nit.*	T. Phos.*	T. coli.†	F. coli.†
Secondary	30	30	4	400	200
Advanced	10	3	4	400	200

Discharge Locations

Current
Mid-Bay
Long Island Sound

** values in mg/L*
† values in MPN/100 ml

1.5.4 Alternative Analyses for Oyster Bay—Cold Spring Harbor

Treatment plant loadings as proposed by the engineering consultants were evaluated as shown in Table 1—7.

The results of modeling studies have shown that there is a relatively minor improvement in surface water quality for all constituents whether receiving secondary or advanced treatment with outfalls located at mid-bay or present locations. For example, an increase of 0.1 milligrams per liter of nitrogen is seen under the highest loading (7.29 cfs) with secondary treatment at the present location. These results are consistent with the high flushing rate of the area and the levels of nutrients in Long Island Sound waters which reflect loadings from the East River.

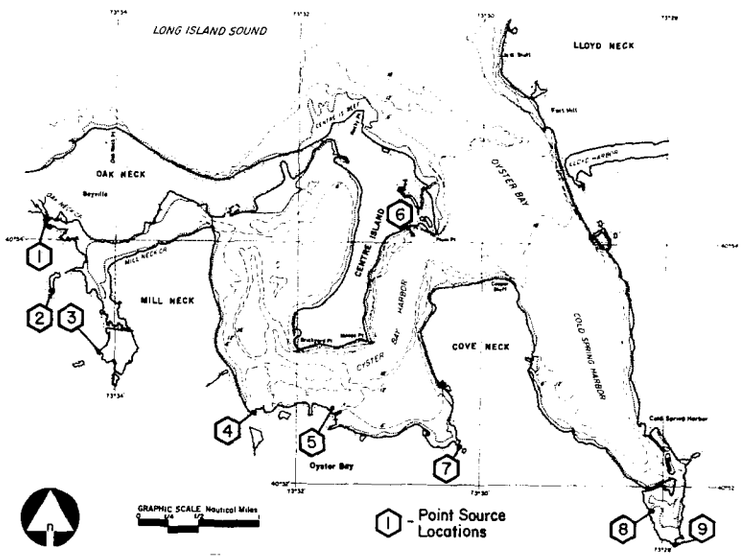


FIGURE 1—18 *Point Source Locations for Oyster Bay—Cold Spring Harbor Complex.*

Point Sources for the Huntington—Northport Complex

1. Mill Road Creek
2. Huntington STP
3. Huntington Harbor Creek
4. Centerport Mill Pond
5. Stony Hollow Run
6. Northport STP
7. Storm drain

Table 1—8

SUMMARY OF ALTERNATIVES EXAMINED FOR HUNTINGTON BAY—NORTHPORT HARBOR COMPLEX

Plant

Huntington @ 13 MGD
Huntington concurrent operation @ 6.5 MGD
Northport concurrent operation @ 6.5 MGD

Treatment Type and Effluent Characteristics

	BOD_5*	T. Nit.*	T. Phos.*	T. coli.†	F. coli.†
Secondary	30	30	4	400	200
Advanced	10	2	4	400	200

Discharge Locations

Huntington

Current
Mid-Bay
Long Island Sound

Northport

Current
Mid-Bay

* *values in mg/L*
† *values in MPN/100 ml*

1.5.5 Structural Alternative Analyses—Huntington-Northport Complex

The objective of this work was to provide quantitative estimates of the effects of projected effluent discharges on receiving water quality using the verified numerical model. A variety of treatment plant loadings as proposed by the engineering consultants was examined and the loadings are listed in Table 1—8.

Comparisons of secondary versus advanced waste treatment with concurrent discharge of 6.5 million gallons per day at two plants indicated that secondary treatment is clearly unacceptable. Nitrogen, phosphorus and BOD concentrations would be approximately one order of magnitude higher than they are at present. The impact of this increase is difficult to quantify but it is reasonable to assume that significant increases in these parameters will result in adverse changes in the system. Coliform counts are presently above the limit set for shellfishing (not more than 70 MPN per 100 milliliters due mainly to the contributions from Huntington Harbor Creek and storm drain inflow. The incremental effect of sewage treatment plant discharge on coliform concentrations is minimal since coliforms are essentially removed in the treatment process.

