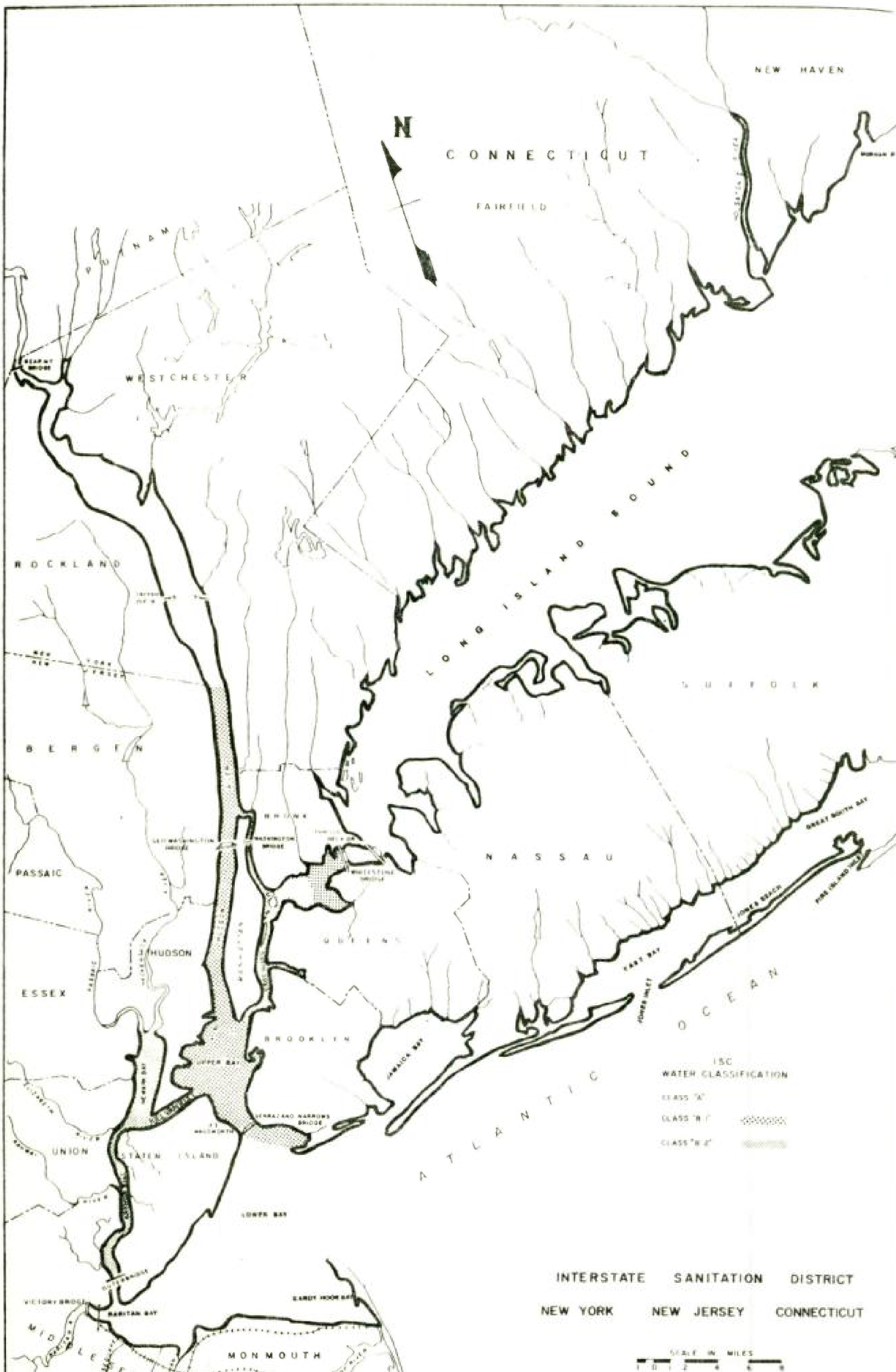
DISSOLVED OXYGEN ASSIMILATIVE CAPACITY IN THE NEW YORK HARBOR COMPLEX

Prepared by

INTERSTATE SANITATION COMMISSION

NEW YORK * NEW JERSEY * CONNECTICUT

March 1983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by

Interstate Sanitation Commission
10 Columbus Circle
New York, New York 10019

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Introduction

Pursuant to the Federal Clean Water Act, present requirements are for not less than secondary treatment of municipal wastewater and equivalent treatment for industrial discharges. However, an amendment to the Federal Clean Water Act (Section 301(h)) makes it possible for Publicly Owned Treatment Works (POTWs) to apply for permits allowing lesser treatment if they discharge into marine waters. To obtain such waivers of the secondary treatment requirement, it is necessary to satisfy a number of criteria designed to establish that there will be no adverse effect on the environment and that other dischargers will not have to increase their treatment to compensate.

Prior to the autumn of 1982, some communities had already applied for waivers pursuant to Section 301(h) and it was expected that others would follow. To provide some of the needed information on present and projected future water quality conditions in the New York Harbor Area, and to provide an improved basis for determinations in connection with proposals for lesser waste treatment, the Interstate Sanitation Commission (ISC) undertook to prepare this report. The United States Environmental Protection Agency (EPA) made a grant to the Commission of $20,000 to support the undertaking including contracting for runs utilizing the New York Harbor Water Quality Model developed under the New York City 208 Study. A steering committee composed of representatives from the New York State Department of Environmental Conservation (DEC), the New Jersey Department of Environmental Protection (DEP), the US EPA, and the ISC provided advice and information important to the conduct of the work leading up to this report. The Committee met frequently and took an active part at every stage up to preparation of the report. The ISC bears the responsibility for the report and its conclusions.

Dissolved oxygen and its companion parameter biochemical oxygen demand are key factors in determining what waste loadings waterbodies can reasonably accept. For that reason, a consulting firm (HydroQual, Inc.) was engaged to make specified runs on previously developed mathematical models for the New York Harbor Area shown on the map (See Chapter 2, Figure 1). The objective was to show whether, using presently applicable standards of water quality for the several parts of the New York Harbor Area, there is any unused assimilative capacity for dissolved oxygen, now and under foreseeable 1990 conditions. While a number of water quality conditions enter into assessment of possible options under Section 301(h), assimilative capacity for dissolved oxygen is being considered first. Only if unused capacity for that parameter exists, will it be useful to inquire further.

The agencies represented on the Steering Committee provided data inputs which were used in the model runs. They also reviewed the consultant's draft report and provided comments.

This present report of the ISC has used information developed by the consultant, agencies represented on the Steering Committee, and the knowledge and experience of the Commission itself.

The ISC wishes to thank all of the persons and agencies involved for their cooperation, both individually and as members of the Steering Committee.

Chapter 1. The Setting

The waters of the New York Harbor Area, as considered for the present purpose, include for the most part waters of New York and New Jersey. However, they include to some extent Western Long Island Sound where several communities also have applied for permission to treat wastewater in ways that would not meet existing effluent requirements and that could contribute to further stress on waters of interest to both New York and Connecticut.

It is common knowledge that the area involved comprises the largest population center in the nation and one of its most heavily industrialized regions. In 1981, point source wastewater discharges from POTWs contributed approximately 1.5 million pounds per day of BOD to the Region's waters. Additionally, large volumes of BOD entered the waterways from industries, combined sewer overflows and raw discharges.

During the past 10-15 years, there has been a marked improvement in the quality and quantity of waste treatment. From 1970 to 1982, public expenditures totaling approximately $5.1 billion have brought most of the volume of waste discharges of POTWs to the secondary treatment level. An additional $770 million will be spent on work presently in progress and a minimum of $1.1 billion will be needed for work now in the planning stages. Many private facilities also have upgraded their treatment or installed pollution control equipment where previously there was none. The objective has been to bring the facilities which do not yet afford secondary treatment or its equivalent to the requirement. This large and continuing effort participated in by federal, state and local governments, and by the private sector, has had significant results. It has raised the quality of the Region's waters to the point where many parts of the New York Harbor Complex meet appplicable standards for increasing portions of the most difficult summer months. Even in the most heavily contaminated areas, the season of substandard water quality conditions (at least so far as dissolved oxygen is concerned) has been materially shortened from approximately four months of the year to little more than two months of the summer's warmest water conditions. Overall, conditions still leave much to be desired if the objective is everywhere to achieve the quality characteristics associated in the standards with existing use classifications.

Subareas of the Region have been assigned different use classifications. Actual treatment given by point source dischargers also varies. All dischargers have been expected to bring their facilities up to the secondary treatment capability. Some have responded more rapidly and fully than others. Primary treatment is still provided by a number of the plants in New

Jersey across from New York City. Construction of the North River and Red Hook Plants and their operation up to the best levels of treatment attained elsewhere in the Harbor Area, will involve in the neighborhood of $1 billion for new construction and substantial outlays on a continuing basis for operations.

In addition, combined sewers account for large, but still inadequately measured discharges of untreated sewage and industrial wastes. Inadequate maintenance accounts for some of the problem during dry weather; flushing of accumulated deposits seriously aggravates it in times of precipitation. While the details of the problem vary in New York and New Jersey, it exists in both States.

Finally, it should be noted that this report examines only dissolved oxygen on a specific basis as a quality parameter. While there is a substantial amount of data on this and several other parameters, there are also data gaps which will affect the ability of the regulatory agencies to know fully what the effects of lessened treatment would be. As will be pointed out later in this report, even the conditions related to dissolved oxygen are not entirely known. A similar observation can be made for the other "conventional" parameters. Further, there is much less data on toxics in the Harbor Area and less known of the specific relationships of variations in treatment regimes to public health, marine biota, and other uses.

In addressing the issues which the US EPA, the States, and the ISC will face in the immediate and near future, many factors need to be considered. Dissolved oxygen content of the waterbodies is an essential element in determining water quality. However, the questions concerning degree of treatment and water quality are likely to be presented in terms of "more or less" rather than as absolutes.

Chapter 2. The Modeling and Its Results

As metioned in the introduction to this report, dissolved oxygen is a key factor in determining whether assimilative capacity exists in a waterbody. This is by no means the only factor that must be examined when considering waiver applications under Section 301(h) of the Federal Clean Water Act. However, if a waterbody does not have enough dissolved oxygen to meet all applicable water quality standards, it is clear that the water is already degraded below acceptable levels.

Besides dissolved oxygen, among other parameters that must be considered are: toxics (including synthetic organics and heavy metals), oil and grease, and coliforms. Further, the effects of these quality parameters, both singly and in combination, on the several uses of the area's waters need to be taken into account. It is also important to recognize the factors of human health and the proper maintenance of marine biota.

The evaluations in this report are based solely on dissolved oxygen assimilative capacity and can be used as a guide to determine whether applications for Section 301(h) waivers warrant further consideration.

In order to provide the States of New York and New Jersey and the US EPA - Region 2 with data regarding dissolved oxygen assimilative capacity, the Commission contracted with HydroQual, Inc. of Mahwah, N.J. to perform computer runs utilizing a steady-state water quality model. Some of the text in this chapter that relates to the model and the graphs resulting from the model runs are taken directly or paraphrased from HydroQual's report to the Commission (HydroQual, Inc., 1983).

The Model

The model used is the New York Harbor Water Quality Model originally developed for the Commission (Hydroscience, Inc., 1975). Improvemnts were made during the New York City 208 Areawide Wastewater Management Study (Hydroscience, Inc., 1978b) and an accompanying Rainfall/Runoff Model was developed (Hydroscience, 1978a). The results of the model runs were furnished to the Commission in the HydroQual report. One must bear in mind that the model is only a tool for developing information with which to address water quality management questions.

"The model is deterministic in nature and accounts for the cause-and-effect relationships between wastewater inputs and water quality impacts ... [It] is advective-dispersive in nature and is based on the mass balance concept ... The model is segmented vertically into two layers in the Hudson River from the

Narrows upstream to the Bear Mountain Bridge. This vertical segmentation is necessary to account for the two-layer density induced circulation pattern and observed water quality stratification which exists in the Hudson River. Elsewhere the model is vertically homogeneous and is segmented horizontally both longitudinally and laterally, to account for water quality variations." (HydroQual, Inc., 1983, p. 2-1) The outputs generated by the model estimate mid-tidal seasonally averaged conditions.

Average values generated as outputs from the model cannot be directly compared to the "never less than" values that are required by applicable water quality standards. As work done during the New York City 208 Project showed, it is necessary to subtract 1.0 mg/l from the average dissolved oxygen values calculated by the model to obtain "never less than" values that can be compared to the existing dissolved oxygen requirements. The graphs presented later in this chapter were developed by the consultant, except that this 1.0 mg/l adjustment has been made.

To run the model, carbonaceous BOD values are required for the following types of wastewater loadings: POTW discharges, raw discharges, industrial discharges, bypasses, leakages, combined sewer overflow discharges, and storm drain discharges. Additionally, information on rainfall and water temperatures is required. These inputs were developed by the Steering Committee and supplied to the contractor. The 1981 loads were based on actual 30 day BOD effluent averages for that year. For 1990, the BOD loads were based on the more stringent 30 day average of 30 mg/l or 85% removal (definition of secondary treatment).

It must be noted that certain inputs or model characteristics are much better defined than others. The loadings from POTWs and industries are fairly well-known. Loadings from combined sewers and the benthic deposits are less well-defined. Although limited sampling has been done over the years, much work remains to be done in order to obtain a better data base for these oxygen-demanding sources.

Another data input about which little is known is instream nitrification. "... no nitrification was evident in New York Harbor during any of the calibration/verfication periods." (HydroQual, 1983, p. 2-38) At this time, it is not known whether instream nitrification will occur in the future.

Model Sensitivity

Analyses were performed during this study and during the NYC 208 Project to determine model sensitivity to various factors. The results of these analyses are as follows. "... the effect of transport changes is most pronounced in the Hudson River (which receives the greatest freshwater flow of all the harbor waterways)." (HydroQual, 1983, p. 2-31) During the NYC 208 Project, model runs were made holding everything constant except flow. A baseline flow condition of 7600 cubic feet per second (cfs), and two additional flow conditions, 3200 cfs and 18,400 cfs were used to test transport sensitivity of the model. Under the latter two conditions, dissolved oxygen at the critical point (the point of lowest dissolved oxygen) in the Hudson River varies from 0.5 - 1.0 mg/l from the baseline. In other harbor locations the variability was within 0.5 mg/l. Therefore, "... the choice of freshwater flow can be of significance in any potential wasteload allocation analysis." (Ibid)

It was concluded that from sensitivity analyses performed during the NYC 208 Project "... that nitrification would have lowered dissolved oxygen values at critical locations throughout the harbor by 1.0 - 1.5 mg/l depending upon the rate of oxidation." (HydroQual, 1983, p. 2-33) The oxidation rate was varied from 0.0 - 0.1/day at 20 degrees C.

During this project, tests performed on the BOD oxidation coefficient showed little sensitivity to that factor -- approximately 0.2 - 0.3 mg/l of dissolved oxygen when the coefficient was varied from 1/2 to 1 1/2 times the baseline value used. These tests were run for 1990 with all POTWs at secondary treatment. When the temperature regime was varied ± 5 degrees F from the assumed 1990 summer conditions, the dissolved oxygen values predicted by the model varied by approximately 0.5 mg/l from the baseline values.

Model runs were performed to show the effect of varying CSO/storm drainage loadings using the NYC 208 Rainfall/Runoff (R/R) Model. The model predicts dissolved oxygen deficits attributable to the amount of rainfall. For instance, the R/R Model estimates that in the Hudson River the dissolved oxygen deficit ascribed to a normal summer rainfall is up to 0.37 mg/l; in the East River it is up to 0.53 mg/l; and in the Arthur Kill up to 0.65 mg/l. Increased rainfall would increase the dissolved oxygen deficit approximately in proportion to the rainfall.

The choice of boundary conditions, that is, the loadings entering the model area at its boundaries, is important. Although these values can be measured on a current basis, they are estimated for model runs predicting future conditions. The model shows the East River to be particularly sensitive to boundary conditions. Model runs under somewhat comparable conditions yielded lower dissolved oxygen concentration results in this study than in the NYC 208 Project. This occurred because the boundary conditions for the East River during the NYC 208 Project arbitrarily assumed a lower (approximately 1/2 the value) dissolved oxygen deficit entering the system. The boundary conditions used during this study were the same as those used for verification of the model.

The sensitivity analyses described in this section are solely for the purpose of illustrating how the model predictions react to changes of the factors discussed. Later in this report comments will be made on the relationship between the model runs and values for these factors that can be expected realistically to occur.

Alternative CSO Estimation Methods

A weakness in present efforts to have the model simulate combined sewer influences is that, compared to the total size and extent of the Region's combined sewer systems, few samplings of combined sewer discharges have ever been made. Throughout the years, it has been the contention of the Commission that during dry weather, sewage settles and is stored in the combined sewers in New York. This belief is based on several facts: (1) the cross-sectional areas of many of the New York CSOs are very large and many CSOs have flat bottoms; (2) the New York City POTWs, for the most part, have weak influent concentrations; and (3) the POTWs in New Jersey generate approximately three times as much sludge per gallon of sewage as do the New York City POTWs. Of course, dry weather settling in the New Jersey CSOs also may be significant, but the problem is believed to be nowhere near the magnitude of that in New York. The stored sewage is flushed from the CSOs during wet weather and causes a lowering of the dissolved oxygen in the waterways. As an alternative to conducting a combined sewer overflow sampling study, at the present time, a "paper" study was conducted during this project.

Three different methods of estimating BOD loadings from combined sewer overflow discharges were investigated during this project: the NYC 208 Rainfall/Runoff (R/R) Model, a formula utilized by the Steering Committee and a formula developed by HydroQual. The latter two formulas assume that organic material settles and is stored in the New York City and Yonkers sewerage systems during dry weather; the R/R Model does not. The assumption under which all three methods were applied to the model runs is that there is no settling in the New Jersey combined sewers. The Steering Committee and HydroQual formulas were run with two different theoretical influent concentrations to the New York POTWs: 150 mg/l and 225 mg/l. Actual POTW influent concentrations were used for the New Jersey sources. The formula utilized by the Steering Committee assumes that the wet weather concentration to the CSOs will be 1/2 the dry weather concentration. The formula also assumes that during dry weather, 85% of the difference between the theoretical and actual POTW influent concentrations is settling in the sewer lines. The HydroQual formula is derived from a mass balance analysis and assumes that the concentration of BOD in the CSO discharges is the same as that entering the POTWs during wet weather. It is postulated that the aforementioned concentrations include the effects of previously stored BOD. This could be the case either if there were no deposits of solids in the sewers or if, during periods of combined sewer overflow, the solids removed from the sewer bottoms were distributed evenly between the flows reaching the treatment plants and the flows discharged through regulators and so not reaching treatment plants.

Results obtained by employing each of the three methods were calculated for 1981 summer conditions which had an average rainfall of 0.12 inches/day. The combined sewer overflow BOD discharges produced by the R/R Model, the HydroQual formula, and the forumla utilized by the Steering Committee at an assumed 150 mg/l BOD New York influent concentrations were, respectively, 350,000 lbs/day, 433,000 lbs/day and 830,000 lbs/day.

Sufficient observed data which could verify any of these three estimates have not been gathered. The R/R and Steering Committee formulas stand at opposite ends of the spectrum. The former rests on a factually untenable no settling - no discharge supposition; the latter is perhaps an upper limit of what may occur. The HydroQual formula yields a result standing part way between these extremes, but closer to that of the R/R estimate. However, its hypothesized wet weather discharges are arbitrarily assigned in order to make the calculations possible.

As explained above, there is controversy concerning the facts about deposition of solids in the Region's combined sewers. In doing the modeling for 1981, each of the three fomulas for estimating combined sewer discharges of biochemical oxygen demand was used. In the runs relating to predicted 1990 conditions, and so in the 1990 graphs, only the R/R Model's combined sewer formulation was used. An idea of the different results that would be yielded by application of each of the three formulas to calculate dissolved oxygen maximum deficits attributable to wet weather combined sewer discharges can be obtained from Table 1. If either the HydroQual formula or the formula utilized by the Steering Committee had been used for the 1990 runs, the predicted dissolved oxygen deficits would be larger.

Strengths and Limitations of the Model

Because the model is a steady-state mathematical approximation of a natural system and its predictions are for mid-tidal seasonally averaged conditions, certain limitations must be kept in mind. However, this model has been used for present purposes because it is the only available predictive tool which gives reasonably complete coverage of the desired area.

