INTERSTATE SANITATION COMMISSION
10 COLUMBUS CIRCLE - Room 1620
NEW YORK, NEW YORK 10019

D R A F T

HYDROQUAL REPORT TO ISC

OFFICE COPY
M.W.'s copy

Draft
adw 1/5/83

DRAFT

HU

EVALUATION OF WATER QUALITY MANAGEMENT ALTERNATIVES IN NEW YORK HARBOR

HydroQual, Inc.

1 LETHBRIDGE PLAZA
MAHWAH, NEW JERSEY 07430

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

DRAFT

EVALUATION OF WATER QUALITY MANAGEMENT ALTERNATIVES IN NEW YORK HARBOR

Job No. ISCO0010

HydroQual, Inc.
1 Lethbridge Plaza
Mahwah, New Jersey 07430

December, 1982

HydroQual, Inc.

CONSULTANTS IN WATER POLLUTION CONTROL

THOMAS J. MULLIGAN
JOHN P. ST. JOHN
THOMAS W. GALLAGHER
EUGENE J. DONOVAN, JR.
O. KARL SCHEIBLE

[illegible]

DRAFT

January 5, 1983

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

Attn: New York Harbor Water Quality Steering Committee

Gentlemen:

We are pleased to transmit our draft report, Evaluation of Water Quality Management Alternatives in New York Harbor.

The report summarizes preliminary work which was undertaken to assess the effect of various wastewater management alternatives on dissolved oxygen conditions in New York Harbor. This work was performed in anticipation of the submission of applications for waiver of secondary treatment requirements from various dischargers in accordance with Section 301(h) of the Clean Water Act. All detailed technical results are presented in the Appendix. On the basis of the results obtained, it appears that certain wastewater management options with less than secondary treatment at all municipal sources will maintain water quality standards for dissolved oxygen, at least marginally, and can be considered.

We appreciate the opportunity to have been of service.

Very truly yours,

HYDROQUAL, INC.

John P. St. John, P.E.

JPSJ:kk
Enclosure

ACKNOWLEDGEMENTS

DRAFT

James J. Fitzpatrick served as Project Manager of this study for HydroQual, Inc., James A. Hallden was Project Engineer and performed almost all of the model executions and graphical and tabular displays of the results. William M. Leo and Michael T. Kontaxis provided technical advice in the New York Harbor Water Quality Model. John P. St. John was Principal Engineer and drafter the report. Donald J. O'Connor was project Consultant.

The timely cooperation and technical input of the New York Harbor Water Quality Steering Committee is gratefully acknowledged.

DRAFT

TABLE OF CONTENTS

LIST OF FIGURES DRAFT

DRAFT

DRAFT

LIST OF TABLES

SECTION 1

DRAFT

INTRODUCTION

BACKGROUND

Section 301(h) of the Clean Water Act allows certain municipal wastewater dischargers to file an application to the U.S. Environmental Protection Agency for a waiver of secondary treatment. Such applications must be reviewed and approved by appropriate state and interstate officials prior to consideration by the federal government. The regulations established by USEPA for implementation of Section 301(h) are stringent requiring, among other things, that:

1) applicants be coastal communities discharging to the ocean or tidal estuaries

2) the modified discharge maintain all applicable state water quality standards

3) modification of a discharge not require additional levels of treatment for other dischargers in the case of overlapping effects.

A substantial portion of New York Harbor falls under the federal classification of a coastal tidal estuary. As a result, it is expected that a number of applications for waiver will be received for various municipal discharges in the metropolitan area.

In review of these applications by regulatory personnel, consideration will be given to the fact that water quality in New York Harbor has been below applicable standards historically, particularly that for dissolved oxygen, and that due to the interactive nature of New York Harbor, there are substantial overlapping effects among the dischargers. The effect of modification of any particular discharge must also consider the impact of all the interactive discharges. In the case of New York Harbor with many discharges and the states of New York and New Jersey involved, questions of equity must also be considered.

PURPOSE OF STUDY

The present investigation was conducted to provide the New York Harbor Water Quality Steering Committee (U.S. EPA Region II, Interstate Sanitation Commission, States of New York and New Jersey) with basic technical information necessary for review of certain aspects of any 301(h) applications which may be submitted by dischargers to New York Harbor. The study is intended to provide information in the following areas.