Comparisons of secondary versus advanced treatment with a single plant discharging 13 million gallons per day at the present Huntington STP location indicate there would be effective nitrogen and BOD removal with advanced treatment but little removal of phosphorus. Again, there appears to be negligible impact with respect to coliform concentrations due to treatment plant discharges.

Comparisons of secondary treatment alternatives with different outfall locations indicate that substantial improvement in water quality would occur by moving the outfalls to the mid-bay area. Under these conditions, neither concurrent discharge of 6.5 million gallons per day at the present Huntington and Northport plants nor 13 million gallons per day discharge from the Huntington plant alone causes appreciable change over the present condition.

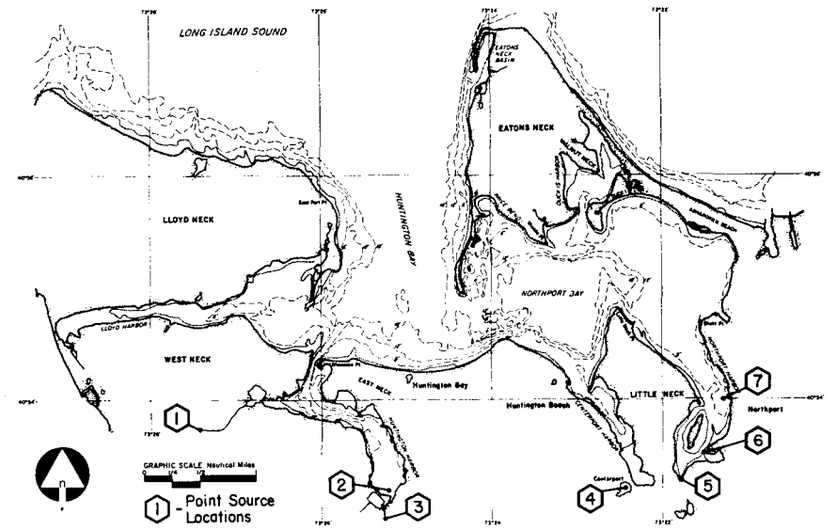


FIGURE 1—19 *Point Source Locations for Huntington-Northport Complex.*

Point Sources for Port Jefferson Harbor Complex

1. Port Jefferson Creek
2. Exxon Storm Sewer
3. Port Jefferson STP
4. Long Island Lighting Company
5. Setauket Creek
6. Conscience Bay Stream

Table 1–9

SUMMARY OF ALTERNATIVES EXAMINED FOR PORT JEFFERSON HARBOR

Plant

Port Jefferson @ 2, 5, 8.5, 10 and 15 MGD discharge rates

Effluent Characteristics

	BOD_5*	T. Nit.*	T. Phos.*	T. coli.†	F. coli.†
Secondary	30	30	4	400	200

Discharge Locations

Current
Mid-Bay
Harbor Entrance

** values in mg/L*
† values in MPN/100 ml
BOD and Fecal coliform values are 7 day arithmetic means

1.5.6 Alternative Analyses for Port Jefferson Harbor

The 208 Study, in response to requests by county agencies involved in the 201 Facilities Plan for Port Jefferson, ran a series of management alternatives using the verified numerical model. Table 1–9 lists the various options examined.

Since tidal cycle and degree of flushing are highly significant in Port Jefferson, the "worst case" tide giving minimum flushing was used in the models.

Discharging 15 million gallons per day to the current location results in a four-fold increase in total nitrogen and a three-fold increase in total phosphorus over baseline conditions or discharge at the harbor entrance.

Modeling results for BOD and coliforms show essentially the same results as found for nutrients; that is, a significant increase over baseline conditions with 15 million gallons per day discharging at the current location and decreasing effects as the outfall is moved closer to the mouth of the harbor. However, there are more localized effects in these parameters especially around the discharge points.