Although the model results reasonably reproduce observed

Table 1
Maximum Predicted Dissolved Oxygen Deficits Produced by Wet Weather BOD Loadings from Combined Sewer Overflows Using Three Alternate Estimation Methods

Waterway	Maximum Dissolved Oxygen Deficit (mg/l)		
	Rainfall/ Runoff Model	HydroQual Formula	Formula Utilized by the Steering Committee
Hudson River	0.37	0.52	1.45
East River	0.53	0.81	2.12
Arthur Kill	0.65	0.73	0.76

Notes: (1) All 3 methods assume rainfall for an average summer to be 0.12 inches/day

(2) The HydroQual formula and the formula utilized by the Steering Committee assume that the concentration of BOD generated during dry weather is 150 mg/l

data in some areas, there are certain locales where the predictions consistently deviate from observed data. "One such area is the Hudson River adjacent to Manhattan. The model reasonably well reproduces the average dissolved oxygen value in the lower layer at the critical point [the point of lowest dissolved oxygen] in the profile, but generally tends to overestimate lower layer oxygen values upstream of this location. In a similar manner, the model often tends to underestimate dissolved oxygen values in the upper layer of the Hudson River." (HydroQual, 1983, p. 2-35) In Raritan Bay, the model consistently underestimates dissolved oxygen by 1 to 2 mg/1 when compared to observed data.

At the time when this study was done, and when the consultant operated the Model for it, 1981 was the most recent year for which information was fully available. The model runs executed for the study, so far as they dealt with that year, did so in two ways. Some of the graphs below depict 1981 dissolved oxygen conditions throughout the harbor area. Actual waste loadings from that year and observed data for flow, temperature, and other parameters already noted were employed. On these bases, the model was operated to calculate dissolved oxygen in all of the 425 segments comprising the total study area. In testing the model against observed dissolved oxygen conditions for those points where actual sampling and analyses were done in 1981, and in making checks with similar work done during the New York City 208 Study, the facts concerning the performance of the model in the several waterways of the area were ascertained. This is the basis on which it has already been said that the model simulates actual water quality conditions better in some parts of the harbor area than in others.

In addition to filling out the depiction of dissolved oxygen conditions throughout the entire area, a model run was made to provide answers to another set of circumstances. Actual 1981 conditions were assumed except that upgrading construction then still in progress, was taken as though completed and in operation.

For 1990, a series of assumptions were made. The first of them is that the cardinal requirement for secondary treatment would be met by all POTWs by that time and that all industrial discharges would be made under conditions of best practical treatment (BPT), as the Clean Water Act now mandates. A limited number of other assumptions also were made as alternative scenarios. These are discussed more specifically in connection with the graphs on which the model runs employing these scenarios are depicted.

Despite the absence of knowledge concerning some relevant factors, the model runs provide useful analyses that give an approximation of what conditions are and might be in the future. There is likely to be controversy over how much latitude for error should be allowed in utilizing the dissolved oxygen values calculated from the model, but it does provide functional information.

Results of Model Runs

This study uses the results of the model runs to assess harborwide dissolved oxygen. Figure 1 shows the model area and the 425 segments into which it is divided. Figure 2 shows the location of the centerline plotting transects, that is the segments whose values are plotted on the graphs in this chapter. The transect plots presented on the graphs are useful as overviews. However, in order to obtain a full account of the dissolved oxygen conditions, as developed by the model runs, the conditions in all the waterway segments must be considered. The tables accompanying the graphs show the following for each waterbody: the number and percent of segments not meeting dissolved oxygen standards, the low dissolved oxygen value and the segment(s) where it occurs, and the amount of excess assimilative dissolved oxygen capacity, if any.

Unless otherwise specified, the following assumptions apply to all graphs. The benthic demands were the same as used during the NYC 208 Project. An average summer rainfall of 0.12 inches/day was used to determine CSO loadings using the R/R Model. On the Hudson River transects, only plots of the bottom layer (the layer with lower dissolved oxygen values) are shown. In all plots the minimum dissolved oxygen values are shown, that is the average values calculated by the model minus 1.0 mg/l. These are the values that can be compared to existing water quality standards. For all graphs for 1990, the industrial loads are taken to be the Best Practical Treatment (BPT). Leakage loads for both years were calculated using the NYC 208 methodology, but updated with 1981 data. Bypass loads were used for 1981, but were assumed not to exist for 1990.

Figure 3 shows two plots for the summer of 1981. In both cases, the industrial loadings were the actual values for that year. However, for POTW loadings one curve uses the actual 1981 loads and the other uses the same loads but upgraded, assuming work in progress was already completed (PVSC at 30 mg/l and Red Hook and North River at an assumed 65 mg/l). The latter set of conditions was used for illustrative purposes. These plots, used in conjunction with Tables 2 and 3, show that violations of water quality requirements occur in many areas throughout the harbor complex under both sets of conditions.

Figure 4 shows 1990 summer projections with all POTWs at secondary treatment. Using Table 4 and Figure 4, it can be seen

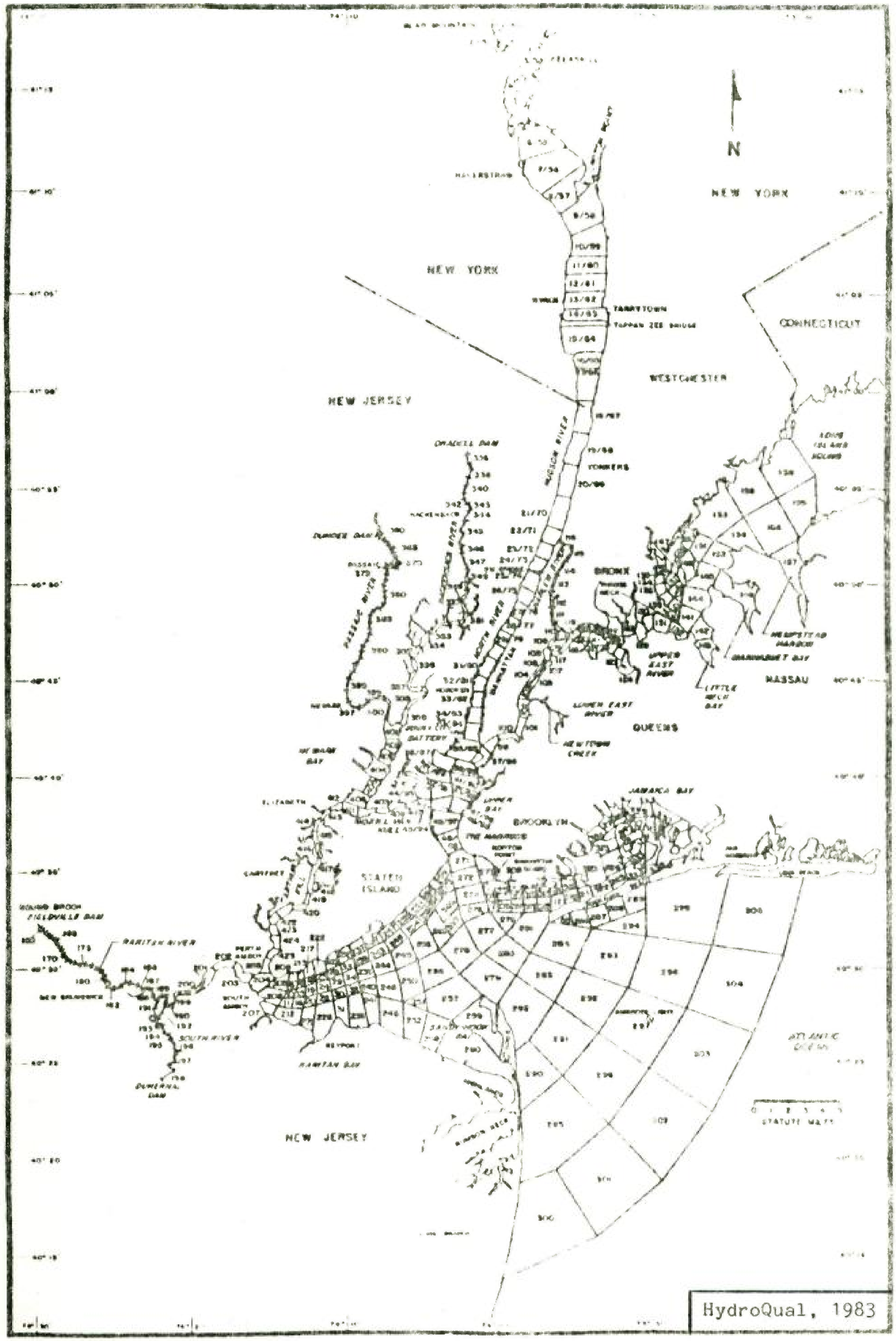


Figure 1
New York City 208 Mathematical Model Area and Segmentation

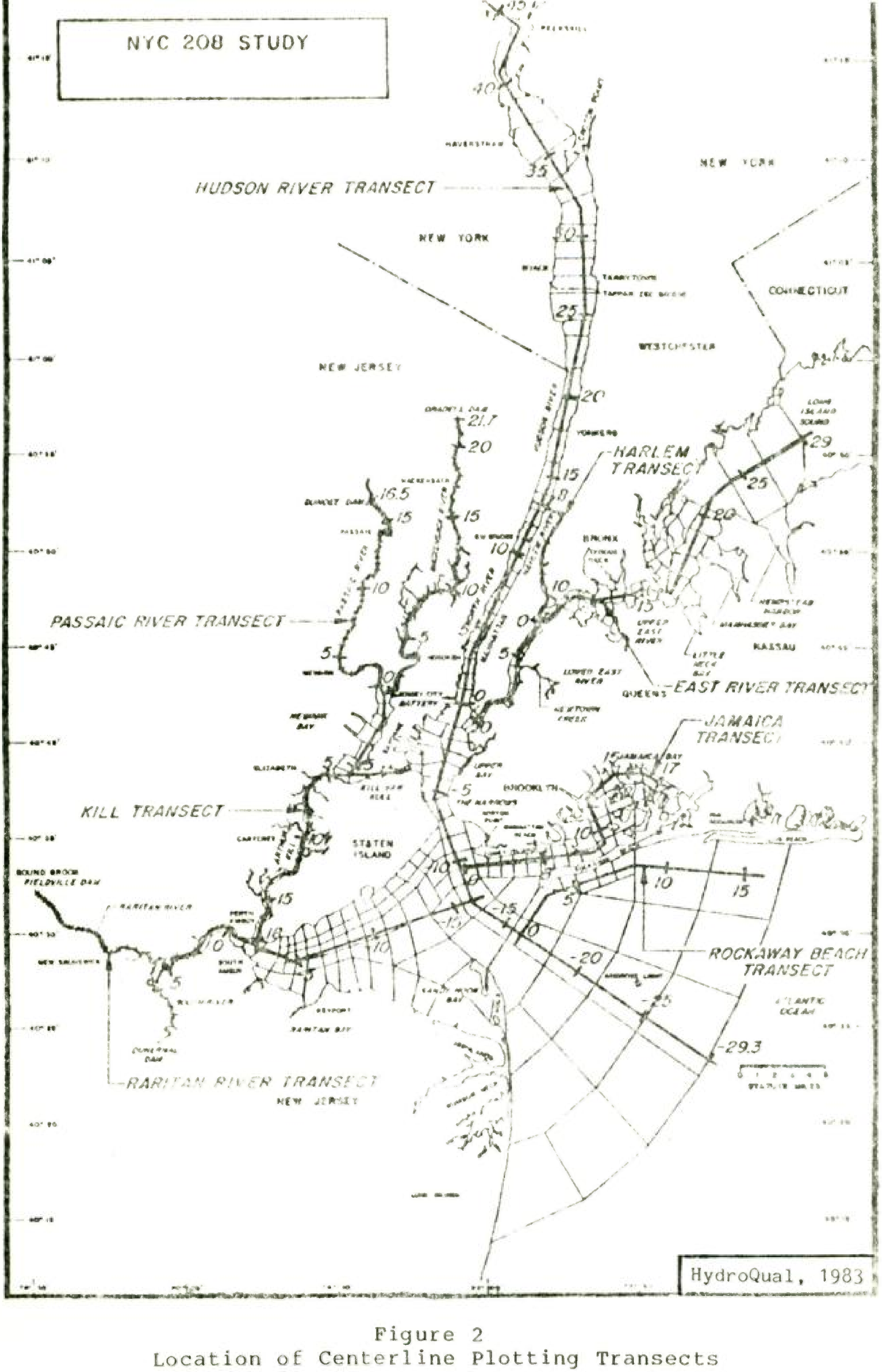


Figure 2
Location of Centerline Plotting Transects

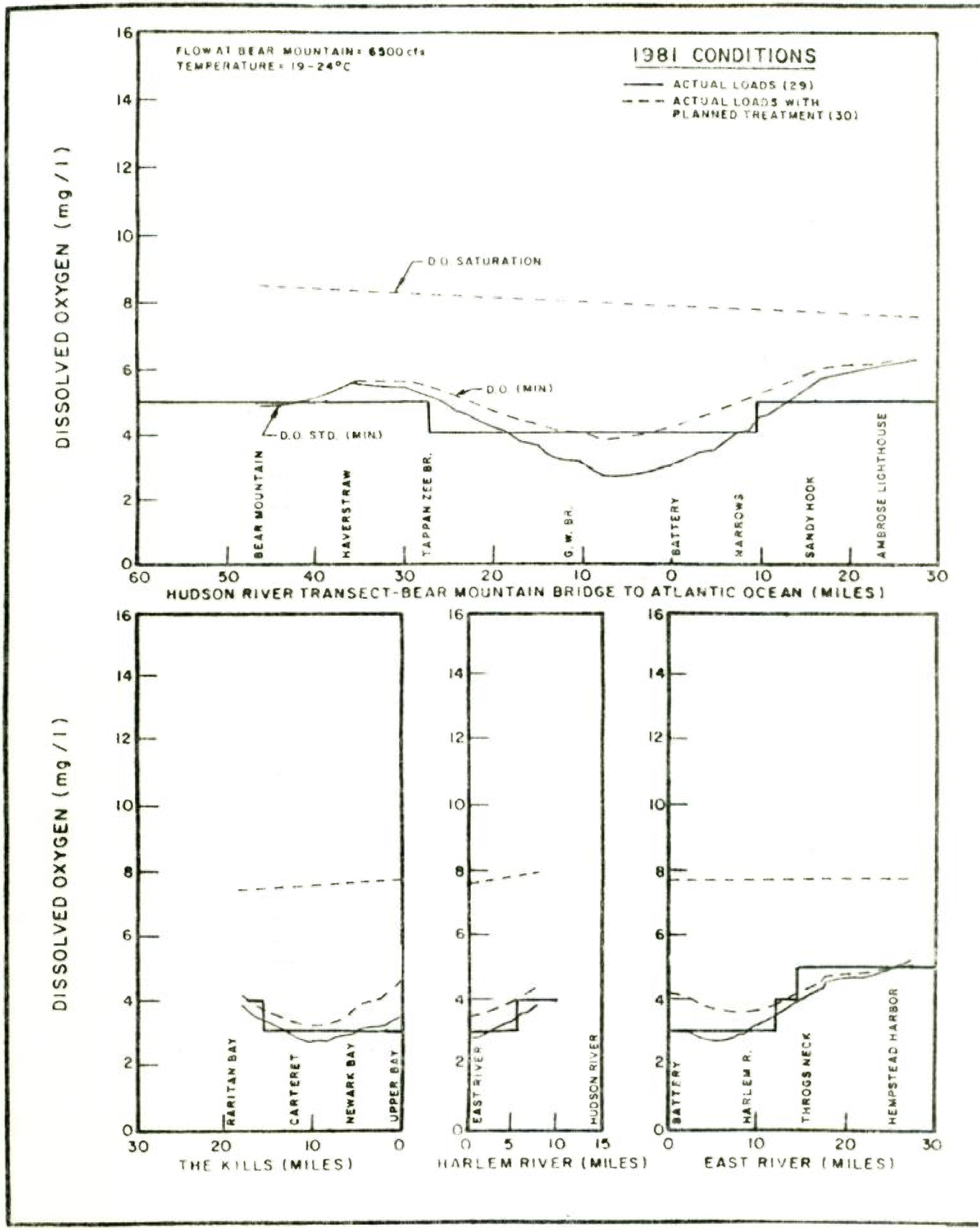


Figure 3a
1981 Summer Projected Seasonal Minimum Dissolved Oxygen Profiles

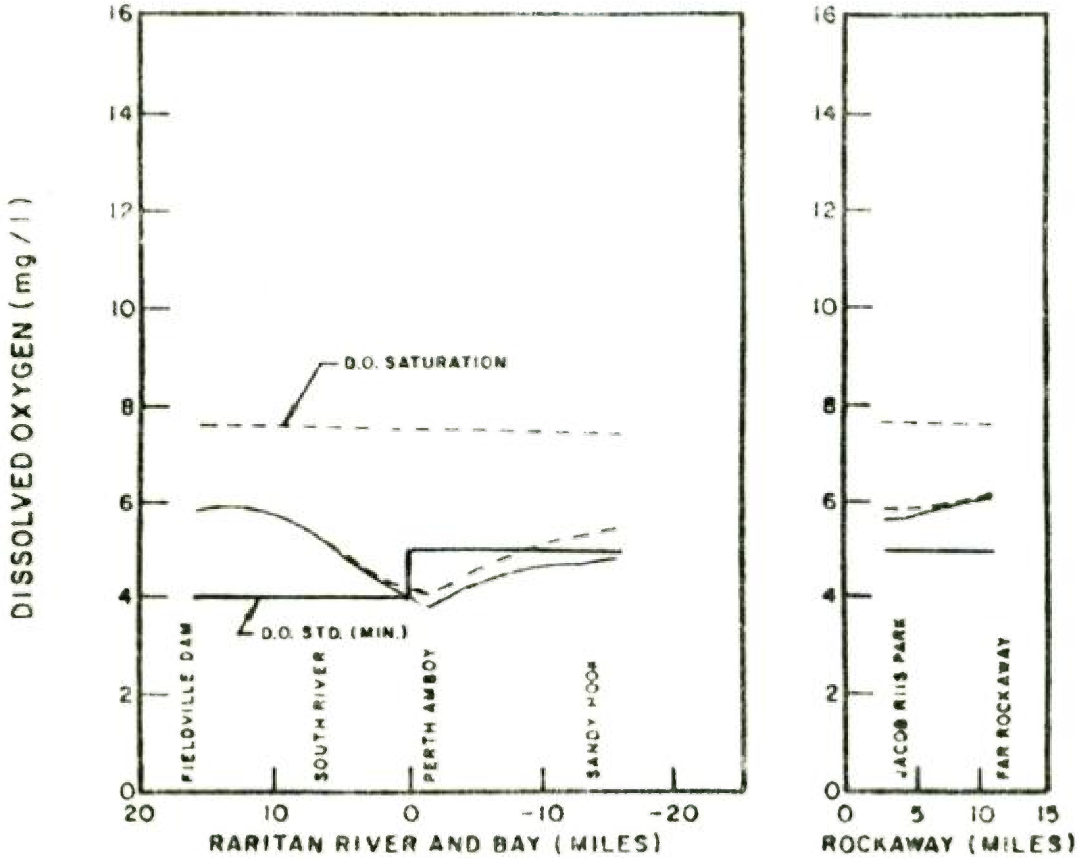


Figure 3b
1981 Summer Projected Seasonal Minimum Dissolved Oxygen Profiles

Table 2
1981 Summer Conditions with Actual Loadings (1)(2)