DRAFT

1) what is the estimated distribution of dissolved oxygen in New York Harbor in the future after implementation of secondary wastewater treatment at all POTWs and best practical treatment (BPT) at all direct industrial discharges

2) on the basis of the above, how much assimilation capacity will exist, if any, which would permit the disposal of less-than-secondary treated wastewaters from POTWs and maintain water quality standards for dissolved oxygen

3) if some assimilation capacity is estimated to exist in the future at secondary treatment, what would be the effect of various reductions in treatment efficiency at all and selected POTWs on harbor dissolved oxygen under various environmental conditions

4) what are the most important factors in the foregoing estimates, and how sensitive are the results to these factors.

SCOPE OF WORK

The report is a summary of technical activities which were undertaken to achieve the foregoing objectives. A brief

DRAFT

description of methodology is presented on the application of the New York Harbor Water Quality Model. The specifications for the analysis which were established by agreement with the Steering Committee are reviewed in detail. The output of specific model runs executed in accordance with the specifications are presented in graphical and tabular form. A brief discussion of results is also presented.

SECTION 2

DRAFT

METHODS OF ANALYSIS

WATER QUALITY MODEL

? The most technically advantageous method to address water quality issues in the metropolitan area is by application of the New York Harbor Water Quality Model. This model was originally developed for the Interstate Sanitation Commission (ISC) and subsequently refined during the New York City 208 Areawide Wastewater Management Study. The model is deterministic in nature and accounts for the cause-and-effect relationships between wastewater inputs and water quality impacts. It was developed specifically to address planning questions such as those previously indicated. [Balanced presentation would also set forth limitations of the model & the modeling approach

The New York Harbor Water Quality Model is advective-dispersive in nature and is based on the mass balance concept. The basic differential equations are applied in three-dimensions in a finite-difference format. Figure 2-1 is a schematic diagram of the refined segmentation system of New York Harbor established for the 208 Study version of the model. The model is segmented vertically into two layers in the Hudson River from the Narrows