In all cases, differences between baseline and proposed alternatives became increasingly less by moving the outfall closer to the harbor entrance. This is a reflection of the effect of boundary conditions on water quality in the harbor. One might conclude that the presence of contaminants in Long Island Sound could reduce the benefits of relocating a waste discharge nearer the harbor entrance. (However, any marked future improvement in Sound water quality will increase the benefits to be gained from good waste management steps taken now.)

Additional analyses have led to the recommendation to allow secondary treatment at the existing outfall if dissolved oxygen levels are monitored, and to motivate nitrogen removal if dissolved oxygen levels are not maintained above 5.0 milligrams per liter.

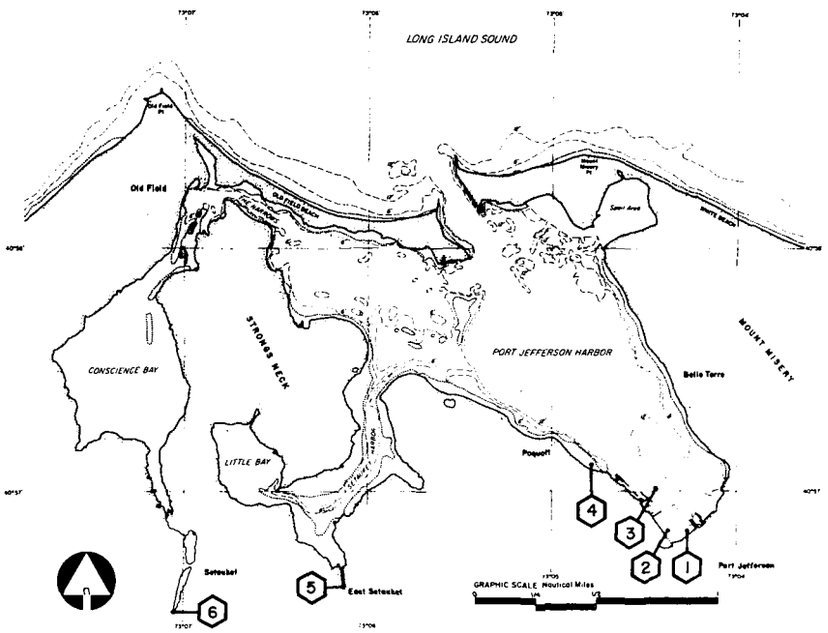


FIGURE 1–20 *Point Source Locations for Port Jefferson Harbor Complex.*

Point Sources for the Peconic Estuary—Flanders Bay System

1. East Creek
2. Reeves Creek
3. Crescent Duck Farm
4. Meetinghouse Creek
5. Broad Cove Duck Farm
6. Terry's Creek
7. Shubert Duck Farm
8. Sawmill Creek
9. Riverhead STP
10. Peconic River
11. Little River
12. White Brook
13. Goose Creek
14. Birch Creek
15. Mill Creek
16. Hubbard Creek

Table 1—10

SUMMARY OF ALTERNATIVES EXAMINED FOR PECONIC ESTUARY—FLANDERS BAY

Plant

Riverhead @ 1, 9 and 20 MGD discharge rates

Treatment and Effluent Characteristics

	BOD_5*	T. Nit.*	T. Phos.*	T. coli.†	F. coli.†
Secondary	30	30	4	400	200

Discharge Locations

Current Site
Mid-Bay
Flanders Bay—Great Peconic Bay Boundary

** values in mg/L*
† values in MPN/100 ml
BOD and Fecal coliform values are 7 day arithmetic means

1.5.7 Alternative Analyses for Peconic Estuary—Flanders Bay

As with each of the other modeled bays, a series of structural management alternatives were proposed. In addition, the 208 Study responded to requests by outside agencies to assist in modeling various alternatives for the 201 Riverhead Facilities Plan. The range of alternatives is given in Table 1—10.

Results of the modeling effort indicate there will be no significant effects on salinity within the area no matter which outfall location is chosen. It should be remembered that the model assumes complete vertical mixing in the water column and therefore predicted values are lower than the values that may occur in localized areas near discharge plumes. This holds for both conservative and non-conservative constitutents.