Waterway	Number of Segments	D.O. Requirement (mg/l)	Segments Below D.O. Requirement		Lowest Predicted D.O. (mg/l)		Predicted Available D.O. Capacity (mg/l) (3)
			Number	%	Value	Segment	
Hudson River (4)	36	4	27	75	2.71	79	-1.29
	34	5	4	12	4.68	66	-0.32
Upper N.Y. Bay	28	4	28	100	3.10	37,39, 86	-0.90
Lower N.Y. Bay	3	4	0	0	4.03	271	+0.03
	32	5	21	66	4.12	269	-0.88
Newark Bay	6	3	1	17	2.77	401	-0.23
Kill Van Kull	5	3	0	0	3.05	411	+0.05
Arthur Kill	14	3	10	71	2.57	418	-0.43
	1	4	1	100	3.48	268	-0.52
Raritan Bay	50	5	46	92	3.76	204	-1.24
Sandy Hook Bay	2	5	0	0	5.17	259	+0.17
Atlantic Ocean	24	5	0	0	5.64	282	+0.64
Rockaway Inlet	7	5	0	0	5.08	322	+0.08
Jamaica Bay	6	4	0	0	4.60	330	+0.60
	7	5	5	71	4.61	331	-0.39
East River	19	3	13	68	2.71	104,105	-0.29
	6	4	6	100	3.36	124	-0.64
	3	5	3	100	3.93	130	-1.07
Harlem River	3	3	0	0	3.09	111	+0.09
	3	4	3	100	3.49	114	-0.51
Western L.I. Sound (5)	27	5	22	81	4.35	141	-0.65

Notes: (1) Model Run Conditions:
CSO loadings determined using NYC 208 R/R Model with an average rainfall of 0.12 inches/day; POTW loadings = actual 1981 values; industrial loadings = actual 1981 values; leakage loadings calculated with NYC 208 methodology but updated with 1981 data; bypass loadings determined from 1981 data; and benthic loadings used from NYC 208

(2) Run 29 from HydroQual Report

(3) A plus sign (+) denotes the mg/l that the lowest D.O. value is above the D.O. requirement; a minus sign (-) denotes the mg/l that the lowest D.O. value is below the D.O. requirement

(4) Bear Mountain to the Battery

(5) Including Little Neck Bay, Manhasset Bay and Hempstead Harbor

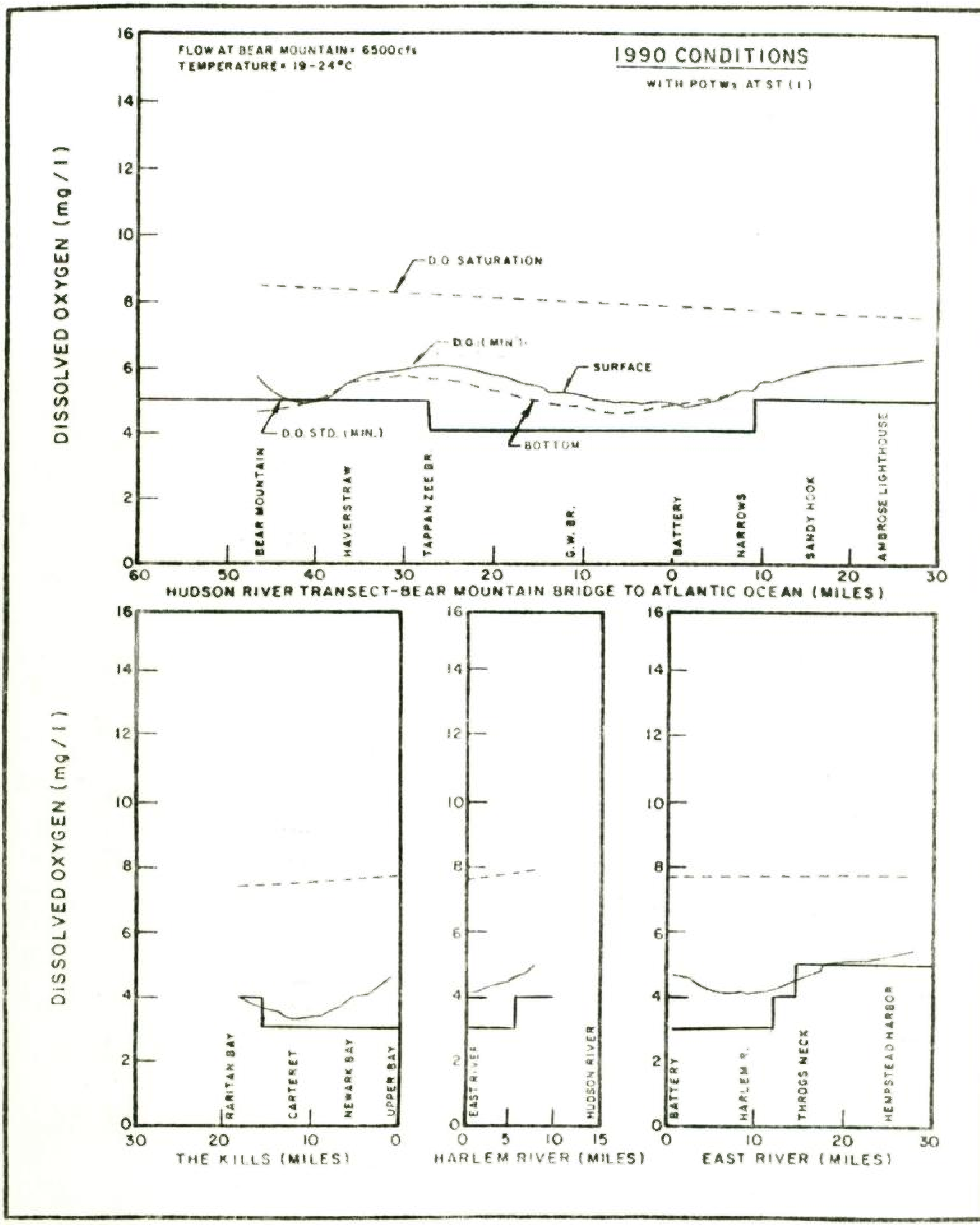


Figure 4a
1990 Summer Projected Seasonal Minimum Dissolved Oxygen Profiles

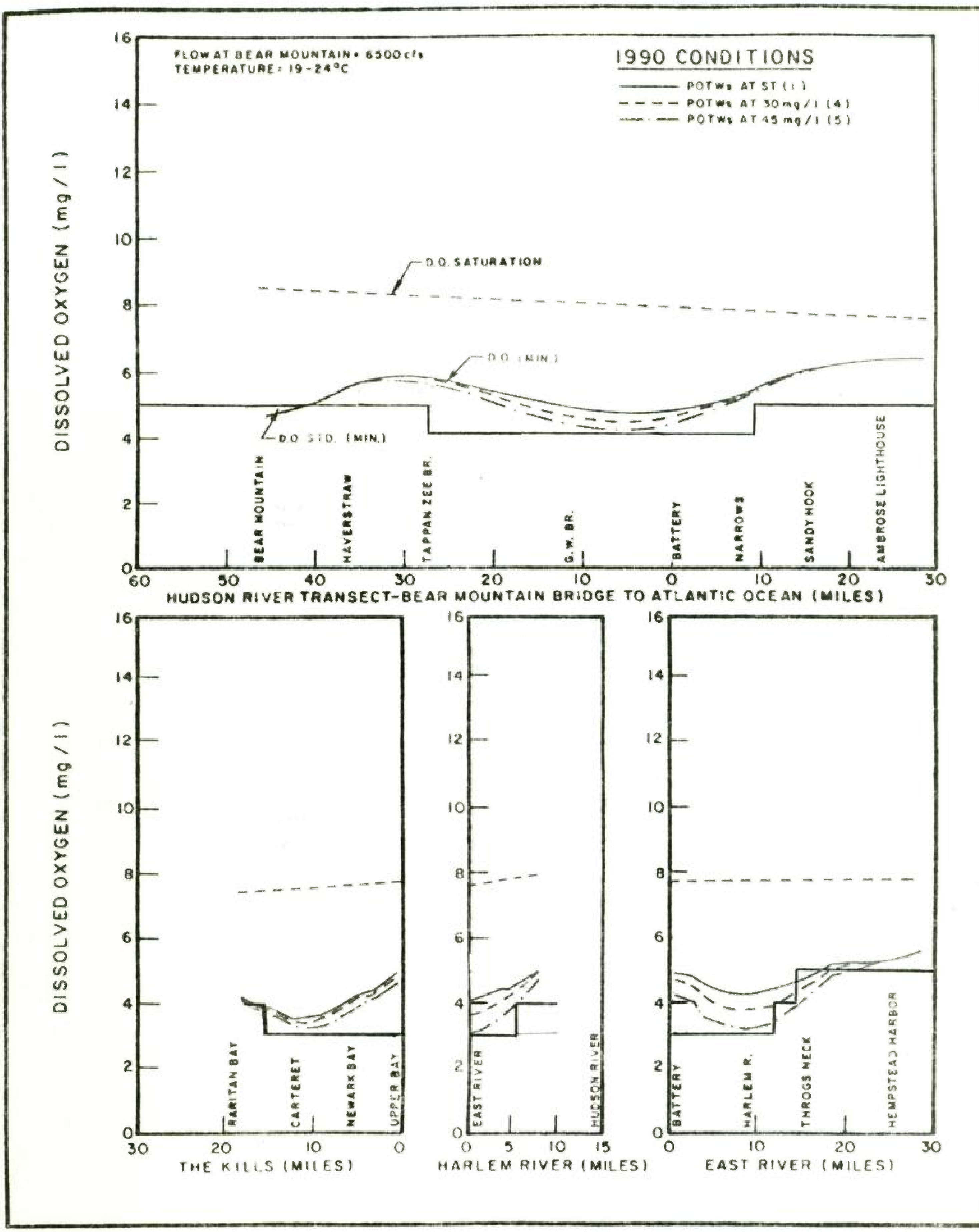


Figure 5a
1990 Summer Projected Seasonal Minimum Dissolved Oxygen Profiles

that with all POTWs at secondary treatment, only a few areas still would violate the standards.

As an illustration of what might occur with less than secondary treatment at all POTWs during the summer, Figure 5 and Tables 5 and 6 show decreased values of dissolved oxygen with the POTWs uniformly at 30 mg/l and at 45 mg/l. The 30 mg/l conditions cause a greater portion of the Region's waters to violate standards than if treatment plants were operating at full secondary treatment. The 45 mg/l conditions cause even greater violations of standards compared to the 30 mg/l conditions.

As an example of what might occur with less than secondary treatment at some POTWs during the summer, Figure 6 compares two assumed scenarios with secondary treatment. One scenario assumes secondary treatment at all POTWs except for Red Hook and North River where 65 mg/l is assumed for their effluents. The other assumes secondary treatment except for 60% BOD removal at the following POTWs: North River, Red Hook, Newtown Creek, Hunts Point, Bowery Bay, Wards Island, Passaic Valley, and each Hudson County POTW. As with the illustration showing less than secondary treatment at all plants, this scenario shows that less than secondary treatment, at only selected plants during the summer, degrades the waters below standards over a wider region than with secondary treatment.

A good case could have been made for not attempting to ascertain at this stage of the work how less than secondary treatment in 1990 would affect assimilative capacity. However, from their previous experience in the Region, the members of the Steering Committee anticipated that the modeling probably would show variations in the several subareas of the harbor. While modeling was being done, they wished to gain some impressions as to what might happen if some deviations in conformity to the universal secondary treatment requirement were allowed under Section 301(h). It was considered that deviations of at least two types might occur:

1. All POTWs might be allowed to remove somewhat less biochemical oxygen demand than allowed by the present definition of full secondary treatment; or

2. Some plants might receive waivers of some kind under Section 301(h) while others might not.

The runs assuming all POTWs discharging at 30 and 45 mg/l were made to illustrate the first possibility; the run assuming 8 "major" dischargers to be permitted waivers was made to illustrate what might happen if a truly significant fraction of the Region's total POTW effluents would receive less than secondary treatment. The work was scoped in this way without any effort

Table 4
1990 Summer Conditions with Secondary Treatment (1)(2)

Waterway	Number of Segments	D.O. Requirement (mg/l)	Segments Below D.O. Requirement: Number	%	Lowest Predicted D.O. (mg/l): Value	Segment	Predicted Available D.O. Capacity (mg/l) (3)
Hudson River (4)	36	4	0	0	4.63	77	+0.63
	34	5	6	18	4.68	50	-0.32
Upper N.Y. Bay	28	4	0	0	4.84	39,86	+0.84
Lower N.Y. Bay	3	4	0	0	5.29	273	+1.29
	32	5	0	0	5.33	248,269	+0.33
Newark Bay	6	3	0	0	3.71	401	+0.71
Kill Van Kull	5	3	0	0	4.22	411	+1.22
Arthur Kill	14	3	0	0	3.41	418	+0.41
	1	4	0	0	4.01	268	+0.01
Raritan Bay	50	5	32	64	4.22	204	-0.78
Sandy Hook Bay	2	5	0	0	5.70	259	+0.70
Atlantic Ocean	24	5	0	0	6.00	282,285	+1.00
Rockaway Inlet	7	5	0	0	5.47	322	+0.47
Jamaica Bay	6	4	0	0	4.83	330	+0.83
	7	5	1	14	4.85	331	-0.15
East River	19	3	0	0	4.14	118	+1.14
	6	4	0	0	4.26	124	+0.26
	3	5	3	100	4.64	130	-0.36
Harlem River	3	3	0	0	4.35	111	+1.35
	3	4	0	0	4.69	114	+0.69
Western L.I. Sound (5)	27	5	5	19	4.92	141,142	-0.08

Notes:

(1) Model Run Conditions:
CSO loadings determined using NYC 208 R/R Model with an average rainfall of 0.12 inches/day; POTW loadings = secondary treatment; industrial loadings = Best Practical Treatment (BPT); leakage loadings calculated with NYC 208 methodology but updated with 1981 data; bypass loadings assumed not to exist; and benthic loadings used from NYC 208

(2) Run 1 from HydroQual Report

(3) A plus sign (+) denotes the mg/l that the lowest D.O. value is above the D.O. requirement; a minus sign (-) denotes the mg/l that the lowest D.O. value is below the D.O. requirement

(4) Bear Mountain to the Battery

(5) Including Little Neck Bay, Manhasset Bay and Hempstead Harbor

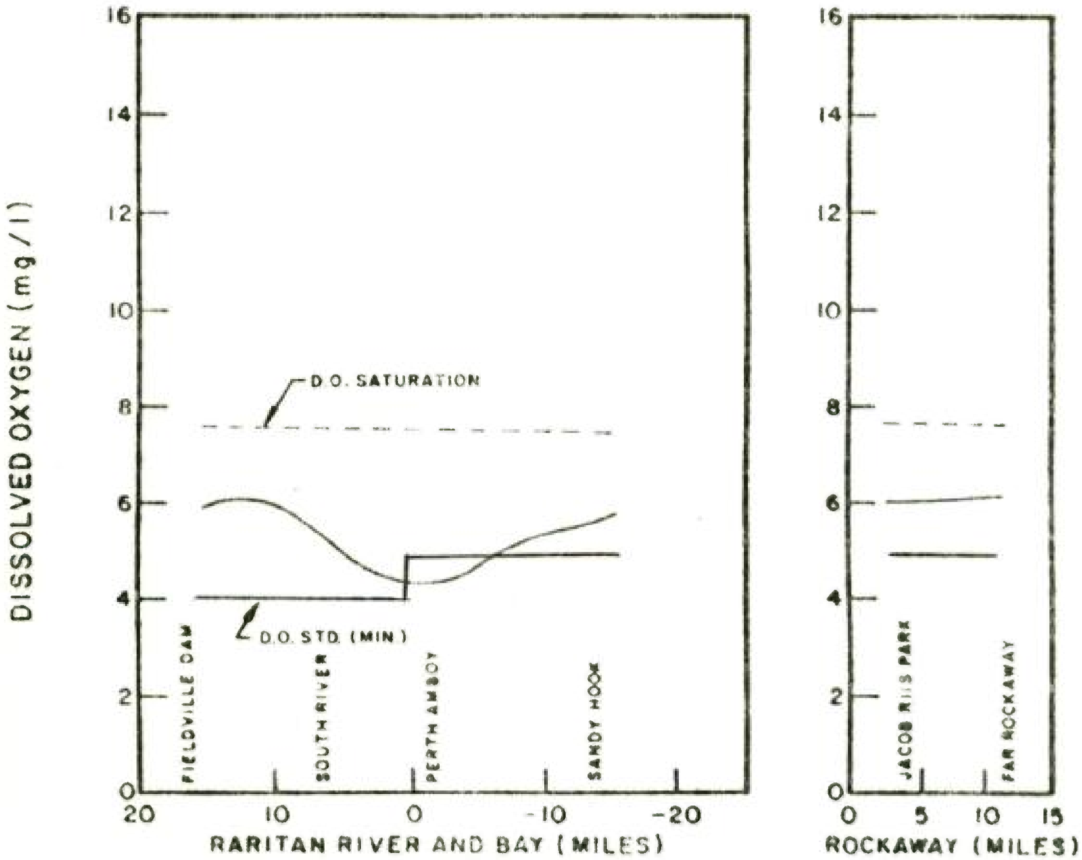


Figure 4b
1990 Summer Projected Seasonal Minimum Dissolved Oxygen Profiles

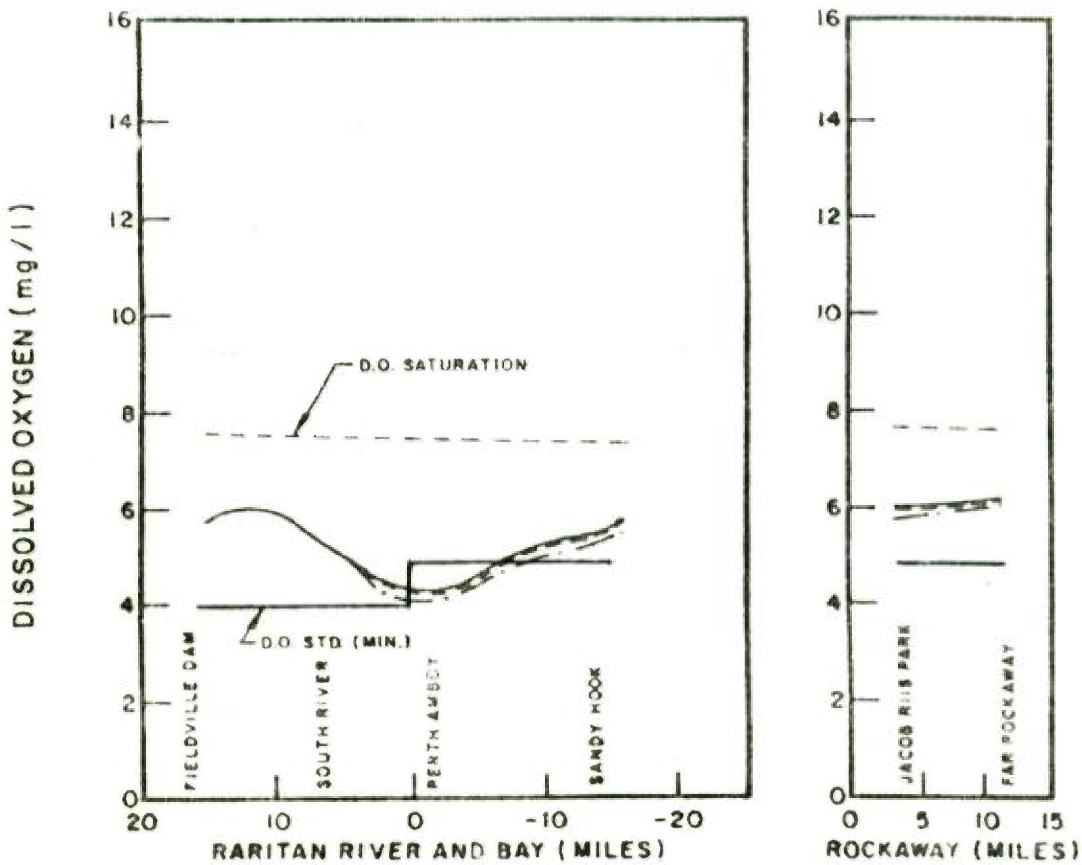


Figure 5b
1990 Summer Projected Seasonal Minimum Dissolved Oxygen Profiles

Table 5
1990 Summer Conditions with POTWs at 30 mg/l (1)(2)