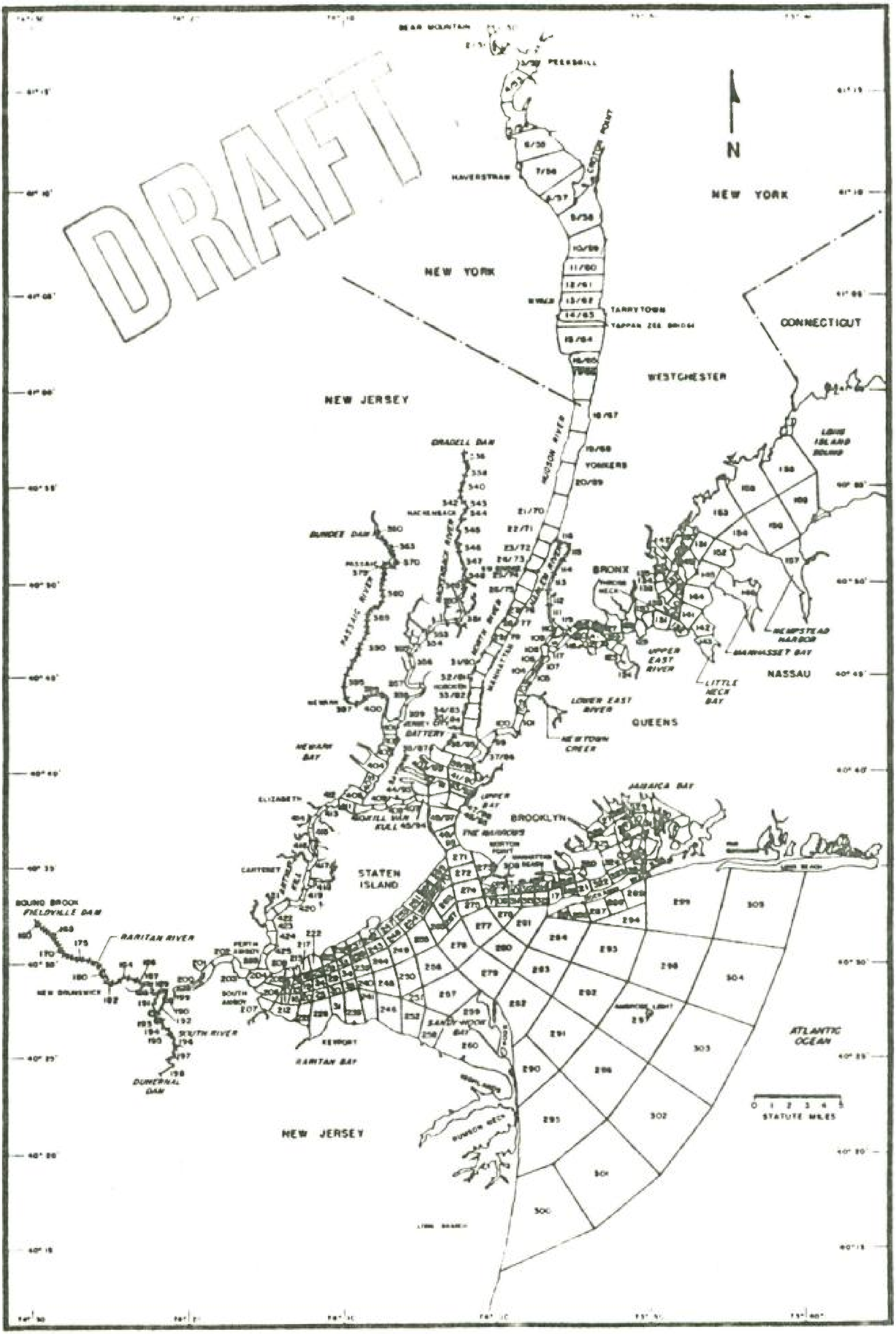

FIGURE 2-1

SCHEMATIC OF N.Y.C. 208 MODEL SEGMENTATION

DRAFT

upstream to the Bear Mountain Bridge. This vertical segmentation is necessary to account for the two-layer density induced circulation pattern and observed vertical 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.

Two versions of the New York Harbor Water Quality Model exist, steady-state and time-varying. The latter version was developed primarily to account for the immediate short term (hours to days) effect of dynamic events, particularly combined sewer overflow and stormwater discharges during and subsequent to rainfall events. The former model, steady-state, was developed to calculate the effects of continuous discharges on a steady basis and is the version employed for this analysis. The steady-state model can be considered as a seasonal model primarily as all factors in the model were averaged over a three month period during the summer (mid-June through mid-September) for most of the calibration/validation periods.

Previous Calibrations

The New York Harbor Water Quality Model was calibrated and validated with a variety of water quality data sets during both

DRAFT

TABLE 2-1

SUMMARY OF VERIFICATION PERIODS AND TRIBUTARY FRESHWATER FLOWS

(NYC 208 Study)

	Freshwater Flow (cfs) at				
Verification Period	Hackensack River	Passaic River	Raritan River	South River	Bear Mountain
Summer 1965	0	79	128	32	3200
Summer 1970	9	185	380	0	5300
Summer 1975	21	1267	1023	192	11800
September 1975	21	1267	1023	192	11800
Nov.-Dec. 1976	3	386	432	75	18400
July 1977	28	207	330	45	7600