The one million gallons per day case is representative of the present condition which has often resulted in severe oxygen depletion in the Peconic Estuary during evening hours due to diurnal cycles in photosynthetic activity.

Increases in nutrient concentrations above the present condition may be expected to reach 345% for the nine million gallons per day discharge and 710% for the 20 million gallons per day situation. These estimates are based on nutrient accumulations near the outfall where the impact of the discharges is the greatest. Increases in nutrients at the entrance to Flanders Bay are expected to be 200% (nine million gallons per day) and 400% (2[illegible] million gallons per day) above the present condition.

Model predictions do not show significant changes in coliform concentrations resulting from increased effluent loads. These predictions are based on the assumption that the projected concentrations are truly representative of 24 hour loads from the operating plant and that the coliform decay coefficient of 0.5 per day is appropriate.

Incremental increases in BOD were shown to be similar to increases in nitrogen and phosphorus in areas close to the outfalls. Increases in BOD values at the entrance to Flanders Bay are relatively smaller than nutrient changes due to biological decomposition in diluted discharges. However, while tidally averaged model predictions do not show severe oxygen depletion due to effluent discharges, one should not assume that these situations will not occur at one time or another. Results of the field survey and model sensitivity studies have shown that even under present nutrient loadings, oxygen depletion can be expected to occur from time to time. Dissolved oxygen concentrations in the Peconic Estuary are primarily dependent on phytoplankton photosynthetic-respiration activity. Dissolved oxygen is therefore a function of available nutrients, light intensity and temperature and will vary according to the times of day and season.

Discharge of proposed effluent loads at the mid-bay locations indicates that concentration/gradients are far less pronounced and that better mixing of pollutants would be achieved. Concentration of nutrients at the mouth of the bay with this alternative is much the same as for discharge at the present location, indicating that although the discharge point is closer to the entrance, increased flushing will maintain lower levels of nutrients. Near the outfall, increases over the one million gallons per day case are 163% (nine million gallons per day) and 338% (20 million gallons per day). This represents an improvement in receiving water near the outfall of greater than 50% compared with discharge at the present site.

Discharge at the mouth of the bay results in significantly better mixing and dispersion of nutrients than at the present location. The pollutants are carried out and diluted in Great Peconic Bay so that receiving water nutrient concentrations are believed to be lower than for both other alternatives. While nutrient concentrations in the vicinity of the outfall are essentially the same when discharged at the mouth or at mid-bay locations, nitrogen and

phosphorus concentrations within the bay are generally 20% less for the nine million gallons per day discharge and 30–40% less for the 20 million gallons per day discharge when the outfall is located at the entrance to the bay.

Since dissolved oxygen concentrations are highly sensitive to changes in rates of photosynthesis and respiration, a series of evaluations were carried out to determine the maximum permissible nutrient loadings which would maintain phytoplankton populations at levels not expected to cause oxygen depletion. Results of these analyses indicated that discharge of six million gallons per day with nitrogen removal at the mid-bay site would maintain nutrient concentrations and phytoplankton populations within a range where oxygen depletion would not be expected.