Waterway	Number of Segments	D.O. Requirement (mg/l)	Segments Below D.O. Requirement		Lowest Predicted D.O. (mg/l)		Predicted Available D.O. Capacity (mg/l) (3)
			Number	%	Value	Segment	
Hudson River (4)	36	4	0	0	4.35	77	+0.35
	34	5	6	18	4.66	50	-0.34
Upper N.Y. Bay	28	4	0	0	4.54	37,86	+0.54
Lower N.Y. Bay	3	4	0	0	5.15	273	+1.15
	32	5	0	0	5.18	269	+0.18
Newark Bay	6	3	0	0	3.65	401	+0.65
Kill Van Kull	5	3	0	0	4.10	411	+1.10
Arthur Kill	14	3	0	0	3.34	418	+0.34
	1	4	1	100	3.97	268	-0.03
Raritan Bay	50	5	35	70	4.18	204	-0.82
Sandy Hook Bay	2	5	0	0	5.65	259	+0.65
Atlantic Ocean	24	5	0	0	5.96	282,285	+0.96
Rockaway Inlet	7	5	0	0	5.31	322	+0.31
Jamaica Bay	6	4	0	0	4.60	330	+0.60
	7	5	2	29	4.62	331	-0.38
East River	19	3	0	0	3.55	118	+0.55
	6	4	5	83	3.71	124	-0.29
	3	5	3	100	4.26	130	-0.74
Harlem River	3	3	0	0	3.86	111	+0.86
	3	4	0	0	4.34	114	+0.34
Western L.I. Sound (5)	27	5	13	48	4.68	141,142	-0.32

Notes: (1) Model Run Conditions:
CSO loadings determined using NYC 208 R/R Model with an average rainfall of 0.12 inches/day; POTW loadings = 30 mg/l; industrial loadings = Best Practical Treatment (BPT); leakage loadings calculated with NYC 208 methodology but updated with 1981 data; bypass loadings assumed not to exist; and benthic loadings used from NYC 208

(2) Run 4 from HydroQual Report

(3) A plus sign (+) denotes the mg/l that the lowest D.O. value is above the D.O. requirement; a minus sign (-) denotes the mg/l that the lowest D.O. value is below the D.O. requirement

(4) Bear Mountain to the Battery

(5) Including Little Neck Bay, Manhasset Bay and Hempstead Harbor

Table 6
1990 Summer Conditions with POTWs at 45 mg/l (1)(2)

Waterway	Number of Segments	D.O. Requirement (mg/l)	Segments Below D.O. Requirement		Lowest Predicted D.O. (mg/l)		Predicted Available D.O. Capacity (mg/l) (3)
			Number	%	Value	Segment	
Hudson River (4)	36	4	2	7	3.97	77	-0.03
	34	5	6	18	4.64	50	-0.36
Upper N.Y. Bay	28	4	0	0	4.16	37	+0.16
Lower N.Y. Bay	3	4	0	0	4.93	273	+0.93
	32	5	1	3	4.98	269	-0.02
Newark Bay	6	3	0	0	3.41	401	+0.41
Kill Van Kull	5	3	0	0	3.83	411	+0.83
Arthur Kill	14	3	0	0	3.10	418	+0.10
	1	4	1	100	3.80	268	-0.20
Raritan Bay	50	5	37	74	4.04	204	-0.96
Sandy Hook Bay	2	5	0	0	5.56	259	+0.56
Atlantic Ocean	24	5	0	0	5.90	283,285	+0.90
Rockaway Inlet	7	5	0	0	5.11	322	+0.11
Jamaica Bay	6	4	0	0	4.32	330	+0.32
	7	5	6	86	4.34	331	-0.66
East River	19	3	1	5	2.97	118	-0.03
	6	4	6	100	3.19	124	-0.81
	3	5	3	100	3.89	130	-1.11
Harlem River	3	3	0	0	3.36	111	+0.36
	3	4	1	33	3.95	114	-0.05
Western L.I. Sound (5)	27	5	20	74	4.45	141	-0.55

Notes: (1) Model Run Conditions:
CSO loadings determined using NYC 208 R/R Model with an average rainfall of 0.12 inches/day; POTW loadings = 45 mg/l; industrial loadings = Best Practical Treatment (BPT); leakage loadings calculated with NYC 208 methodology but updated with 1981 data; bypass loadings assumed not to exist; and benthic loadings used from NYC 208

(2) Run 5 from HydroQual Report

(3) A plus sign (+) denotes the mg/l that the lowest D.O. value is above the D.O. requirement; a minus sign (-) denotes the mg/l that the lowest D.O. value is below the D.O. requirement

(4) Bear Mountain to the Battery

(5) Including Little Neck Bay, Manhasset Bay and Hempstead Harbor

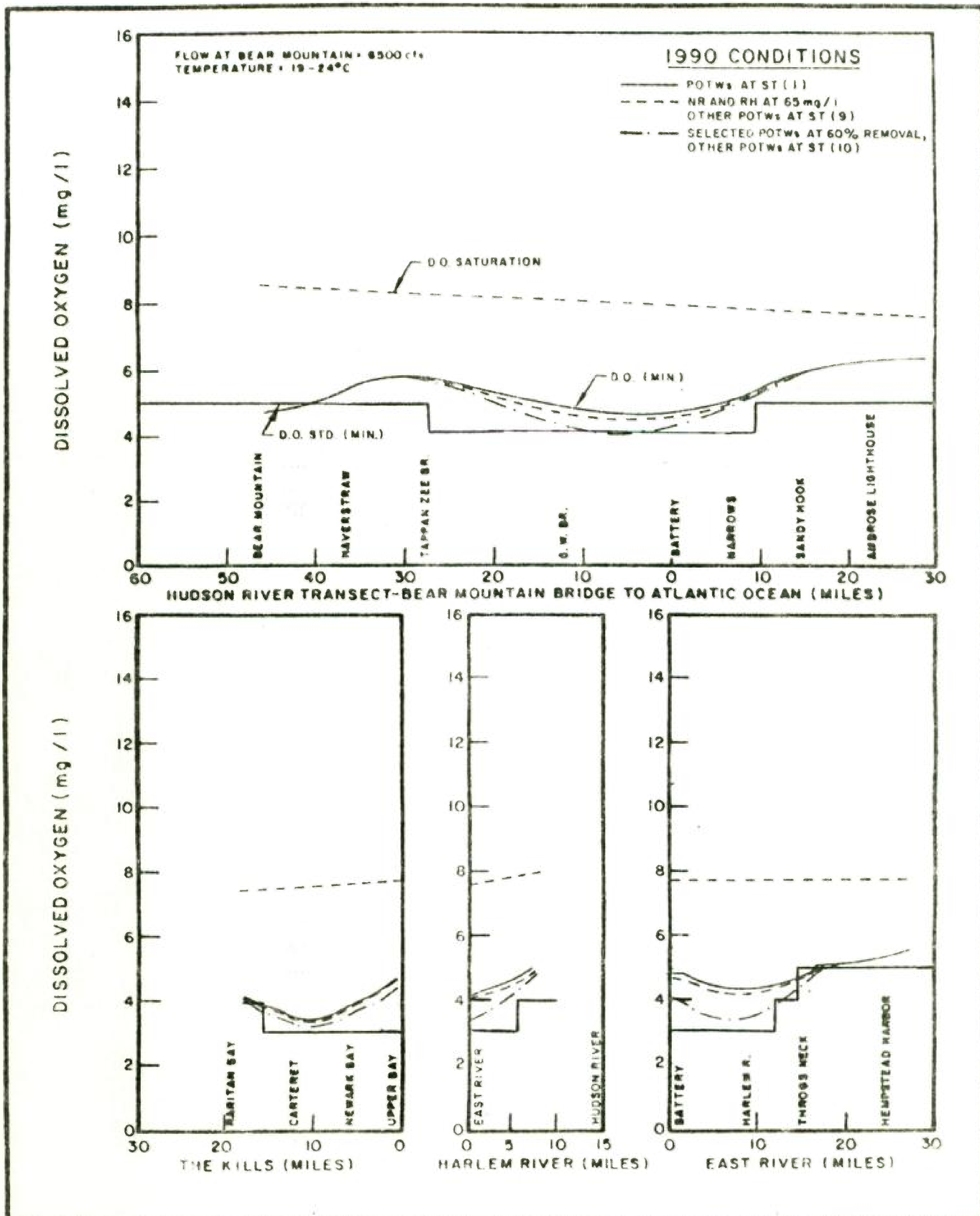


Figure 6a
1990 Summer Projected Seasonal Minimum Dissolved Oxygen Profiles

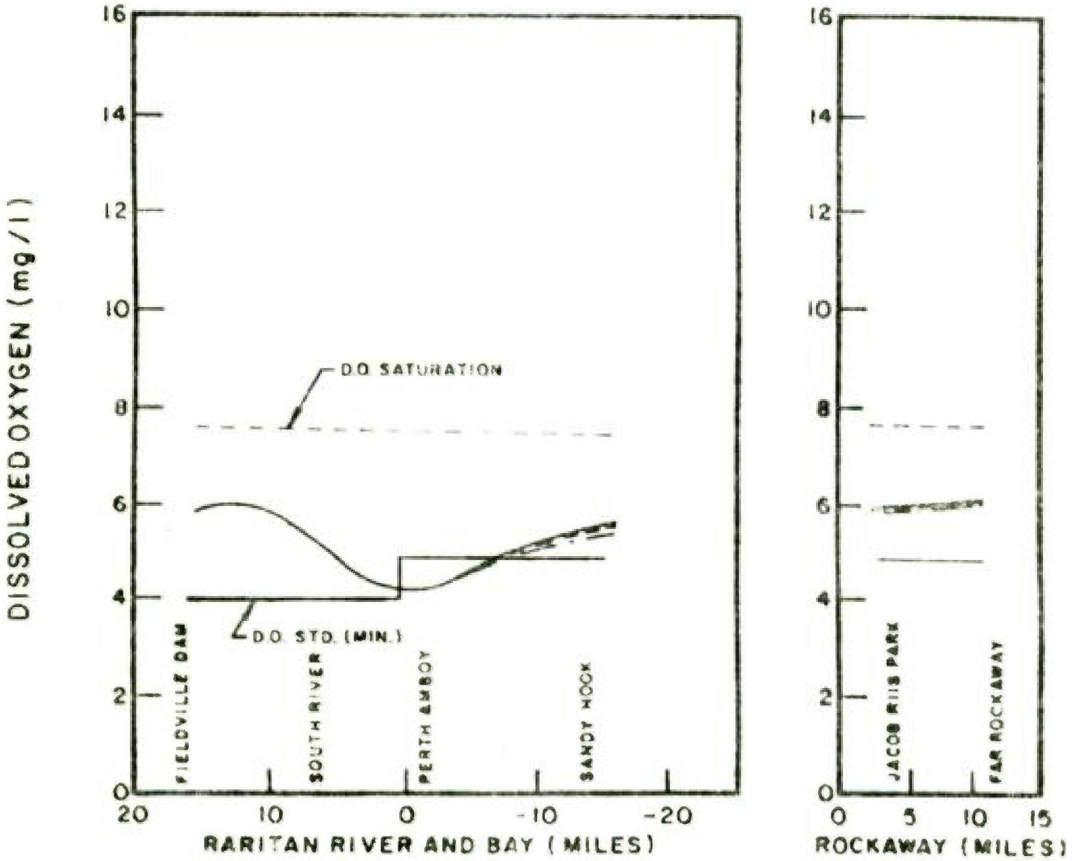


Figure 6b
1990 Summer Projected Seasonal Minimum Dissolved Oxygen Profiles

to assess the merits or equity considerations involved in either approach.

As previously discussed, alternate methods of CSO load estimates and sensitivity analysis of CSO loads due to rainfall were examined. The long-term average summer rainfall in the model area, and the summer rainfall during 1981 (used for baseline conditions), is 0.12 inches/day. During the NYC 208 Project, summer rainfall records were examined for 1948 through 1975. The wettest summer had an average rainfall of approximately 0.19 inches/day. Four other summers had average rainfalls of approximately 0.17 inches/day. The 0.24 inches/day used to demonstrate model sensitivity is not likely to occur. However, 0.17 inches/day is a summer rainfall average that experience shows will occur from time to time in the future. It can be considered as a "rainy summer" condition. Calculations were made to determine the additional dissolved oxygen deficit that would occur at this rainfall when compared with a 0.12 inches/day rainfall using the NYC 208 R/R Model which does not account for BOD deposition in the CSOs. These further deficits of dissolved oxygen that would result during a rainy summer occur in almost all model segments and would increase the deficits by approximately 0.1 - 0.2 mg/l. In Newark Bay the additional deficit would be 0.45 mg/l.

Water quality projections for winter and transitional periods of the year must be examined. Figure 7 and Table 7 show 1990 winter projections with all POTWs at secondary treatment for winter conditions (2 - 7 degrees C harborwide). Two other temperature regimes were also examined -- 10 degrees C and 15 degrees C with POTW effluents of 30 mg/l of BOD harborwide. Figure 7 shows lower dissolved oxygen values when the POTWs were assumed to be at 30 mg/l effluent BOD across the board and the season was a transitional time of year, that is with the area's waters at 10 and 15 degrees C. In all cases, dissolved oxygen requirements were met throughout the harbor complex.

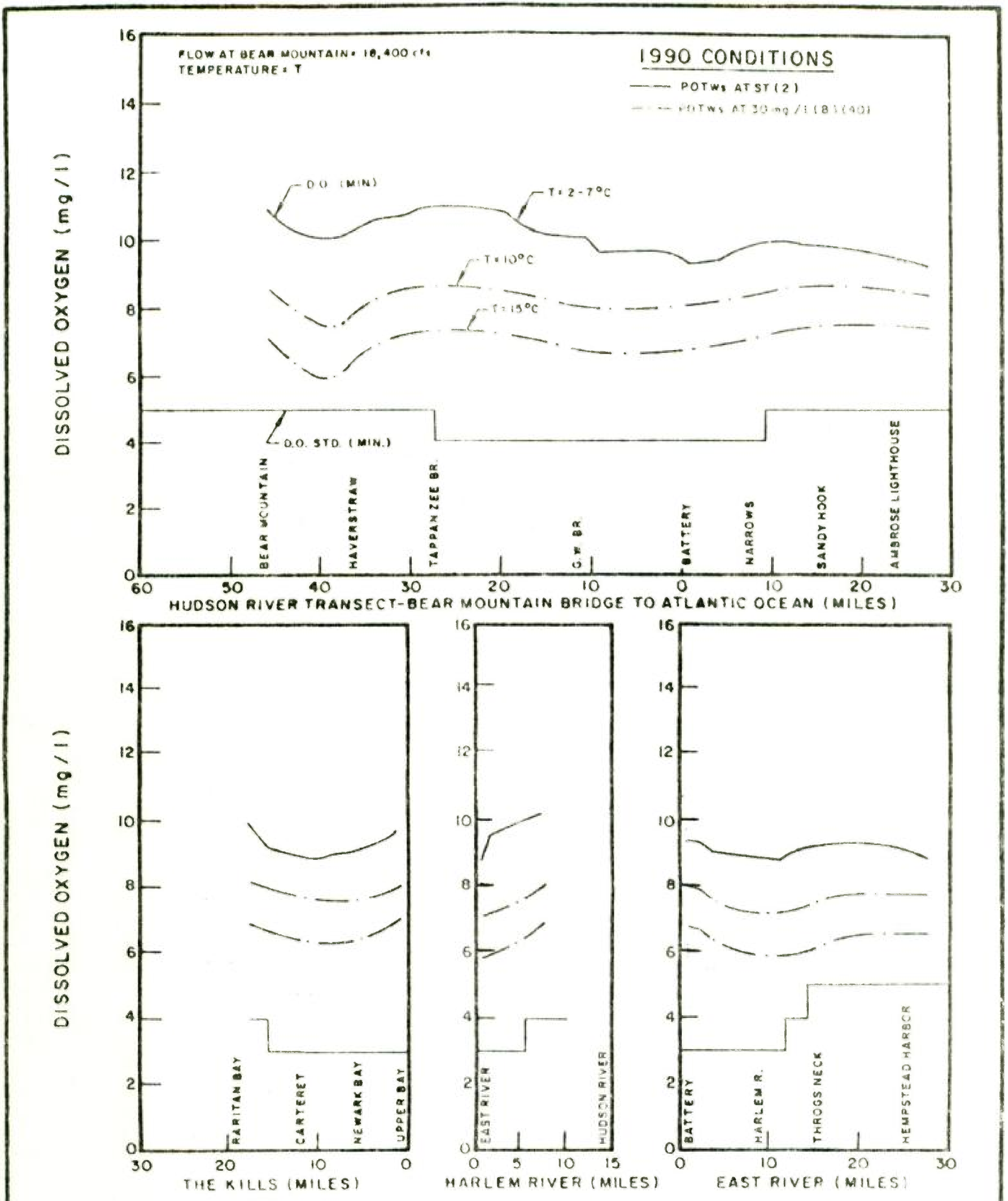


Figure 7a
1990 Winter Projected Seasonal Minimum Dissolved Oxygen Profiles

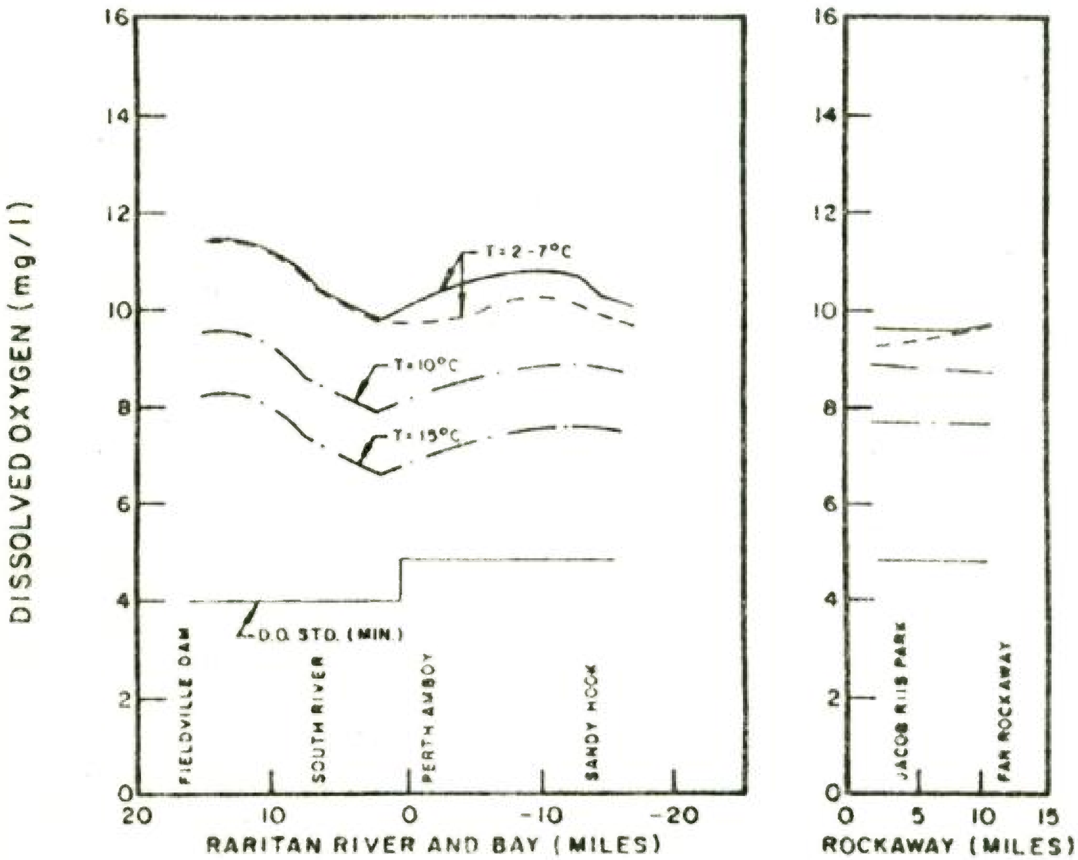


Figure 7b
1990 Winter Projected Seasonal Minimum Dissolved Oxygen Profiles

Table 7
1990 Winter Conditions with Secondary Treatment (1)(2)

Waterway	Number of Segments	D.O. Requirement (mg/l)	Segments Below D.O. Requirement		Lowest Predicted D.O. (mg/l)		Predicted Available D.O. Capacity (mg/l) (3)
			Number	%	Value	Segment	
Hudson River (4)	36	4	0	0	9.68	79	+5.68
	34	5	0	0	10.04	55	+5.04
Upper N.Y. Bay	28	4	0	0	9.26	85	+5.26
Lower N.Y. Bay	3	4	0	0	9.85	271	+5.85
	32	5	0	0	9.70	306	+4.70
Newark Bay	6	3	0	0	8.37	401	+5.37
Kill Van Kull	5	3	0	0	9.10	411	+6.10
Arthur Kill	14	3	0	0	8.75	417	+5.75
	1	4	0	0	9.61	268	+5.61
Raritan Bay	50	5	0	0	9.72	307	+4.72
Sandy Hook Bay	2	5	0	0	11.17	259	+6.17
Atlantic Ocean	24	5	0	0	9.28	301	+4.28
Rockaway Inlet	7	5	0	0	9.93	317	+4.93
Jamaica Bay	6	4	0	0	11.16	330	+7.16
	7	5	0	0	11.17	331	+6.17
East River	19	3	0	0	8.71	121	+5.71
	6	4	0	0	8.69	124	+4.69
	3	5	0	0	9.22	130	+4.22
Harlem River	3	3	0	0	9.72	111	+6.72
	3	4	0	0	10.02	114	+6.02
Western L.I. Sound (5)	27	5	0	0	8.92	158,159	+3.92

Notes: (1) Model Run Conditions:
CSO loadings determined using NYC 208 R/R Model with an average rainfall of 0.12 inches/day; POTW loadings = secondary treatment; industrial loadings = Best Practical Treatment (BPT); leakage loadings calculated with NYC 208 methodology but updated with 1981 data; bypass loadings assumed not to exist; and benthic loadings used from NYC 208

(2) Run 2 from HydroQual Report

(3) A plus sign (+) denotes the mg/l that the lowest D.O. value is above the D.O. requirement; a minus sign (-) denotes the mg/l that the lowest D.O. value is below the D.O. requirement

(4) Bear Mountain to the Battery

(5) Including Little Neck Bay, Manhasset Bay and Hempstead Harbor

Chapter 2 - References

HydroQual, Inc., January 1983. New York Harbor: Model Run Data for Water Quality Management Alternatives.