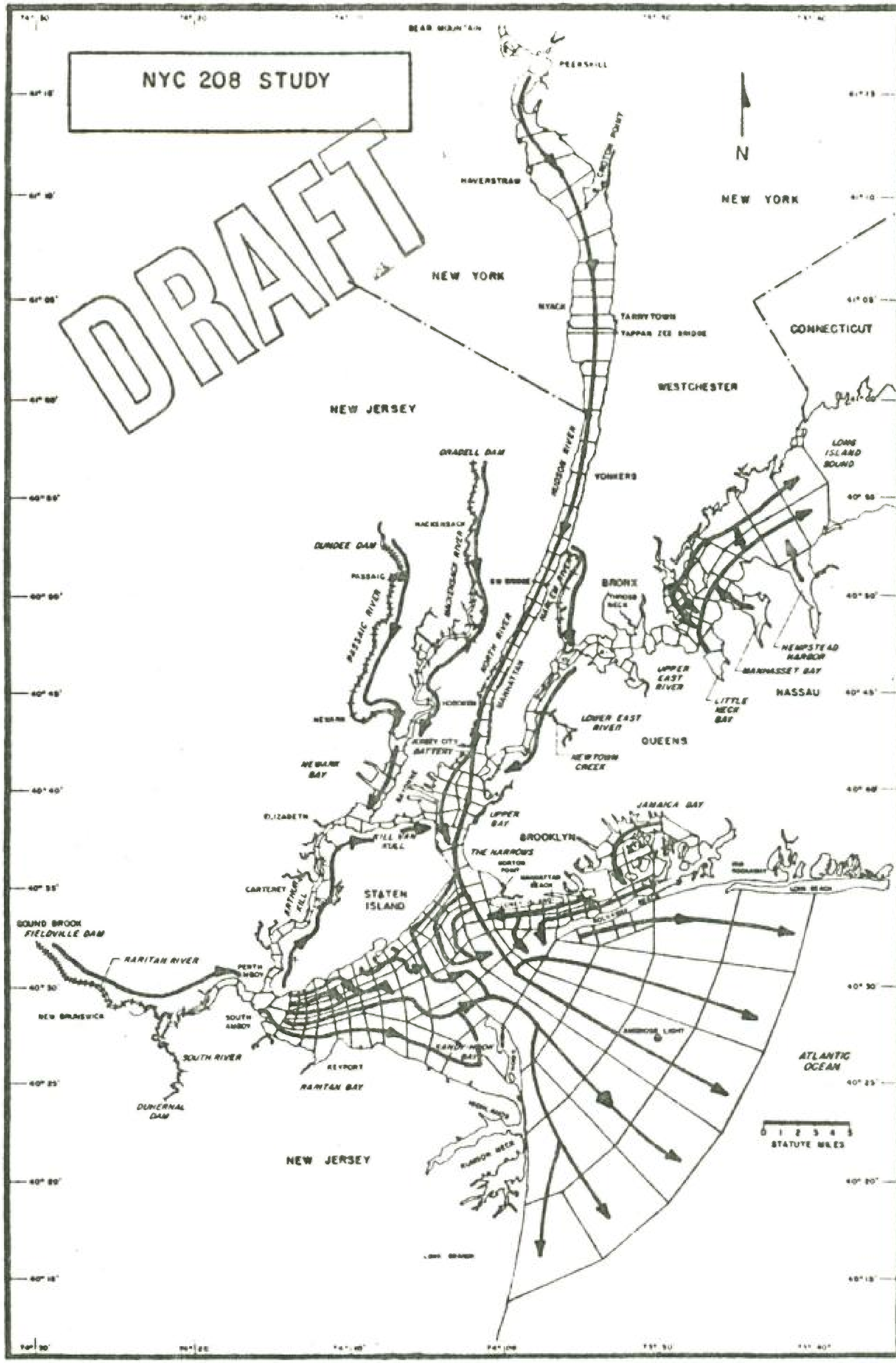

FIGURE 2-2
ILLUSTRATION OF FLOW ROUTING IN STEADY STATE MATHEMATICAL MODEL

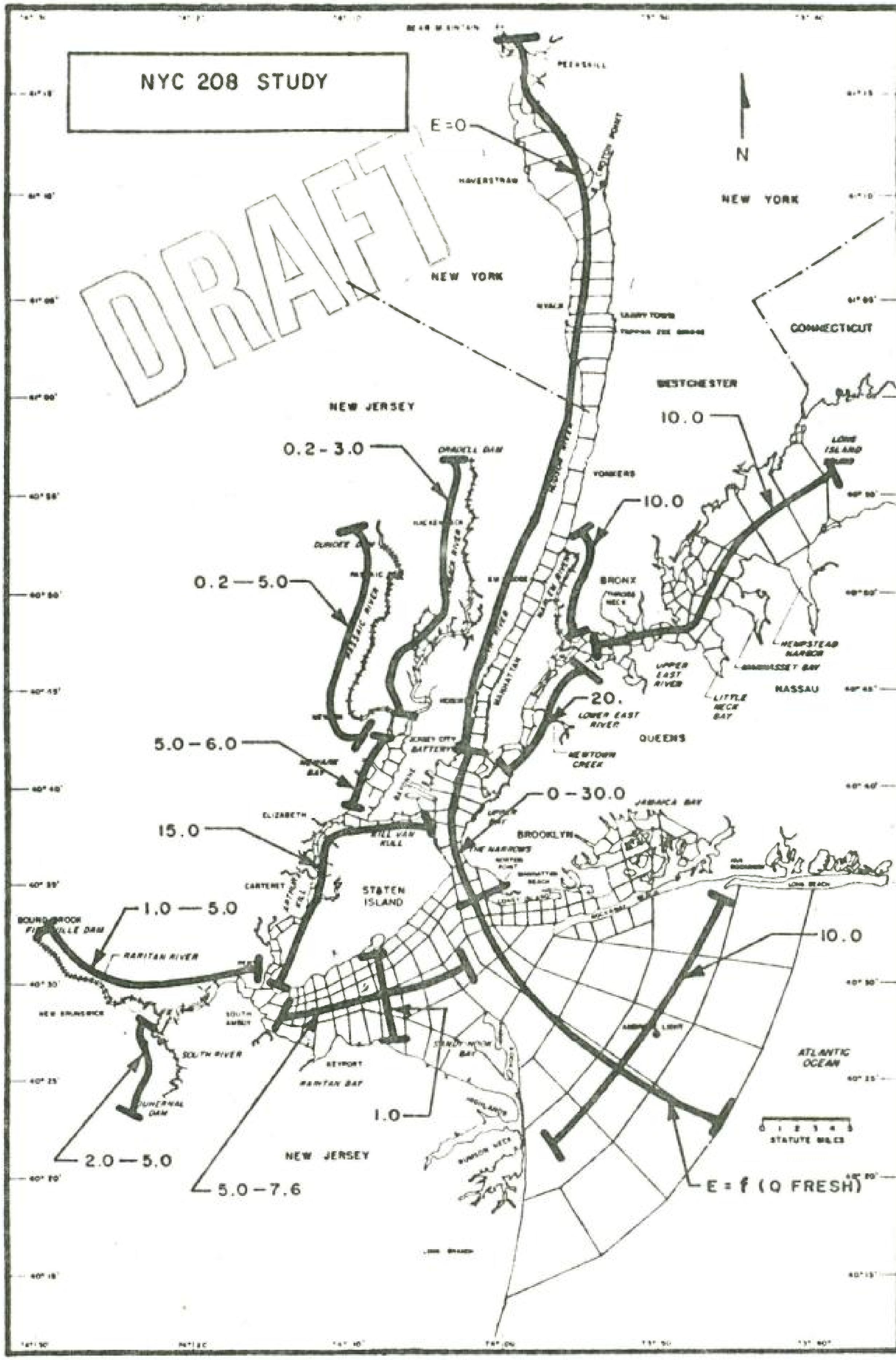

FIGURE 2-3
DISPERSION COEFFICIENT (E) SQ. MILES/DAY

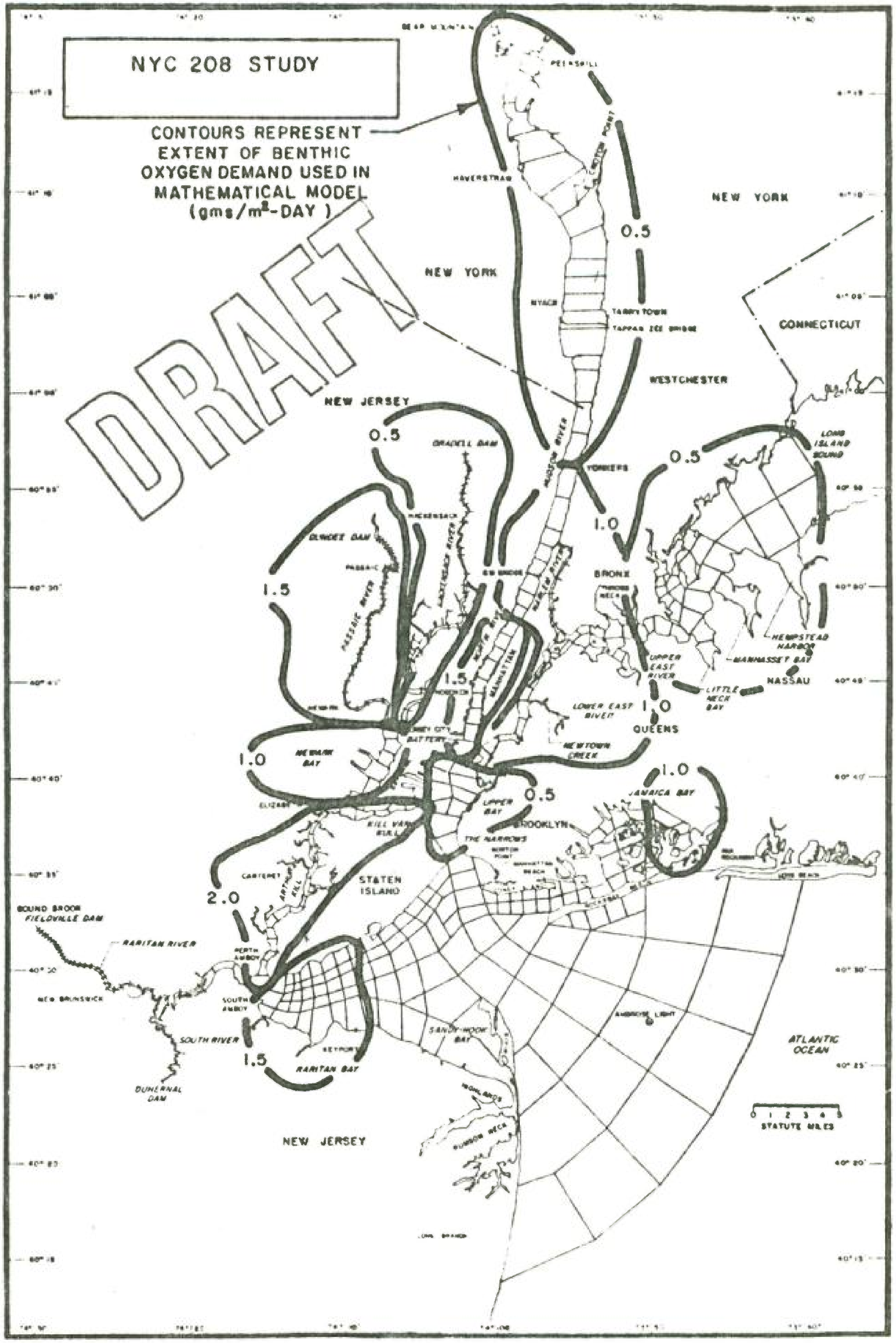

FIGURE 2-4

SUMMARY OF BENTHAL OXYGEN DEMANDS

DRAFT

the ISC and 208 investigations. In the latter study, the steady-state model was tested with data collected under five different flow and temperature conditions. Flow conditions varied from 3,200 cfs in the Hudson River at Bear Mountain during the summer of 1965 to 18,400 cfs during the fall of 1976. Table 2-1 indicates the calibration/validation periods for the 208 Study and shows the freshwater flow inputs at the various boundaries of the model.

During the 208 Study, the seasonal water quality model was tested against data for salinity, BOD, dissolved oxygen, total kjeldhal nitrogen, nitrate nitrogen, total and fecal coliform data, total phosphate, suspended solids and selected heavy metals. Verifications with salinity data which indicate the adequacy of the model's transport characteristics and verifications with dissolved oxygen are pertinent to this investigation.

Figure 2-2 indicates the general flow routing scheme by which fresh water flow introduced at the boundaries of the system are routed through the model. Figure 2-3 illustrates dispersion coefficients for various locations in the model as determined from calibration with salinity and/or chloride data for the various periods indicated in Table 2-1. Figure 2-4 indicates the distribution of benthal oxygen demand throughout New York Harbor as assigned from sampling data obtained during the 208 Study.