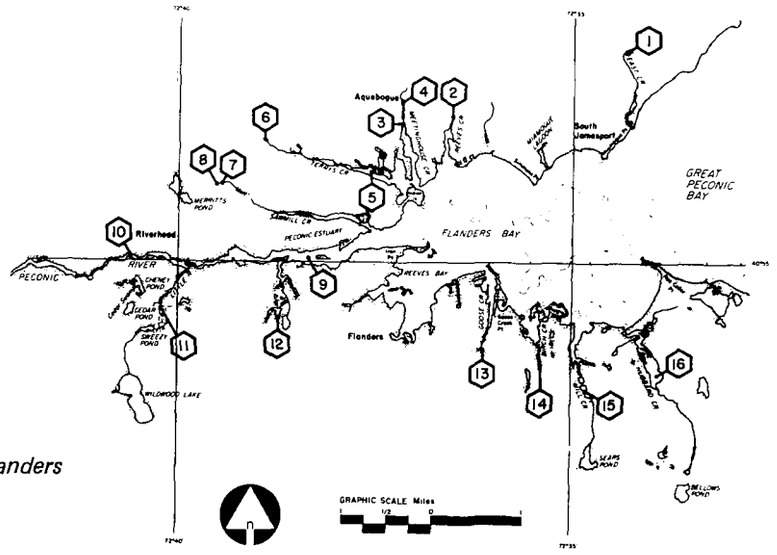
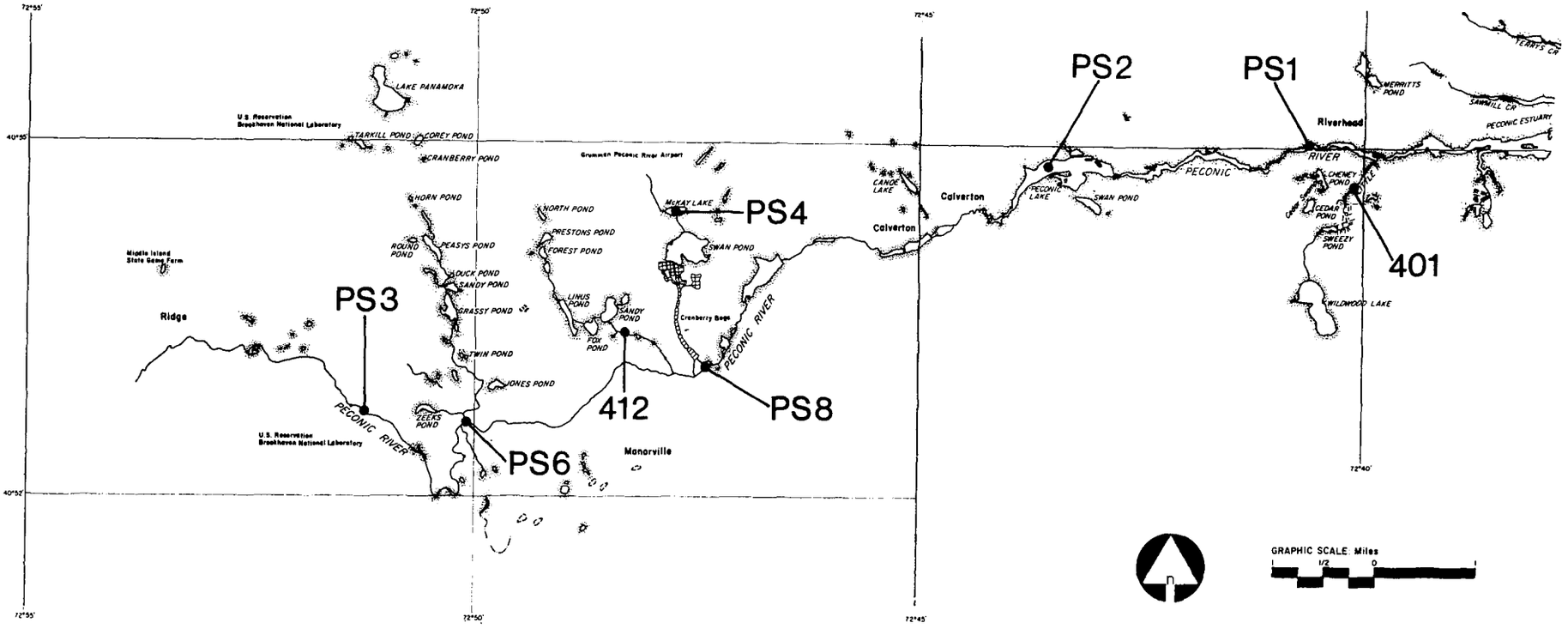


FIGURE 1–21 *Point Source Locations for Peconic Estuary—Flanders Bay System and Peconic River.*