Hydroscience, Inc., March 1978a. New York City 208 Task Report 225.

Hydroscience, Inc., March 1978b. New York City 208 Task Report 314.

Hydroscience, Inc., October 1975. Development of a Steady-State Water Quality Model for New York Harbor.

Chapter 3. Assimilative Capacity

Virtually any discharges of wastes into the waters of New York Harbor and vicinity will affect their quality. Small discharges of relatively innocuous substances may have so little effect as to be imperceptible. Similarly, some small changes in the composition and volume of waste loadings may have little or no significant effects. However, the waters receive literally hundreds of small discharges, as well as large ones. The problem in many respects is the aggregations and their cumulative effects.

In the New York Harbor Area, the discharges from sewage treatment plants and industrial outfalls are both varied and very large. Thus, small individual variations in composition and volume may not be noticeable without thorough monitoring, although even miniscule amounts of some toxics could be very harmful. However, in this area, pristine purity is not the realistic issue. Many waterbody segments are below the minimum requirements of existing standards; others are marginal, and still others are in relatively good condition. However, it is also true that the use classifications are not the same throughout the Region. The local population relies heavily on its waters for recreation, including the primary contact with the waters involved in swimming and use of small boats. Fish survival and fish propagation are designated uses, although the high dissolved oxygen content required for the latter is not expected everywhere in the Harbor area. Moreover, some uses are less directly affected than others by the dissolved oxygen parameter.

The analyses presented in Chapter 2 show distinctly different results for warm water and cold water portions of the year. The present dissolved oxygen standards of 3 mg/l, 4 mg/l, or 5 mg/l (depending on the use classification of the waters involved) are minimum values which are required to be met at all times. However, it is well-known that cold water can retain more oxygen than warm water. Even more, warm temperatures stimulate biological activity in the waters to the point where oxygen is depleted much more rapidly than it can be replenished. The model runs done for this study reflect these circumstances. They show that with regionwide water temperatures ranging from 19 to 24 degrees centigrade (taken to be ordinary summertime conditions), distinctly less dissolved oxygen is present than when the waters are at 10 or 15 degrees centigrade. Even higher values for dissolved oxygen were shown to exist when the model was run with regionwide temperatures ranging from 2 to 7 degrees centigrade -- a midwinter condition.

The question to be answered is whether the area's waters have the capacity to assimilate additional biochemical oxygen demand without falling below the dissolved oxygen content of 3 mg/l, 4 mg/l or 5 mg/l as the case may be. Since both the standards and the values calculated by the model are numerical, one method of answering the question would be simply to compare the model results for the Region as a whole and for its individual segments or waterways with the 3 mg/l, 4 mg/l and 5 mg/l requirements. Any numbers over the applicable required value would be available assimilative capacity. Comparing lower readings with the applicable standard would show the amount of dissolved oxygen deficit which must be made up before available assimilative capacity would begin to appear.

However, as shown at a number of places in this report, the present calculations have necessarily been made without full knowledge of all relevant factors. For this reason, usable excess assimilative capacity is available when the model results show a reasonable plus margin in comparison to the minimum standard applicable to the particular waters.

Under summertime conditions no unused assimilative capacity is available at present nor, for all practical purposes, is it expected with all discharges receiving secondary treatment. This does not mean that all calculated values for dissolved oxygen shown by the 1981 and 1990 model runs are below the 3, 4 or 5 mg/l requirements of the applicable standards. However, it does mean that in portions of the Greater New York Harbor Complex this is the case, or that relatively small margins above the minimum requirements are predicted to exist.

For example, the East River adjacent to Long Island Sound is not predicted to achieve the minimum applicable standard, even with all of the Region's treatment facilities at full secondary treatment. The Hudson off Manhattan shows an average value of 0.63 mg/l over the minimum requirement. The most severely stressed parts of the Arthur Kill would barely make the standard, and Raritan Bay would exhibit a borderline condition. But, it must be remembered that these depictions are based on assumed "normal" temperature conditions and rainfall for an ordinary summer. They also rely on use of the Rainfall/Runoff Model which minimizes the effects of combined sewer overflows. If the summer is hotter than usual, or wetter than usual, or worse still, if the summer is both hot and rainy, the margins in many of the places where the model shows them to exist must be expected to decrease or disappear.

The differences in the results can be illustrated by varying the assumed conditions, but keeping them within reasonable ranges. If one takes the critical point in the Hudson River; the stretch of the East River, which under the model's calculations for this study showed the meeting of the applicable 4 mg/l standard; and most of the Arthur Kill, the following would be predicted to occur:

1. Hudson River - the surplus of 0.63 mg/l with 2 degrees F above baseline water temperatures shrinks to 0.40 mg/l; with an increase to 0.17 inches of rainfall it shrinks to 0.48 mg/l; with both the increased temperature and rainfall it shrinks still further to 0.25 mg/l.

2. East River - the surplus of 0.26 mg/l with 2 degrees F warmer than baseline water temperatures becomes 0.02 mg/l; with an increase to 0.17 inches of rainfall it becomes 0.04 mg/l; with both the increased temperature and rainfall the surplus changes to a deficit of 0.20 mg/l.

3. Arthur Kill - the surplus of 0.41 mg/l with 2 degrees F warmer than baseline water temperatures becomes 0.15 mg/l; with an increase to 0.17 inches of rainfall it becomes 0.14 mg/l; with both the increased temperature and rainfall the surplus changes to a deficit of 0.12 mg/l.

These figures are obtained by interpolating results of HydroQual model run numbers 17 and 20 for rainfall and run numbers 1 and 14 for temperature.

Further, if any of the factors not taken into account by the model should be present in 1990, the dissolved oxygen calculations would show even lower values. These factors include potential interseasonal effects of benthal deposits, nitrification, and a more realistic accounting for combined sewer discharges.

It is apparent that under winter conditions there is a great deal of assimilative capacity. In the intermediate seasons, there is somewhat less. Whether this should mean anything for possible treatment regimes at the Region's POTWs is a question that can be answered properly only after the situation is specifically assessed. Present requirements do not allow for seasonal variation, except in some instances with respect to disinfection. New standards that would allow for lesser treatment during some or all of the cold water period of the year cannot fruitfully be discussed in general terms. It is necessary to know with reasonable precision how much available capacity there would be at various times during the cold water season and how the operations of treatment plants might be adjusted on a practicable basis to take advantage of the temperature variations without harm to the environment.

The conclusions reached in this chapter must be understood within the context of the postulates set for the model runs. Some of the factors not considered have been pointed out. However, there is a large question which has not been touched upon. Should policymakers or technicians suppose that limited numbers and types of forgivenesses from secondary treatment for POTWs would be the only results of relaxing requirements between now and 1990?

The Clean Water Act, regulations under it, and complementary state practices and procedures contain other routes for obtaining exceptions to treatment requirements. Industrial point sources can obtain variances on a number of grounds. Generally speaking, some of them are analogous to the criteria for waivers pursuant to Section 301(h). Others may be even more broadly construed to allow deviations from secondary treatment equivalency when there is said to be insufficient justification for putting an industrial establishment to the cost of particular control measures or when there is not enough social justification for doing so.

Since lessened treatment will not bring environmental benefits, permission to POTWs to use whatever unexhausted assimilative capacity there may be for reasons of capital or operating cost reduction can stimulate similar efforts to obtain relief by the private sector. Whether it would be thought equitable or politically feasible to grant 301(h) waivers in the public sector, while steadfastly holding to secondary treatment equivalency for the private dischargers into the same waters needs to be expressly considered. If some or many nonpublic dischargers are also given relief from the strictest requirements of the Clean Water Act, the dissolved oxygen predictions developed by the model runs in this study would have overestimated available assimilative capacity, if any.

A somewhat similar observation can be made about the POTWs. The model runs which assume similar treatment requirements for all municipal treatment facilities are somewhat freer from objection as to their likelihood. Those which seek to predict which and how many plants will receive 301(h) or other relief may be questioned by some observers as to the trustworthiness of the postulates. Regardless of the letter of the law, it is possible that those POTWs which have not filed 301(h) applications will wonder why they should continue to hew to the strict secondary treatment line when their neighbors have receded from it or been excused from existing pressures for upgrading. Whether or not the 301(h) route is open to them, these present nonapplicants may hereafter use whatever avenues they can to establish parity of burdens between themselves and any dischargers who have been allowed to reverse the direction of the past decade and move toward performance at the level of full secondary treatment as now understood.

For these reasons, as well as because of the purely technical caveats concerning the accuracy of modeling results, one should probably conclude that the estimates of dissolved oxygen in the waters of the Region are probably the most favorable that can be predicted.

Chapter 4. Lessened Treatment ?

To make informed judgments concerning the feasibility of seasonal variations in treatment regimes, a number of considerations must be weighed. There is no evidence that the greater amounts of contaminant matter discharged, if treatment requirements are relaxed to any extent, would be beneficial to water quality conditions. The only possible environmental gain is that, depending on the kind and extent of lessened treatment accorded, there might be some decrease in the amounts of sewage sludge for which disposal options need to be examined and put into operation. However, this would mean that the ingredients in the sludge would have been put out into the water in the first instance at the ends of the treatment plant outfalls rather than further offshore at the dump sites. Accordingly, the questions needing answers are whether during the cold weather months additional wastes can be absorbed without lowering ambient water quality enough to interfere with present and intended uses, how factors other than dissolved oxygen would be affected, and whether programs for operating treatment facilities on a seasonably variable basis can be economic and efficient.

The benefits that might come from lessened treatment would be in respect of costs. The large quantities of sludge associated with full secondary treatment must be transported in order to dispose of them. Also, certain aspects of operations that might be curtailed with lesser treatment consume great amounts of electricity. Although no estimates can be made in this study, cutbacks probably could save significant sums for the governmental entities operating the treatment systems.

Types of Treatment

In judging conditions for which unused assimilative capacity may be projected, this study provides model run data for three types of situations. By looking at the results of the 1981 runs, it is possible to estimate what 1990 conditions will be if there is neither upgrading nor downgrading of present treatment facilities and if the plants are operated to the same standard of performance as they now achieve. From some of the runs, it is possible to estimate what the assimilative capacity status will be in the future if all plants will have been upgraded to secondary treatment. A third condition about which the model runs offer data is that in which all plants would be providing secondary treatment, except for 8 "major facilities" which would be allowed to treat to a standard of 60% removal. While these assumptions and the results obtained by employing them are instructive, a number of other scenarios need to be considered if one is to canvass realistically the possibilities for the next decade or so. 301(h) applications are now pending. While some time will yet elapse before the permits involved are granted or denied, the decisions should be governing treatment regimes before 1990, as well as during that year and perhaps beyond. We know that the North River and Red Hook plants have a long way to go before they will be in place and operating at secondary treatment. Also, several POTWs in New Jersey which affect the harbor area presently afford only primary treatment. If the assumption that they will be upgraded to secondary facilities by 1990 proves correct, the simulations in the model runs may give a suitable depiction of conditions as they actually will be. But this certainly will not be the situation much before 1990 and, under fiscal and other constraints, one also should consider scenarios which take a less optomistic view than secondary treatment fully achieved by 1990.

Nevertheless, it is advisable to begin consideration of the opportunities and problems presented by seasonal treatment regimes with relatively simple assumptions and a limited number of variables. Once these are understood, the more complex situations which approach the likely realities more closely can be analyzed with greater hope of success.

Length of Season

Because of the continuing need for secondary treatment during the summer months, all facilities in the harbor area should be brought up to that level of capability and maintained there. However, if seasonal standards requiring lesser treatment in the cold water period of the year were deemed appropriate, these POTWs could be operated so as to provide less than full secondary treatment during the season for which that was allowed. In order to implement such a procedure, it would be necessary not only to develop and issue the seasonal requirements and limitations, but to fix spécifically the time during which cold weather operations would be permitted.

The Cold Water Season

The model runs done at 10 and 15 degrees C show assimilative capacity available. Such temperatures obviously are not found during July, August, and September; nor are they characteristic of the weeks immediately on either side of these hottest months. They are intermediate temperatures to be expected during the transitional seasons. Winter conditions generally produce waters ranging from somewhat below to somewhat above 5 degrees C. These contain the highest amounts of dissolved oxygen.

It follows that if one were to attempt to utilize the assimilative capacity completely at all times, it would be necessary gradually to adjust waste loadings throughout the Region as the waters cool from their summer highs and warm from the midwinter and late winter readings.

No such fine tuning is possible. Nevertheless, more should be known about dissolved oxygen conditions and their changes during the eight months which the model runs explored only to a minor extent. Until now, relatively little attention has been paid to such data because the use of year-round standards has made it necessary to concentrate on how requirements are met during the most difficult months. It has been properly assumed that if treatment regimes were such as to keep the waterways from being unduly stressed in the summer, the rest of the year would be even less of a problem and would not call for any measures other than those already being taken for July, August, and September.

An important factor in considering the boundaries of the cold water season is the extent to which people can be expected to come into direct contact with the waters of the harbor area. The fishing season gets underway in earnest in early spring and runs well into the fall. Swimming includes June as well as the three months of warmest water.

Of course, if dissolved oxygen is the only criterion, the considerations just mentioned may be somewhat off the mark. Concentration is properly on the health of marine biota and fish survival and propagation i.e., on the organisms which obtain their oxygen directly from the waterways. However, if overall practicality of regimes for treatment plant operation are considered, it will become relevant to pay some heed to the dates of primary contact recreational seasons, even though the discussion of warm and cold water seasons is mostly in respect to assimilative capacity as measured by dissolved oxygen.

All things considered, it might be that the warm water season should begin as early as April 1 and not conclude until October 31. Advocacy of a shorter season would depend on the gaining of more specific information concerning the actual course of conditions during the autumn, winter, and spring. It should also depend on ascertainment of the interseasonal effects, if any, of discharges made into the harbor area.

Interseasonal Effects

Currents and tides sooner or later transport floating, suspended, and dissolved wastes out to sea. Retention time, even in the most obstructed parts of the area, probably does not exceed a month. However, some probably small portions of the waste discharges may never leave the confines of sheltered embayments. Far greater in significance are the deposits from sewage and industrial wastes which come to rest on bottoms and shores. There is build up of benthic material which may accumulate sufficiently over a number of seasons to become a factor in biochemical oxygen demand within the waterways. The extent to which larger residues, deposited during the cold water season because of lessened treatment, would release their biochemical oxygen demand in the summer is presently unknown. Because there is not now any unused assimilative capacity during the summer months and because the completion of upgrading to secondary treatment of facilities not yet to that standard will not, for all practical purposes, produce excess assimilative capacity, cold weather reductions of treatment could be detrimental.

Shellfisheries

There is need to ask whether the shellfisheries of the Region are to be protected and restored. It has been an assumption of management policies and goals in recent times, especially for the presently less heavily polluted waterways, that shellfish culture is a protected use. Dissolved oxygen conditions cannot be said to constitute a problem for shellfish in the cold water season. However, coliforms are a year-round concern. Low temperatures do not remove coliforms. This is why year-round chlorination has been practiced at those treatment plants whose effluents are acknowledged to affect commercial shellfish beds.

Reduced treatment is likely to make increased dosages of chlorine or other disinfection necessary to control coliforms within the limits required for safe shellfish harvesting. The expense involved for this additional chemical treatment would be great. In fact, it could well offset any savings gained from operating installed facilities at less than secondary treatment. This matter needs to be examined carefully. It has both policy and technical aspects.

Operating Concerns

There should be relatively little difficulty in reducing treatment abruptly on whatever date may be set for the beginning of the cold water season. Care would have to be taken to see that while some installed facilities were not in use for the extended seasonal period, equipment did not deteriorate. At the start-up end of the process, the conversion to full secondary operations would not be so simple. It should be expected to take a month or longer to resume warm water operations and to bring the plant up to proper efficiency and reliability. This means that the cold water operating period should be fixed for a shorter time than considerations of assimilative capacity of the receiving waters would of itself indicate.

Multiple Variability

The New York Harbor Area, as defined for this study, has numerous treatment plants of all sizes. The only model runs done for this study which postulated some plants operating at less than secondary treatment in 1990 made the exceptions in favor of eight so-called "major facilities". Actually, a total of 25 applications have been filed from communities in New York and New Jersey. At present, one cannot know whether any of these applications for 301(h) waivers will be granted and, if so, which facilities will receive permits allowing reduced treatment. Nor does one know how long the cold water season would be.

The locations of many of the treatment plants in the Region, and the movement patterns of the area's receiving waters, are such that substantial interactions occur. Thus, it is difficult, if not impossible, to consider any one of the proposals for lesser treatment or forgiveness from upgrading to secondary treatment, in isolation. In fact, this study has the purpose of providing some of the technical information on which decisions about possibilities for any reduced treatment can be based.

If all of the applicants are to have an opportunity to operate on a seasonal treatment basis, the length of the permissible season may have to be substantially reduced in order to remain within the limits of unused assimilative capacity. If only some of the applicants are to be successful, serious questions of equity will need to be faced in determining which ones. The problem may be not only in making allocations among plants, but in determining the equities among the states so far as rights to utilize the waste disposal use of the Region's waters. To complicate matters still further, in the East River - Long Island Sound portion of the Region, this study has made no assumptions about waste loadings in Connecticut, except Greenwich.

Other Factors

Finally, it should be remembered that this study addresses only the question of available assimilative capacity so far as dissolved oxygen is concerned. Treatment measures affect other parameters as well. The standards for the several use classifications contain specific values for allowable concentrations of substances in receiving waters. However, for many of the polluting components of waste discharges, including most toxics, neither requirements nor limitations have been developed. Thus tolerance levels are neither known nor generally agreed upon.

There may be a number of other questions related either to the consistency of seasonal treatment with overall water quality management policy or pertaining to the place which 301(h) as a whole has in the general scheme of things for this Region. No effort can be made here to identify all of them. However, the matter of sludge policy and administration has such obvious importance for the Region that a word may be appropriate here.

Ocean dumping has been a major concern in recent years. The question has been whether sludges, especially those with the toxic properties characteristic of this area, should be disposed into water. Either for the long or intermediate term, major efforts are underway to move the deposit of sludges further from the coast. Other efforts are to place such dumping under stringent controls. Yet, a consequence of lessened treatment, either seasonally or year-round, would be to increase the deposit of untreated or partially treated sludges from these very same sources close inshore where their effects on the marine environment of the Region would be most direct and immediate. Some reconciliation of this apparent inconsistency would seem to be required, if lessened treatment becomes a reality conforming to law.