Point Sources For South Shore Bays

	Source Name	Node No.
	Hempstead Bay	
1.	Lawrence STP	2
2.	W. Long Beach STP	2
3.	Bay Park STP	13
4.	Mill River (E + W)	11
5.	Long Beach STP	13
	Middle Bay	
6.	LILCO Power Plant	14→9
7.	Oceanside Incinerator	9
8.	Parsonage Creek	18
9.	Milburn Creek	19
10.	East Meadow Brook	21
11.	Freeport Creek (tidal, fed by East Meadow Brook)	21
12.	Freeport STP	21
13.	Freeport Incinerator	21
	East Bay	
14.	Merrick Incinerator	22
15.	Jones Beach STP	34
16.	Newbridge Creek	23
17.	Bellmore Creek	40
18.	Cedar Swamp Creek	23
	South Oyster Bay	
19.	Seamans Creek	17
20.	Seaford Creek	17
21.	Massapequa River	41
22.	Carman Creek	51
	Great South Bay	
23.	Amityville Creek	52
24.	Woods Creek	52
25.	Great Neck Creek	53
26.	Strongs Creek	53
27.	Neguntatogue Creek	53
28.	Santapogue Creek	54
29.	West Brook	79
30.	Carlls River	54
31.	Park Ave. Apts.	54
32.	Harbor Club Apts.	54
33.	Sampawams Creek	55
34.	Willets Creek	55
35.	Skookwams Creek	55
36.	Trues Creek	56
37.	Watchogue Creek	76
38.	Penataquit Creek	76
39.	Awixa Creek	76
40.	Orowoc Creek	76
41.	Cascade Lakes	76
42.	Pardees Pond	76
43.	Champlin Creek	77
44.	Ocean Beach STP	68
45.	Connetquot River	79
46.	Green Creek	82
47.	Brown Creek	82
48.	Tuthills Creek	84
49.	Patchogue River	84
50.	Patchogue STP	84
51.	Watergate Garden Apts.	84
52.	Justus Roe	84
53.	Swan River	84
54.	Mud Creek	85
55.	Hedges Creek	85
56.	Beaverdam Creek	87
57.	Motts Creek	87
58.	Carmans River	89
59.	Rattlesnake Brook	79

(See Figures 1–13a and 13b for Point Source Locations).

1.5.8 Alternative Analyses for South Shore Bays

Table 1–11 gives a summary of all alternatives examined for the South Shore system. This is by far the most complex of all areas examined both from an ecological viewpoint and from the broad range of structural alternatives to be examined. At least 65 separate model runs have been carried out for this system. It must be remembered that almost all of Nassau County is already sewered, wheareas generally, only the western parts of Suffolk County are presently sewered. This reduces the number of alternatives available for Nassau County while increasing those for Suffolk County. As noted in Table 1–11, a series of regional, sub-regional and small plants are possible in Suffolk County.

Table 1–11

SUMMARY OF ALTERNATIVES EXAMINED FOR SOUTH SHORE BAYS

The Nassau County cases, consisting of several combinations of alternative flows, ocations and diversions were run separately from Suffolk County alternatives. Suffolk County cases were broken down into regional, sub-regional and small plants options and vere run with existing Nassau County average point source loadings as background.

Nassau County Loadings

Lawrence STP @ 1.0 MGD
West Long Beach @ 0.9 MGD
Jones Beach @ 0.2 MGD
Long Beach @ 8.0 MGD
Bay Park @ 75 MGD
Bay Park and Inwood and Cedarhurst and Great Neck Peninsula @ 84.5 MGD

Suffolk County Loadings

Use Nassau County discharges as background
Regional—Southwest Sewer District @ 30 and 54 MGD
—South Central District @ 31 MGD
Sub-Regional—Oakdale Sub @ 9 MGD
—Southeast Sub @ 5.0, 6.5 and 15 MGD
—Yaphank-South Sub @ 6.5 and 8.5 MGD
—With and without duck farms
Small Plants—Patchogue @ 0.5 MGD
—Watergate Apartments @ 0.02 MGD

Treatment Type and Effluent Characteristics

	BOD_5*	T. Nit.*	T. Phos.*	T. coli†
Secondary	30	30	4	400
Advanced	10	3	4	400

Discharge Locations

Nassau	Suffolk
East Rockaway Inlet	Atlantic Ocean
Long Beach STP	Bergen Point
Jones Beach STP	Nicolls Bay
Atlantic Ocean	Patchogue Bay
30–60 MGD recharge	Bellport Bay