Further Work

The 301(h) applications generally contain programs of study intended to result in applicants supplying information which will make it more possible to determine whether any permits containing waivers of the secondary treatment requirement can be granted in the particular case and what the specific contents of their permits should be. However, the interrelated character of the area waters and the interactions among discharges cannot realistically be studied by individual applicants. The needed regional perspective can be supplied only by the public regulatory agencies. Only these bodies have the perspective and the interest to examine the situation on the necessary regionwide basis. Accordingly, it will be essential for EPA, the States and the Interstate Sanitation Commission, as well as the applicants, to proceed with further work to determine whether any available assimilative capacity can safely be used and, if so, how it can be done. To the extent that gaps in present information can be ameliorated or filled by additional modeling, this may need to be done on a basis which includes a number of scenarios more varied than those undertaken for the present study.

It has been emphasized throughout this report that dissolved oxygen is only one of several factors to be considered in satisfying the legal and technical concerns required to be addressed for 301(h) purposes. This is true for seasonal treatment possibilities as well as for any other approaches. It would be harmful rather than helpful if lessened treatment were to be allowed according to any regime because assimilative capacity for biochemical oxygen demand was thought to be available, only to find that other contaminants, removed or reduced by the higher degree of treatment, had been allowed to flourish. The effects of any proposed waiver allowances on other conventional parameters and on toxic contaminants needs to be specifically examined.

If it is decided that seasonal treatment is worth serious consideration, studies should be made to establish which specific treatment regimes can be written into permits and thus brought into lawful use.

Conclusion

The modeling results produced by this study show that there is no available, unused assimilative capacity for biochemical oxygen demand during the summer months. Accordingly, there should continue to be insistence on bringing all POTWs up to the secondary treatment level. They should be required to use this full capability during the warm water season. If seasonal treatment is to be entertained, it can be for only that part of the year when there is good assurance that it would not bring dissolved oxygen levels below the 3 mg/l, 4 mg/l, and 5 mg/l standards.

The postulated conditions which formed the basis of the model runs in this study were relatively favorable to the calculation of high dissolved oxygen values. They omitted a number of factors which probably have an adverse effect on actual dissolved oxygen levels. Even so, the model runs show that, at best, the attainment of full secondary treatment throughout the study area would make the required standards just barely or would leave relatively slender margins of assimilative capacity above the minimum requirements during the critical summer months. Under these circumstances it is inescapable that lessened treatment, to any degree that would result in worthwhile cost reductions, would cause minimum requirements in the area's waters to be violated in many years, if not every year.

This study has been viewed as Phase 1 of the inquiry. Since the modeling results, even with the caveats which must be borne in mind, shows that substantial assimilative capacity for biochemical oxygen demand exists during the cold water season, there is good reason to look further in order to determine whether seasonal treatment regimes could be properly devised. If this could be done in a way to affect significant savings to the POTWs and the communities they serve, without jeopardizing the health, safety, and functional usefulness of the environment, much might be gained.

The work needed before informed judgments can be made falls into two categories: 1. technical, and 2. policy.

Technical Work

Scenarios which show possible alternative conditions under fully realistic simulations for the eight intermediate and cold weather months should be examined. This is essential to predict what effects on the environment would be if less than secondary treatment were to be allowed for some part of the year. It is also vital to devise the specific treatment regimes that could be allowed in permits and the limitations which would have to be prescribed.

For these purposes, the existing New York Harbor Model should be improved so that it can function reliably for all parts of the area and so that it can handle all of the factors involved in realistic portrayals of the regional waterway system. Such an improved model should then be used to calculate dissolved oxygen conditions for the cold water seasonal scenarios. Particular attention should be paid to the conditions during the transitional spring and fall periods. This would enable sound judgments to be made concerning the dates on which it would be appropriate to shift from warm water to cold water operations and back again.

The questions raised in this report concerning at least two subjects related to dissolved oxygen content of the waterways require further investigation. One is the true effects of combined sewer discharges of untreated wastes on dissolved oxygen conditions. More actual knowledge is necessary to establish the extent of this factor's influence and to assess its bearing on decisions as to treatment options.

It would also be well to ascertain whether increased deposits on bottoms and shorelines resulting from the seasons of lesser treatment, if such are allowed, would have any effect on water quality conditions during the summer months and, if so, what effects could be expected.

The calculations and analyses for this study have been made in the context of the accepted and traditional ways of looking at waste management. Waste treatment at the POTWs is the methodology relied upon for keeping biochemical oxygen demanding materials from reaching the waterways in amounts which degrade the waters below allowable levels. It is desirable to investigate alternative means of keeping discharges of biochemical oxygen demand within the limits that would be achieved from operation of all POTWs in accordance with a secondary treatment concept that embodies the 30 mg/l and 85% removal criteria. The model runs done for this study and their analysis show that such containment of biochemical oxygen demand is necessary to meet the 3 mg/l, 4 mg/l and 5 mg/l standards. But they do not mean that requiring all POTWs to operate at 85% removal when 30 mg/l is not as stringent, is the only means of satisfying the objective.

Raw combined sewer overflows and weak influents to treatment plants are contributory factors to the degraded condition of area waters. Where large quantities of sewage solids settle in the sewers, it is difficult and very costly for the plants they serve to achieve 85% removal from sewage streams which contain low concentrations of BOD. To do so, they would have to produce effluents of no more than 10 - 15 mg/l -- close to the minimum concentration can be achieved by the state of the art.

There are several measures which, singly or in combination, could remove waste loadings associated with combined sewer overflows and thus make it possible to relieve some demands on POTWs. If treatment were provided at the regulators controlling flows in those sewers which suffer from substantial deposits of solids, the waterways would not be as much affected by these wastes. If combined sewers were flushed in dry weather, thus forcing more solids to a POTW for treatment, the situation would be ameliorated. If some modification of the bottom contours of the affected sewers were undertaken, settling of wastes in them could also be discouraged.

Conditions in the collection systems of the various areas in the Region differ widely. It follows that not all of these measures, nor even the same measure, is necessary throughout. However, a particular measure could be applied where it is appropriate to the local conditions. With such alternatives, the local governments of the area and the regional collection and treatment systems could either operate under secondary treatment as now understood, or could rely upon a combination of methods to keep more than allowable total poundages of pollutants from reaching the waterways. POTWs and the communities which they serve should be given every encouragement to employ the most cost-efficient means of protecting water quality. But it should be kept in mind that unless sufficient biochemical oxygen demanding wastes are kept from reaching the waterways, the standards cannot be met.

Finally, it should be recalled that the present study has dealt in a specific way only with dissolved oxygen. Acceptable water quality conditions depend on other parameters as well. Notably, these include toxics and coliforms.

Policy Considerations

Whether to grant or deny 301(h) applications, and what specific kinds of waivers to allow, if any, should not be decided in a vacuum. The questions of equity among dischargers raised at the conclusion of Chapter 2 and the matter of a coordinated and sensible sludge disposal policy, mentioned earlier in this chapter, must be taken into account. Environmental management through the regulatory processes of the Clean Water Act, and other federal and state environmental laws, involves fundamental distributions of social and economic benefits and burdens. How these should properly be shared by each state of the Region, the local governments, the private sector, and the public at large must be thoughtfully considered. Public policies must be evolved and applied which will provide a suitable framework for deciding the issues involved in seasonal treatment.

HydroQual, Inc.

CONSULTANTS IN WATER POLLUTION CONTROL

TRANSMITTAL

TO: Interstate Sanitation Commission
10 Columbus Circle
New York, New York 10019

DATE: January 27, 1983

FILE: ISCO0010

ATTENTION: Mr. Howard Golub

RE:

WE ARE SENDING YOU X HEREWITH ___ UNDER SEPARATE COVER VIA

Corrected Information for Runs 3 and 9.

THE ABOVE ARE FOR YOUR ___ INFORMATION ___ APPROVAL
X AS REQUESTED ___ OTHER

REMARKS:

IF ENCLOSURES ARE NOT AS NOTED, PLEASE NOTIFY US AT ONCE.

Jim

James A. Hallden

RUN NUMBER 03

SEGMENT NUMBER	CBOD5 MG/L	DEFICIT MG/L	DISS O2 MG/L	SEGMENT NUMBER	CBOD5 MG/L	DEFICIT MG/L	DISS O2 MG/L
1.	1.87	1.66	6.83	2.	1.64	1.92	6.57
3.	1.25	2.27	6.12	4.	0.92	2.39	6.00
5.	0.73	2.36	6.03	6.	0.53	2.01	6.38
7.	0.38	1.57	6.72	8.	0.29	1.42	6.87
9.	0.22	1.29	7.00	10.	0.17	1.21	6.98
11.	0.14	1.14	7.05	12.	0.12	1.08	7.11
13.	0.11	1.04	7.15	14.	0.10	1.00	7.19
15.	0.09	0.98	7.21	16.	0.11	0.99	7.20
17.	0.10	1.04	7.15	18.	0.10	1.12	6.97
19.	0.10	1.22	6.87	20.	0.22	1.33	6.66
21.	0.20	1.41	6.58	22.	0.20	1.47	6.42
23.	0.20	1.50	6.39	24.	0.20	1.52	6.37
25.	0.21	1.55	6.34	26.	0.41	1.61	6.18
27.	0.38	1.64	6.15	28.	0.36	1.66	6.13
29.	0.35	1.67	6.02	30.	0.36	1.68	6.11
31.	0.34	1.70	6.09	32.	0.34	1.71	5.98
33.	0.33	1.72	6.07	34.	0.32	1.72	6.07
35.	0.33	1.72	6.07	36.	0.39	1.72	5.97
37.	0.44	1.78	5.91	38.	0.37	1.65	5.94
39.	0.38	1.67	5.92	40.	0.35	1.58	6.01
41.	0.36	1.59	6.00	42.	0.35	1.53	6.06
43.	0.36	1.54	6.05	44.	0.34	1.51	6.08
45.	0.35	1.51	6.08	46.	0.37	1.49	6.10
47.	0.37	1.49	6.10	48.	0.33	1.42	6.17
49.	0.29	1.31	6.18	50.	0.50	2.76	5.73
51.	0.49	2.73	5.76	52.	0.52	2.64	5.85
53.	0.44	2.47	5.92	54.	0.33	2.26	6.13
55.	0.33	2.02	6.37	56.	0.28	1.70	6.69
57.	0.17	1.58	6.71	58.	0.13	1.50	6.79
59.	0.10	1.44	6.85	60.	0.09	1.37	6.92
61.	0.09	1.35	6.84	62.	0.08	1.34	6.85
63.	0.08	1.34	6.85	64.	0.08	1.39	6.80
65.	0.10	1.46	6.73	66.	0.10	1.50	6.69
67.	0.12	1.57	6.52	68.	0.15	1.64	6.45
69.	0.19	1.76	6.23	70.	0.20	1.79	6.20
71.	0.23	1.84	6.05	72.	0.24	1.87	6.02
73.	0.26	1.89	6.00	74.	0.28	1.90	5.99
75.	0.31	1.93	5.86	76.	0.29	1.98	5.81
77.	0.29	1.98	5.71	78.	0.30	1.96	5.73
79.	0.30	1.95	5.74	80.	0.30	1.92	5.77
81.	0.32	1.87	5.82	82.	0.33	1.83	5.86
83.	0.34	1.80	5.89	84.	0.35	1.75	5.94
85.	0.37	1.71	5.98	86.	0.43	1.78	5.91
87.	0.33	1.61	6.08	88.	0.34	1.62	6.07
89.	0.30	1.50	6.09	90.	0.30	1.52	6.17
91.	0.30	1.49	6.10	92.	0.29	1.50	6.19
93.	0.32	1.50	6.09	94.	0.32	1.49	6.10
95.	0.28	1.42	6.17	96.	0.28	1.41	6.18
97.	0.25	1.33	6.26	98.	0.24	1.23	6.36

RUN NUMBER 03

SEGMENT NUMBER	CBOD5 MG/L	DEFICIT MG/L	DISS O2 MG/L	SEGMENT NUMBER	CBOD5 MG/L	DEFICIT MG/L	DISS O2 MG/L
99.	0.51	1.86	5.83	100.	0.66	2.01	5.68
101.	0.81	2.16	5.53	102.	0.93	2.28	5.41
103.	0.93	2.33	5.26	104.	0.94	2.40	5.19
105.	0.96	2.37	5.22	106.	0.96	2.44	5.15
107.	0.97	2.44	5.15	108.	0.99	2.47	5.12
109.	0.96	2.46	5.13	110.	0.88	2.41	5.18
111.	0.74	2.30	5.39	112.	0.64	2.20	5.49
113.	0.55	2.09	5.60	114.	0.47	2.00	5.79
115.	0.40	1.90	5.89	116.	0.31	1.79	6.10
117.	1.02	2.48	5.21	118.	1.11	2.52	5.07
119.	0.99	2.51	5.18	120.	0.98	2.51	5.18
121.	1.00	2.48	5.21	122.	0.84	2.43	5.26
123.	0.83	2.44	5.25	124.	0.82	2.46	5.23
125.	0.95	2.50	5.19	126.	0.91	2.47	5.22
127.	0.79	2.39	5.30	128.	0.67	2.26	5.43
129.	0.59	2.17	5.52	130.	0.50	2.07	5.62
131.	0.44	2.00	5.69	132.	0.36	1.88	5.81
133.	0.25	1.65	6.04	134.	0.26	1.66	6.03
135.	0.25	1.66	6.03	136.	0.26	1.68	6.01
137.	0.26	1.67	6.12	138.	0.27	1.70	5.99
139.	0.26	1.69	6.10	140.	0.28	1.74	5.95
141.	0.29	1.77	5.92	142.	0.29	1.77	5.92
143.	0.28	1.76	5.93	144.	0.26	1.69	6.10
145.	0.24	1.61	6.18	146.	0.23	1.60	6.19
147.	0.24	1.62	6.17	148.	0.23	1.58	6.21
149.	0.23	1.58	6.21	150.	0.23	1.53	6.16
151.	0.23	1.53	6.16	152.	0.24	1.54	6.15
153.	0.25	1.46	6.23	154.	0.26	1.45	6.24
155.	0.29	1.36	6.33	156.	0.29	1.35	6.34
157.	0.28	1.33	6.36	158.	0.37	1.21	6.48
159.	0.37	1.21	6.48	160.	0.99	0.95	6.74
161.	0.98	0.92	6.77	162.	0.97	0.89	6.80
163.	0.96	0.87	6.82	164.	0.96	0.84	6.85
165.	0.95	0.81	6.88	166.	0.94	0.79	6.90
167.	0.93	0.76	7.73	168.	0.92	0.72	7.77
169.	0.91	0.69	7.80	170.	0.89	0.66	7.73
171.	0.88	0.63	7.76	172.	0.86	0.60	7.79
173.	0.84	0.56	7.83	174.	0.82	0.53	7.76
175.	0.79	0.49	7.80	176.	0.74	0.45	7.74
177.	0.70	0.43	7.76	178.	0.68	0.42	7.67
179.	0.66	0.41	7.68	180.	0.63	0.41	7.68
181.	0.59	0.41	7.68	182.	0.58	0.42	7.57
183.	0.55	0.43	7.56	184.	0.52	0.43	7.56
185.	0.50	0.44	7.45	186.	0.47	0.46	7.43
187.	0.45	0.49	7.30	188.	0.43	0.52	7.27
189.	0.41	0.57	7.12	190.	0.43	0.73	6.96
191.	0.36	0.52	7.17	192.	0.39	0.65	7.04
193.	0.34	0.55	7.24	194.	0.30	0.48	7.31
195.	0.29	0.44	7.45	196.	0.28	0.41	7.58

R U N   N U M B E R   0 3

SEGMENT NUMBER	CBOD5 MG/L	DEFICIT MG/L	DISS O2 MG/L	SEGMENT NUMBER	CBOD5 MG/L	DEFICIT MG/L	DISS O2 MG/L
197.	0.30	0.40	7.79	198.	0.38	0.42	7.87
199.	0.50	0.96	6.63	200.	0.61	1.27	6.22
201.	0.75	1.61	5.88	202.	0.57	1.63	5.76
203.	0.40	1.78	5.61	204.	0.31	1.86	5.53
205.	0.27	1.78	5.61	206.	0.36	1.75	5.64
207.	0.23	1.62	5.77	208.	0.23	1.74	5.65
209.	0.23	1.73	5.66	210.	0.25	1.67	5.72
211.	0.25	1.65	5.74	212.	0.18	1.58	5.71
213.	0.21	1.70	5.69	214.	0.21	1.69	5.70
215.	0.21	1.63	5.76	216.	0.20	1.59	5.80
217.	0.18	1.66	5.73	218.	0.18	1.63	5.76
219.	0.17	1.57	5.82	220.	0.16	1.54	5.85
221.	0.13	1.51	5.88	222.	0.17	1.61	5.78
223.	0.16	1.55	5.84	224.	0.15	1.50	5.89
225.	0.14	1.47	5.92	226.	0.11	1.46	5.93
227.	0.15	1.52	5.87	228.	0.13	1.47	5.92
229.	0.12	1.42	5.97	230.	0.11	1.37	6.02
231.	0.09	1.31	6.08	232.	0.14	1.45	5.94
233.	0.12	1.39	6.00	234.	0.11	1.33	6.06
235.	0.10	1.26	6.13	236.	0.09	1.23	6.16
237.	0.13	1.31	6.08	238.	0.12	1.28	6.11
239.	0.11	1.23	6.16	240.	0.09	1.12	6.27
241.	0.08	1.09	6.30	242.	0.15	1.11	6.28
243.	0.12	1.11	6.28	244.	0.11	1.09	6.30
245.	0.09	1.00	6.39	246.	0.07	0.88	6.51
247.	0.21	0.96	6.43	248.	0.14	0.99	6.40
249.	0.12	0.98	6.41	250.	0.10	0.92	6.47
251.	0.08	0.73	6.66	252.	0.07	0.76	6.63
253.	0.17	0.92	6.57	254.	0.15	0.94	6.45
255.	0.14	0.92	6.47	256.	0.12	0.85	6.54
257.	0.09	0.68	6.71	258.	0.07	0.67	6.72
259.	0.06	0.63	6.76	260.	0.06	0.62	6.77
261.	0.16	0.94	6.55	262.	0.16	0.94	6.55
263.	0.15	0.91	6.58	264.	0.18	1.00	6.49
265.	0.17	0.98	6.51	266.	0.17	0.97	6.52
267.	0.16	0.92	6.57	268.	0.32	2.01	5.38
269.	0.21	1.09	6.40	270.	0.20	1.05	6.44
271.	0.23	1.16	6.43	272.	0.21	1.08	6.41
273.	0.21	1.12	6.37	274.	0.19	1.00	6.69
275.	0.18	0.95	6.64	276.	0.14	0.84	6.65
277.	0.17	0.88	6.81	278.	0.17	0.79	6.90
279.	0.13	0.68	6.81	280.	0.15	0.73	6.96
281.	0.17	0.70	6.99	282.	0.15	0.56	7.03
283.	0.16	0.58	7.11	284.	0.16	0.58	7.11
285.	0.16	0.57	7.02	286.	0.16	0.54	7.05
287.	0.17	0.50	7.09	288.	0.18	0.48	7.11
289.	0.19	0.46	7.13	290.	0.18	0.46	7.13
291.	0.18	0.48	7.11	292.	0.17	0.49	7.10
293.	0.17	0.49	7.10	294.	0.18	0.48	7.11

RUN NUMBER 03

SEGMENT NUMBER	CBOD5 MG/L	DEFICIT MG/L	DISS O2 MG/L	SEGMENT NUMBER	CBOD5 MG/L	DEFICIT MG/L	DISS O2 MG/L
295.	0.23	0.38	7.21	296.	0.22	0.40	7.19
297.	0.22	0.41	7.18	298.	0.22	0.41	7.18
299.	0.22	0.41	7.18	300.	0.33	0.23	7.36
301.	0.32	0.24	7.35	302.	0.31	0.26	7.33
303.	0.30	0.28	7.31	304.	0.30	0.28	7.31
305.	0.29	0.29	7.30	306.	0.18	0.94	6.75
307.	0.18	0.89	6.80	308.	0.18	0.85	6.84
309.	0.18	0.83	6.86	310.	0.19	0.80	6.79
311.	0.18	0.79	6.90	312.	0.20	0.77	6.82
313.	0.19	0.76	6.93	314.	0.22	0.76	6.83
315.	0.21	0.76	6.93	316.	0.28	0.79	6.80
317.	0.25	0.79	6.80	318.	0.27	0.81	6.78
319.	0.26	0.82	6.67	320.	0.26	0.84	6.65
321.	0.27	0.86	6.63	322.	0.28	0.95	6.54
323.	0.30	1.02	6.47	324.	0.30	1.05	6.34
325.	0.31	1.09	6.20	326.	0.35	1.14	6.25
327.	0.42	1.21	6.18	328.	0.38	1.24	6.05
329.	0.37	1.31	5.98	330.	0.37	1.35	5.94
331.	0.36	1.34	5.95	332.	0.35	1.19	6.10
333.	0.30	1.10	6.29	334.	0.30	1.11	6.38
335.	0.34	1.35	6.04	336.	0.66	0.51	8.18
337.	0.44	0.33	8.36	338.	0.32	0.29	8.40
339.	0.24	0.26	8.43	340.	0.19	0.25	8.44
341.	0.15	0.24	8.45	342.	0.12	0.25	8.44
343.	0.10	0.27	8.32	344.	0.10	0.31	8.28
345.	0.17	0.51	8.08	346.	0.29	0.95	7.54
347.	0.71	1.84	6.55	348.	1.25	2.66	5.73
349.	1.70	3.07	5.32	350.	2.81	3.73	4.56
351.	2.07	3.64	4.55	352.	1.73	3.52	4.67
353.	1.17	3.36	4.73	354.	0.85	3.11	4.98
355.	0.69	2.91	5.08	356.	0.65	2.81	5.18
357.	0.63	2.69	5.20	358.	0.84	2.44	5.35
359.	0.79	2.15	5.54	360.	0.98	1.02	7.67
361.	0.96	1.04	7.65	362.	0.95	1.06	7.63
363.	0.94	1.08	7.61	364.	0.92	1.10	7.59
365.	0.91	1.13	7.56	366.	0.90	1.19	7.50
367.	0.89	1.20	7.49	368.	0.88	1.22	7.47
369.	0.89	1.24	7.45	370.	0.87	1.26	7.43
371.	0.86	1.27	7.42	372.	0.84	1.29	7.30
373.	0.81	1.34	7.25	374.	0.77	1.39	7.20
375.	0.74	1.43	7.16	376.	0.71	1.47	7.12
377.	0.68	1.51	7.08	378.	0.64	1.55	6.94
379.	0.59	1.61	6.88	380.	0.56	1.64	6.85
381.	0.53	1.66	6.73	382.	0.50	1.69	6.70
383.	0.48	1.71	6.68	384.	0.46	1.73	6.66
385.	0.44	1.75	6.54	386.	0.42	1.76	6.53
387.	0.41	1.78	6.51	388.	0.40	1.80	6.49
389.	0.38	1.82	6.37	390.	0.37	1.84	6.35
391.	0.37	1.87	6.32	392.	0.37	1.90	6.19

RUN NUMBER 03

SEGMENT NUMBER	CBOD5 MG/L	DEFICIT MG/L	DISS O2 MG/L	SEGMENT NUMBER	CBOD5 MG/L	DEFICIT MG/L	DISS O2 MG/L
393.	0.37	1.94	6.15	394.	0.39	1.99	6.10
395.	0.41	2.05	5.94	396.	0.47	2.10	5.89
397.	0.47	2.15	5.74	398.	0.50	2.17	5.72
399.	0.55	2.18	5.61	400.	0.63	2.15	5.64
401.	0.82	1.95	5.74	402.	0.65	1.86	5.83
403.	0.55	1.84	5.75	404.	0.45	1.86	5.73
405.	0.44	1.86	5.73	406.	0.44	1.87	5.72
407.	0.36	1.56	6.13	408.	0.41	1.68	6.01
409.	0.44	1.75	5.84	410.	0.45	1.87	5.72
411.	0.46	1.91	5.68	412.	0.49	1.96	5.63
413.	0.56	2.08	5.41	414.	0.55	2.18	5.31
415.	0.54	2.24	5.25	416.	0.55	2.28	5.11
417.	0.55	2.31	5.08	418.	0.50	2.31	4.98
419.	0.47	2.29	5.00	420.	0.44	2.27	5.02
421.	0.40	2.23	5.16	422.	0.39	2.19	5.20
423.	0.37	2.16	5.23	424.	0.35	2.12	5.27
425.	0.34	2.07	5.32				

RUN NUMBER 09

SEGMENT NUMBER	CBOD5 MG/L	DEFICIT MG/L	DISS O2 MG/L	SEGMENT NUMBER	CBOD5 MG/L	DEFICIT MG/L	DISS O2 MG/L
1.	1.87	1.66	6.83	2.	1.64	1.93	6.56
3.	1.27	2.29	6.10	4.	0.95	2.42	5.97
5.	0.76	2.40	5.99	6.	0.57	2.06	6.33
7.	0.41	1.63	6.66	8.	0.32	1.49	6.80
9.	0.25	1.36	6.93	10.	0.20	1.29	6.90
11.	0.17	1.22	6.97	12.	0.15	1.17	7.02
13.	0.15	1.14	7.05	14.	0.13	1.11	7.08
15.	0.12	1.09	7.10	16.	0.15	1.11	7.08
17.	0.14	1.18	7.01	18.	0.14	1.29	6.80
19.	0.15	1.41	6.68	20.	0.29	1.55	6.44
21.	0.28	1.65	6.34	22.	0.30	1.72	6.17
23.	0.31	1.77	6.12	24.	0.31	1.80	6.09
25.	0.34	1.84	6.05	26.	0.76	1.92	5.87
27.	0.71	1.96	5.83	28.	0.67	1.99	5.80
29.	0.64	2.01	5.68	30.	0.64	2.02	5.77
31.	0.60	2.05	5.74	32.	0.60	2.06	5.63
33.	0.57	2.07	5.72	34.	0.56	2.07	5.72
35.	0.54	2.06	5.73	36.	0.53	2.01	5.68
37.	0.57	2.04	5.65	38.	0.49	1.93	5.66
39.	0.50	1.94	5.65	40.	0.47	1.85	5.74
41.	0.47	1.86	5.73	42.	0.46	1.79	5.80
43.	0.47	1.81	5.78	44.	0.45	1.78	5.81
45.	0.46	1.78	5.81	46.	0.48	1.75	5.84
47.	0.47	1.74	5.85	48.	0.43	1.66	5.93
49.	0.37	1.53	5.96	50.	0.51	2.82	5.67
51.	0.51	2.79	5.70	52.	0.53	2.70	5.79
53.	0.46	2.53	5.86	54.	0.35	2.34	6.05
55.	0.37	2.10	6.29	56.	0.31	1.77	6.62
57.	0.20	1.67	6.62	58.	0.16	1.60	6.69
59.	0.12	1.56	6.73	60.	0.12	1.50	6.79
61.	0.11	1.49	6.70	62.	0.11	1.50	6.69
63.	0.12	1.51	6.68	64.	0.12	1.58	6.61
65.	0.14	1.68	6.51	66.	0.15	1.73	6.46
67.	0.18	1.82	6.27	68.	0.22	1.92	6.17
69.	0.28	2.07	5.92	70.	0.32	2.11	5.88
71.	0.37	2.17	5.72	72.	0.40	2.22	5.67
73.	0.43	2.24	5.65	74.	0.48	2.25	5.64
75.	0.54	2.29	5.50	76.	0.47	2.34	5.45
77.	0.46	2.32	5.37	78.	0.46	2.30	5.39
79.	0.44	2.28	5.41	80.	0.44	2.24	5.45
81.	0.45	2.18	5.51	82.	0.45	2.13	5.56
83.	0.46	2.09	5.60	84.	0.47	2.03	5.66
85.	0.47	1.98	5.71	86.	0.54	2.03	5.66
87.	0.43	1.87	5.82	88.	0.44	1.88	5.81
89.	0.39	1.75	5.84	90.	0.39	1.77	5.92
91.	0.39	1.74	5.85	92.	0.38	1.74	5.95
93.	0.43	1.76	5.83	94.	0.43	1.76	5.83
95.	0.37	1.66	5.93	96.	0.36	1.65	5.94
97.	0.33	1.54	6.05	98.	0.30	1.43	6.16

RUN NUMBER 09

SEGMENT NUMBER	CBOD5 MG/L	DEFICIT MG/L	DISS O2 MG/L	SEGMENT NUMBER	CBOD5 MG/L	DEFICIT MG/L	DISS O2 MG/L
99.	0.63	2.11	5.58	100.	0.77	2.23	5.46
101.	0.86	2.36	5.33	102.	0.92	2.45	5.24
103.	0.92	2.49	5.10	104.	0.90	2.53	5.06
105.	0.94	2.51	5.08	106.	0.90	2.55	5.04
107.	0.91	2.55	5.04	108.	0.90	2.57	5.02
109.	0.92	2.57	5.02	110.	0.98	2.55	5.04
111.	0.99	2.49	5.20	112.	0.98	2.43	5.26
113.	0.90	2.35	5.34	114.	0.83	2.27	5.52
115.	0.74	2.19	5.60	116.	0.56	2.08	5.81
117.	0.90	2.57	5.12	118.	0.90	2.58	5.01
119.	0.84	2.55	5.14	120.	0.84	2.54	5.15
121.	0.89	2.52	5.17	122.	0.82	2.46	5.23
123.	0.91	2.48	5.21	124.	1.06	2.52	5.17
125.	0.82	2.54	5.15	126.	0.80	2.50	5.19
127.	0.75	2.42	5.27	128.	0.65	2.29	5.40
129.	0.57	2.20	5.49	130.	0.49	2.10	5.59
131.	0.43	2.02	5.67	132.	0.36	1.91	5.78
133.	0.33	1.68	6.01	134.	0.31	1.69	6.00
135.	0.31	1.69	6.00	136.	0.30	1.71	5.98
137.	0.29	1.70	6.09	138.	0.29	1.73	5.96
139.	0.29	1.72	6.07	140.	0.30	1.77	5.92
141.	0.31	1.80	5.89	142.	0.31	1.80	5.89
143.	0.32	1.79	5.90	144.	0.28	1.72	6.07
145.	0.25	1.64	6.15	146.	0.25	1.63	6.16
147.	0.27	1.65	6.14	148.	0.25	1.60	6.19
149.	0.25	1.61	6.18	150.	0.25	1.55	6.14
151.	0.25	1.55	6.14	152.	0.25	1.57	6.12
153.	0.26	1.48	6.21	154.	0.27	1.47	6.22
155.	0.30	1.37	6.32	156.	0.30	1.36	6.33
157.	0.29	1.35	6.34	158.	0.38	1.21	6.48
159.	0.37	1.22	6.47	160.	1.03	0.96	6.73
161.	1.05	0.93	6.76	162.	1.08	0.90	6.79
163.	1.10	0.88	6.81	164.	1.12	0.86	6.83
165.	1.14	0.84	6.85	166.	1.16	0.81	6.88
167.	1.18	0.79	7.70	168.	1.21	0.76	7.73
169.	1.25	0.74	7.75	170.	1.31	0.72	7.67
171.	1.43	0.71	7.68	172.	1.48	0.69	7.70
173.	1.58	0.68	7.71	174.	1.75	0.68	7.61
175.	1.73	0.67	7.62	176.	1.71	0.68	7.51
177.	1.71	0.69	7.50	178.	1.71	0.71	7.38
179.	1.70	0.74	7.35	180.	1.69	0.78	7.31
181.	1.69	0.85	7.24	182.	1.70	0.89	7.10
183.	1.73	0.96	7.03	184.	1.80	1.03	6.96
185.	1.93	1.12	6.77	186.	2.13	1.24	6.65
187.	2.35	1.35	6.44	188.	2.20	1.42	6.37
189.	1.98	1.50	6.19	190.	1.75	1.64	6.05
191.	1.83	1.51	6.18	192.	1.90	1.64	6.05
193.	2.18	1.65	6.14	194.	2.55	1.69	6.10
195.	2.99	1.71	6.18	196.	3.75	1.71	6.28

RUN NUMBER 09

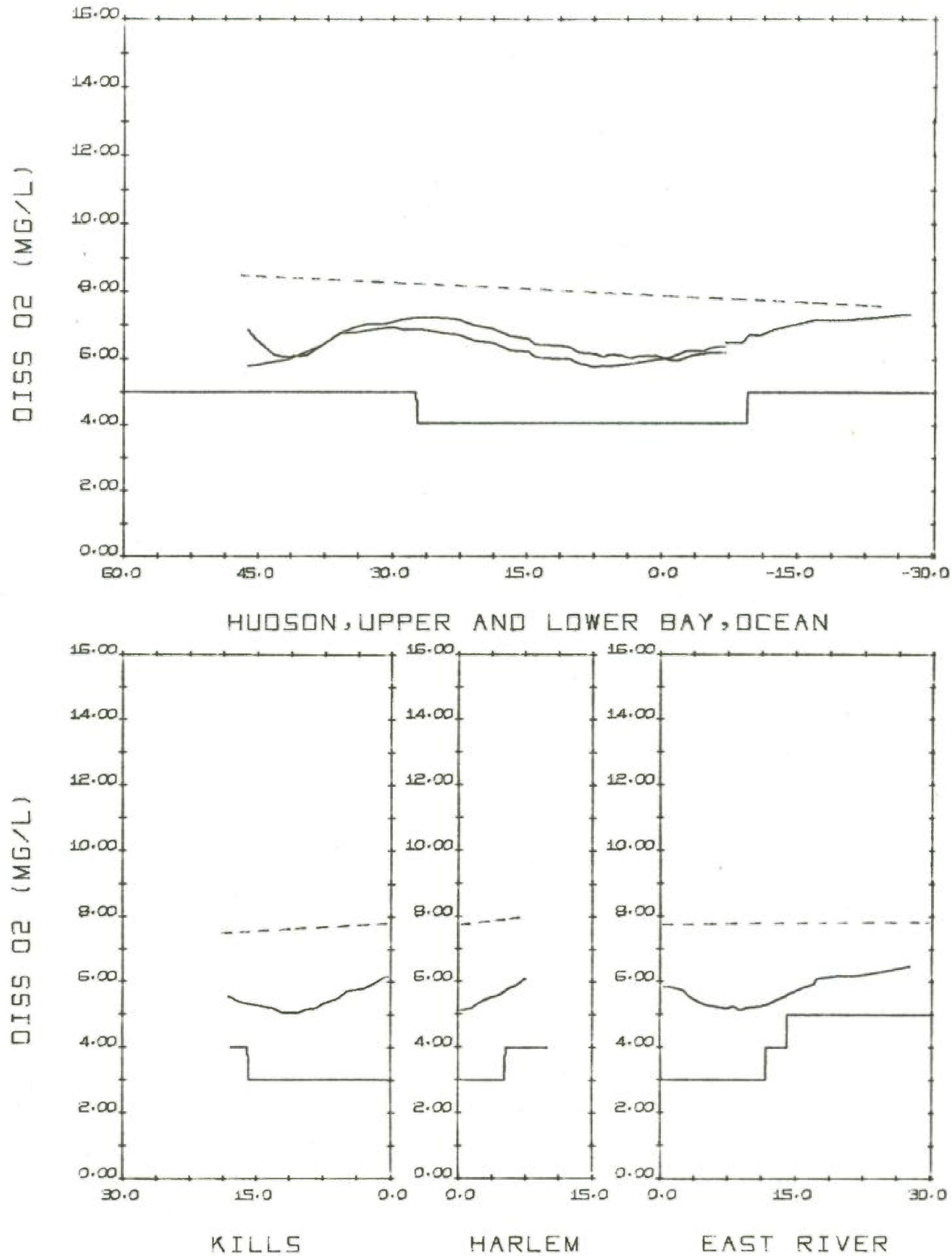
SEGMENT NUMBER	CBOD5 MG/L	DEFICIT MG/L	DISS O2 MG/L	SEGMENT NUMBER	CBOD5 MG/L	DEFICIT MG/L	DISS O2 MG/L
197.	3.70	1.49	6.70	198.	1.81	0.93	7.36
199.	1.52	1.77	5.82	200.	1.32	1.94	5.55
201.	1.26	2.17	5.32	202.	0.96	2.11	5.28
203.	0.65	2.15	5.24	204.	0.47	2.19	5.20
205.	0.39	2.05	5.34	206.	0.48	1.99	5.40
207.	0.32	1.79	5.60	208.	0.33	1.99	5.40
209.	0.34	1.97	5.42	210.	0.34	1.89	5.50
211.	0.34	1.85	5.54	212.	0.26	1.74	5.55
213.	0.30	1.93	5.46	214.	0.30	1.91	5.48
215.	0.29	1.83	5.56	216.	0.28	1.77	5.62
217.	0.26	1.87	5.52	218.	0.26	1.83	5.56
219.	0.24	1.76	5.63	220.	0.23	1.70	5.69
221.	0.21	1.65	5.74	222.	0.24	1.81	5.58
223.	0.22	1.74	5.65	224.	0.20	1.67	5.72
225.	0.19	1.62	5.77	226.	0.18	1.59	5.80
227.	0.21	1.70	5.69	228.	0.19	1.64	5.75
229.	0.17	1.57	5.82	230.	0.16	1.51	5.88
231.	0.15	1.43	5.96	232.	0.19	1.61	5.78
233.	0.17	1.55	5.84	234.	0.15	1.48	5.91
235.	0.14	1.39	6.00	236.	0.13	1.33	6.06
237.	0.18	1.45	5.94	238.	0.16	1.43	5.96
239.	0.14	1.37	6.02	240.	0.12	1.24	6.15
241.	0.12	1.20	6.19	242.	0.18	1.24	6.15
243.	0.16	1.24	6.15	244.	0.14	1.23	6.16
245.	0.12	1.11	6.28	246.	0.10	0.98	6.41
247.	0.22	1.08	6.31	248.	0.17	1.11	6.28
249.	0.15	1.11	6.28	250.	0.12	1.03	6.36
251.	0.10	0.82	6.57	252.	0.09	0.84	6.55
253.	0.20	1.06	6.43	254.	0.18	1.07	6.32
255.	0.17	1.04	6.35	256.	0.14	0.96	6.43
257.	0.11	0.76	6.63	258.	0.09	0.76	6.63
259.	0.08	0.72	6.67	260.	0.08	0.70	6.69
261.	0.20	1.08	6.41	262.	0.20	1.08	6.41
263.	0.18	1.04	6.45	264.	0.22	1.14	6.35
265.	0.22	1.13	6.36	266.	0.21	1.11	6.38
267.	0.19	1.06	6.43	268.	0.54	2.40	4.99
269.	0.26	1.26	6.23	270.	0.24	1.21	6.28
271.	0.29	1.35	6.24	272.	0.26	1.25	6.24
273.	0.28	1.29	6.20	274.	0.23	1.15	6.54
275.	0.21	1.08	6.51	276.	0.17	0.95	6.54
277.	0.20	1.00	6.69	278.	0.19	0.89	6.80
279.	0.15	0.76	6.73	280.	0.17	0.81	6.88
281.	0.18	0.78	6.91	282.	0.16	0.61	6.98
283.	0.16	0.63	7.06	284.	0.17	0.63	7.06
285.	0.17	0.61	6.98	286.	0.17	0.58	7.01
287.	0.17	0.53	7.06	288.	0.18	0.51	7.08
289.	0.19	0.49	7.10	290.	0.19	0.48	7.11
291.	0.18	0.50	7.09	292.	0.18	0.52	7.07
293.	0.18	0.52	7.07	294.	0.18	0.51	7.08