** values in mg/L*
† values in MPN/100 ml

Point Sources for Moriches and Shinnecock Bays*

1. Jergielwiez Processing Plant—Forge River
2. Moriches Duck Farm—Forge River
3. Certified Duck Farm—Terrell River
4. Vigliotta North Farm—Terrell River
5. Vigliotta West Farm—Terrell River
6. Romanowski Duck Farm—Tuthill Cove
7. Vigliotta East Farm—Harts Cove
8. Long Island Co-Op Plant—Seatuck Creek
9. Powell Farm—Seatuck Creek
10. Tuttle Farm—East River

*Duck farms are the principal point sources of pollutant loading for Moriches Bay.

Table 1–12

ESTIMATED LOADINGS FROM DUCK FARMS AND NON-POINT SOURCES FOR MORICHES AND SHINNECOCK BAYS

	Moriches Bay (lbs/day)		Shinnecock Bay (lbs/day)	
Direct rainfall	N	292	N	253
	P	2	P	2
Stormwater run-off	N	188	N	63
	P	53	P	21
Streamflow	N	637*	N	35*
	P	95	P	8
Groundwater seepage	N	698*	N	175*
	P	155	P	39
Duck Farms	N	303	N	0
	P	(150)	P	0
Total	N	2118	N	526
	P	455	P	70

**Total inorganic nitrogen only*
( ) assumes an N/P ratio 0.5 for duck farm effluent

Table 1–13

PROJECTED POINT SOURCE ALTERNATIVES: COMPOSITION OF WASTES

Management Approach	Study Region and Bay	Alternatives	Flow MGD	BOD #/day	TSS #/day	Total-N #/day	Total-P #/day	Total-Coli MPN/day
Sub-Regional	S. E. Sub.	secondary	2.0	500	500	500	67	3.02×10^{10}
	Yaphank to	advanced	2.0	167	167	50	67	3.02×10^{10}
	Moriches	Duck Farms	4.0	double loads				
Small plant	Hampton Bays	secondary	2.0	500	500	500	67	3.03×10^{10}
	to Moriches	advanced	2.0	167	167	50	67	3.03×10^{10}
Small plant	East Hampton	secondary	1.5	375	375	375	50	2.27×10^{10}
	to Shinnecock	advanced	1.5	125	125	38	50	2.27×10^{10}
Small plant	East Quogue	secondary	1.75	438	438	438	58	2.65×10^{10}
	to Shinnecock	advanced	1.75	146	146	44	58	2.65×10^{10}

1.5.9 Alternative Analyses for Moriches–Shinnecock Bays

Treatment plant options and estimated loadings as proposed by the engineering consultants are shown in Table 1–13.

Non-point source loadings for this bay system include direct rainfall, stormwater run-off, streamflow, groundwater seepage and cesspool and septic tank leakage. Table 1–12 lists the relative contributions for both nitrogen and phosphorus from these sources and duck farms. The sources shown fall into two categories, transient and continuous. The continuous sources are of the greatest concern for the bay system. Even though tidal flushing is constantly diluting and removing part of the nutrient load from the system, it is apparent from averaged historical data that the larger continuous nutrient sources from streamflow, groundwater seepage and duck farm point sources are producing elevated nutrient levels in Moriches Bay.

Transient sources such as direct rainfall and stormwater run-off are of less importance to the bay nutrient budget. Since most of Moriches and Shinnecock Bays are well flushed by tidal action, much of the material from these sources will probably be moved out of the system within less than one week.

To reach their full impact, elevated nutrient levels must remain in the system long enough to allow for increased phytoplankton growth and resulting changes in diurnal oxygen concentrations. This phenomenon probably occurs only in the tidal portions of rivers feeding into the Moriches and Shinnecock Bays where flushing rates are lower than the bays'. Obviously, these are the least desirable areas for receiving future point and non-point source loadings.

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