RUN NUMBER 09

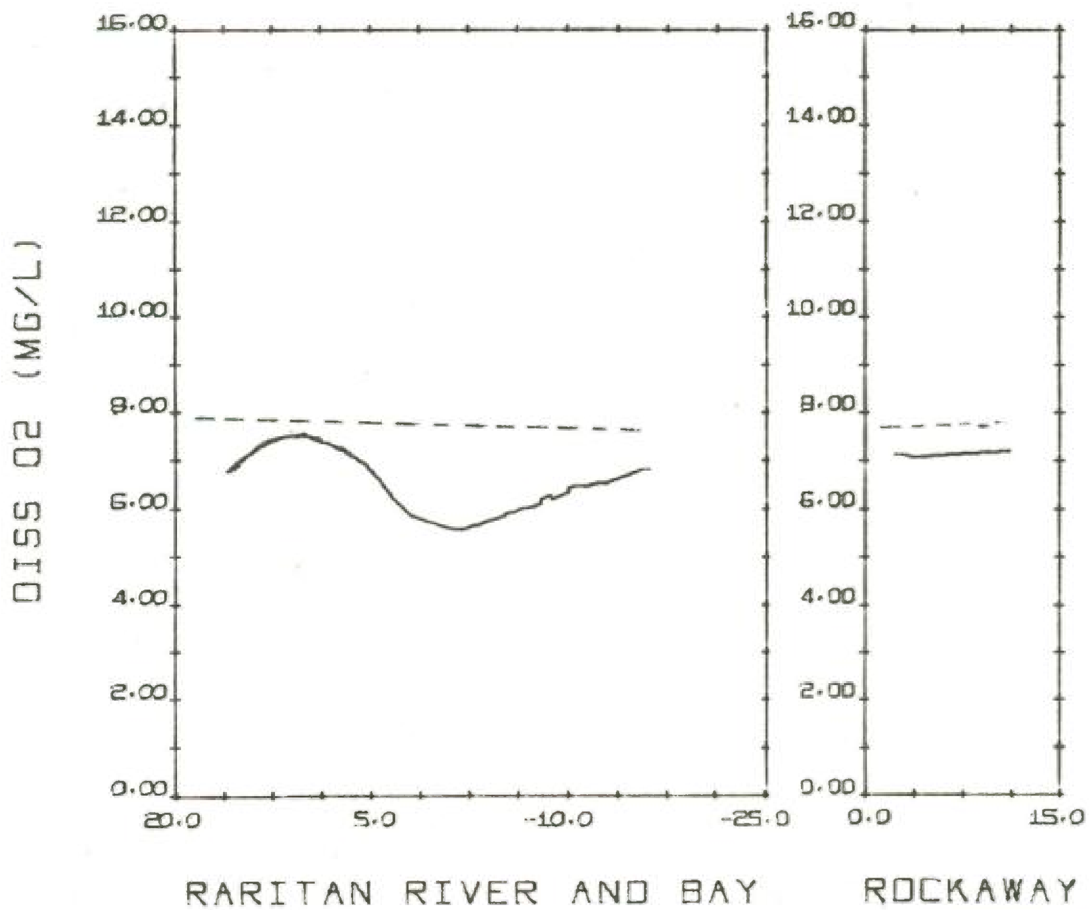
SEGMENT NUMBER	CBOD5 MG/L	DEFICIT MG/L	DISS O2 MG/L	SEGMENT NUMBER	CBOD5 MG/L	DEFICIT MG/L	DISS O2 MG/L
295.	0.23	0.39	7.20	296.	0.22	0.41	7.18
297.	0.22	0.42	7.17	298.	0.22	0.42	7.17
299.	0.22	0.42	7.17	300.	0.34	0.23	7.36
301.	0.32	0.25	7.34	302.	0.31	0.27	7.32
303.	0.30	0.29	7.30	304.	0.30	0.29	7.30
305.	0.29	0.29	7.30	306.	0.22	1.07	6.62
307.	0.21	1.01	6.68	308.	0.21	0.96	6.73
309.	0.20	0.94	6.75	310.	0.20	0.90	6.69
311.	0.20	0.88	6.81	312.	0.20	0.86	6.73
313.	0.20	0.84	6.85	314.	0.22	0.85	6.74
315.	0.21	0.84	6.85	316.	0.26	0.87	6.72
317.	0.24	0.87	6.72	318.	0.25	0.89	6.70
319.	0.25	0.90	6.59	320.	0.26	0.92	6.57
321.	0.26	0.95	6.54	322.	0.29	1.04	6.45
323.	0.32	1.11	6.38	324.	0.34	1.15	6.24
325.	0.36	1.19	6.10	326.	0.42	1.25	6.14
327.	0.45	1.31	6.08	328.	0.43	1.35	5.94
329.	0.44	1.43	5.86	330.	0.43	1.47	5.82
331.	0.42	1.46	5.83	332.	0.39	1.30	5.99
333.	0.35	1.20	6.19	334.	0.34	1.21	6.28
335.	0.40	1.46	5.93	336.	3.14	0.81	7.88
337.	5.54	0.95	7.74	338.	5.04	1.04	7.65
339.	4.61	1.05	7.64	340.	4.47	1.06	7.63
341.	5.14	1.20	7.49	342.	7.60	1.61	7.08
343.	6.93	1.69	6.90	344.	5.83	1.76	6.83
345.	4.47	2.24	6.35	346.	3.54	3.53	4.96
347.	3.16	4.63	3.76	348.	3.86	5.52	2.87
349.	3.67	5.72	2.67	350.	3.99	5.86	2.43
351.	3.20	5.68	2.51	352.	2.73	5.49	2.70
353.	1.93	5.26	2.83	354.	1.54	4.89	3.20
355.	1.27	4.58	3.41	356.	1.20	4.44	3.55
357.	1.15	4.24	3.65	358.	1.37	3.81	3.98
359.	1.39	3.35	4.34	360.	1.24	1.05	7.64
361.	1.56	1.11	7.58	362.	1.66	1.15	7.54
363.	1.68	1.18	7.51	364.	1.70	1.21	7.48
365.	1.72	1.25	7.44	366.	1.74	1.33	7.36
367.	1.85	1.36	7.33	368.	2.31	1.43	7.26
369.	4.51	1.64	7.05	370.	4.48	1.71	6.98
371.	4.44	1.79	6.90	372.	4.38	1.88	6.71
373.	4.25	2.08	6.51	374.	4.10	2.31	6.28
375.	3.99	2.48	6.11	376.	3.89	2.64	5.95
377.	3.81	2.81	5.78	378.	3.75	3.02	5.47
379.	3.75	3.33	5.16	380.	3.81	3.51	4.98
381.	3.94	3.70	4.69	382.	4.16	3.90	4.49
383.	4.51	4.13	4.26	384.	4.40	4.25	4.14
385.	4.31	4.36	3.93	386.	4.23	4.47	3.82
387.	4.16	4.58	3.71	388.	4.12	4.70	3.59
389.	4.11	4.81	3.38	390.	4.14	4.94	3.25
391.	4.22	5.08	3.11	392.	4.36	5.22	2.87

RUN NUMBER 09

SEGMENT NUMBER	CBOD5 MG/L	DEFICIT MG/L	DISS O2 MG/L	SEGMENT NUMBER	CBOD5 MG/L	DEFICIT MG/L	DISS O2 MG/L
393.	4.58	5.38	2.71	394.	4.45	5.50	2.59
395.	4.27	5.62	2.37	396.	3.99	5.61	2.38
397.	3.57	5.44	2.45	398.	3.01	5.09	2.80
399.	2.42	4.61	3.18	400.	1.92	4.04	3.75
401.	1.45	3.01	4.68	402.	1.16	2.74	4.95
403.	0.98	2.61	4.98	404.	0.81	2.55	5.04
405.	0.76	2.48	5.11	406.	0.75	2.42	5.17
407.	0.50	1.86	5.83	408.	0.61	2.05	5.64
409.	0.67	2.17	5.42	410.	0.75	2.38	5.21
411.	0.79	2.44	5.15	412.	0.84	2.50	5.09
413.	0.99	2.65	4.84	414.	1.00	2.78	4.71
415.	1.02	2.84	4.65	416.	1.05	2.90	4.49
417.	1.09	2.93	4.46	418.	0.99	2.92	4.37
419.	0.91	2.88	4.41	420.	0.83	2.83	4.46
421.	0.75	2.75	4.64	422.	0.70	2.68	4.71
423.	0.67	2.63	4.76	424.	0.63	2.57	4.82
425.	0.59	2.50	4.89				



RUN NUMBER 03



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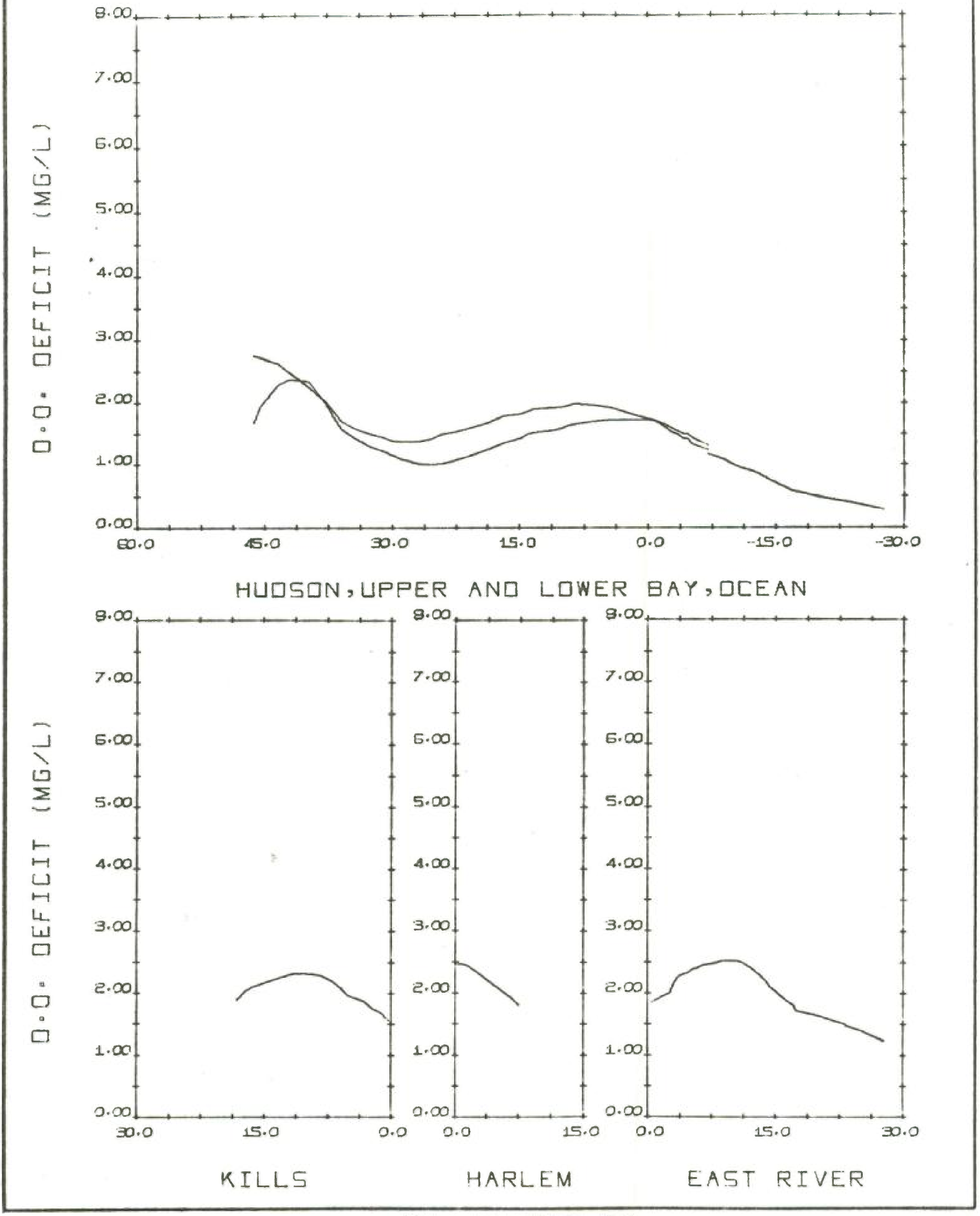

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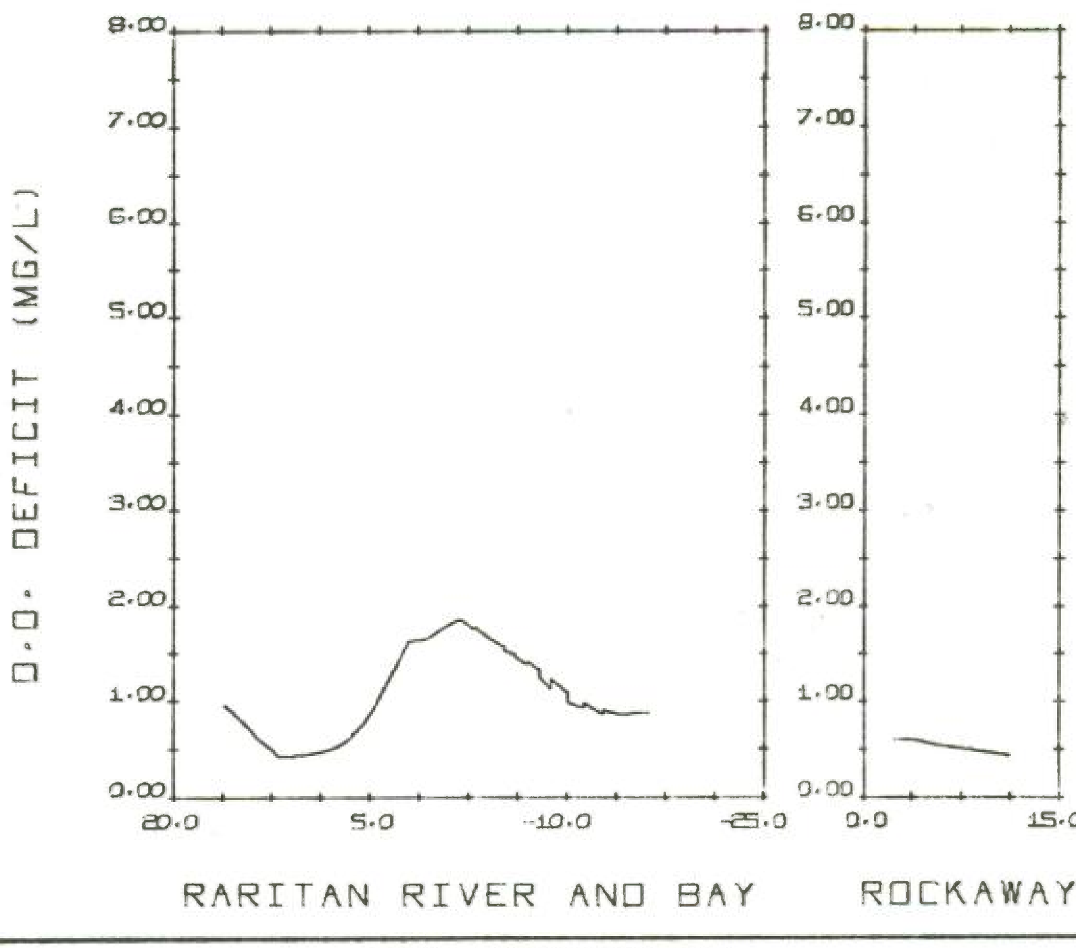


RUN NUMBER 03

Q/nu-ISC

HydroQual, Inc.

CONSULTANTS IN WATER POLLUTION CONTROL

TRANSMITTAL

TO: New York Harbor Water Quality
Steering Committee
C/O Interstate Sanitation Commission
10 Columbus Circle
New York, NY 10019

DATE: January 9, 1983

FILE: ISC00010

ATTENTION:

RE: Water Quality in New York Harbor

WE ARE SENDING YOU X HEREWITH ____ UNDER SEPARATE COVER VIA

1. Appendix to the draft report, Evaluation of Water Quality Management Alternatives in New York Harbor.

2. Revised Figure 4-3 (more carefully compiled from computer plots).

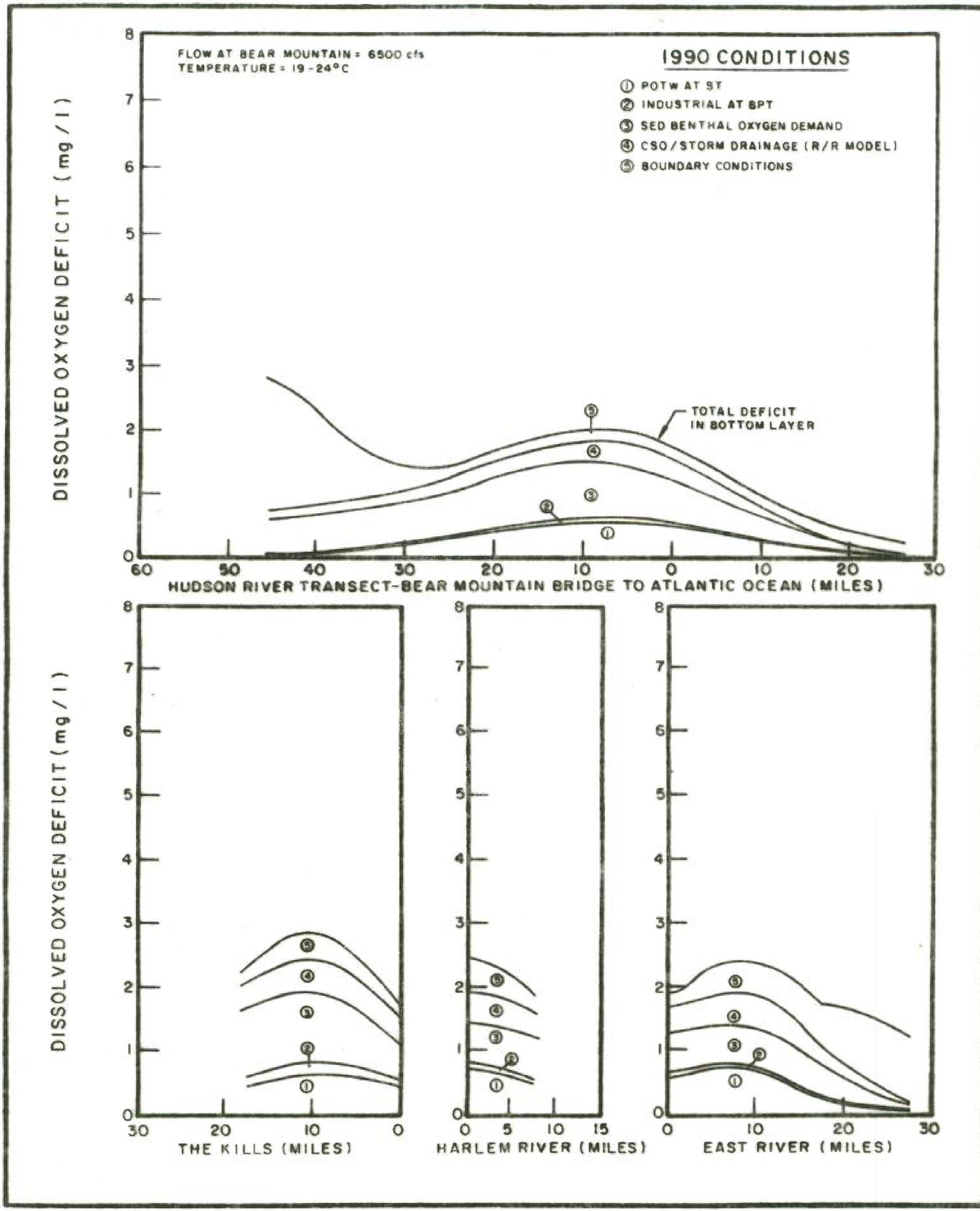
THE ABOVE ARE FOR YOUR X INFORMATION X APPROVAL

X AS REQUESTED ____ OTHER

REMARKS: At our meeting, there was some discussion of potential continuing violation of standards in the Upper East River in the vicinity of Throgs Neck for various treatment options less than secondary. Please note that there is a fairly substantial effect of the assigned East River Boundary condition at this location. While these boundary conditions are felt to be reasonable in the absence of much data in this area, they are assumed. This should be considered in the decision making process.

IF ENCLOSURES ARE NOT AS NOTED, PLEASE NOTIFY US AT ONCE.

John P. St. John, P.E.



FLOW AT BEAR MOUNTAIN = 6500 cfs
TEMPERATURE = 19 - 24°C
1990 CONDITIONS
① POTW AT ST
② INDUSTRIAL AT BPT
③ SED BENTHAL OXYGEN DEMAND
④ CSO/STORM DRAINAGE (R/R MODEL)
⑤ BOUNDARY CONDITIONS
TOTAL DEFICIT IN BOTTOM LAYER
DISSOLVED OXYGEN DEFICIT (mg/l)
HUDSON RIVER TRANSECT-BEAR MOUNTAIN BRIDGE TO ATLANTIC OCEAN (MILES)
THE KILLS (MILES)
HARLEM RIVER (MILES)
EAST RIVER (MILES)

ERRATA

TABLE 3-2

No. 14

$$\text{CSO Load} = F2 \left[\frac{X \times F1 + (X-I)\ F1 + I_{RR} \times F2}{F1 + F2} \right]$$