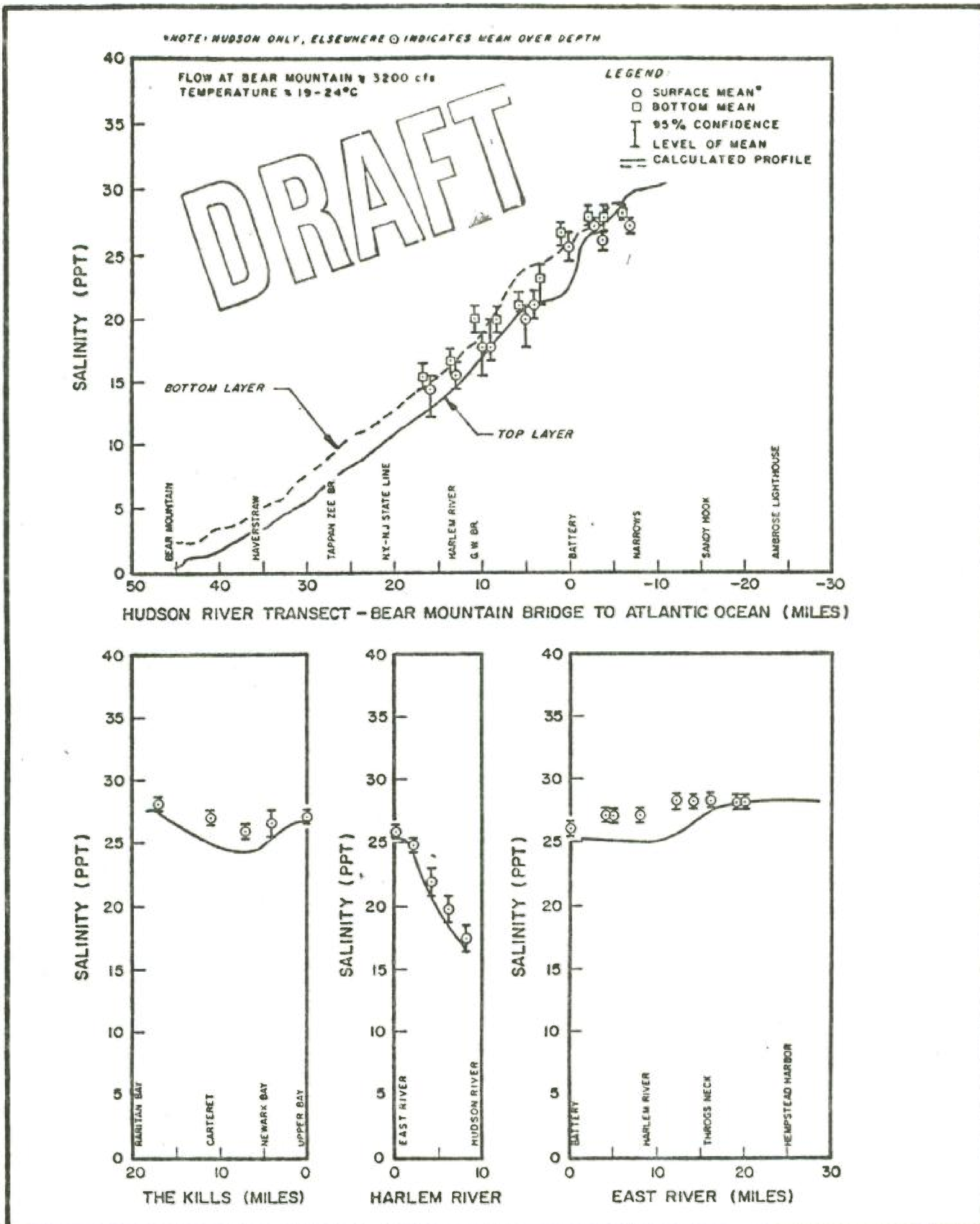

FIGURE 2-5

COMPARISON OF OBSERVED AND CALCULATED SALINITY PROFILES

(JUNE 8 TO SEPTEMBER 14, 1965)

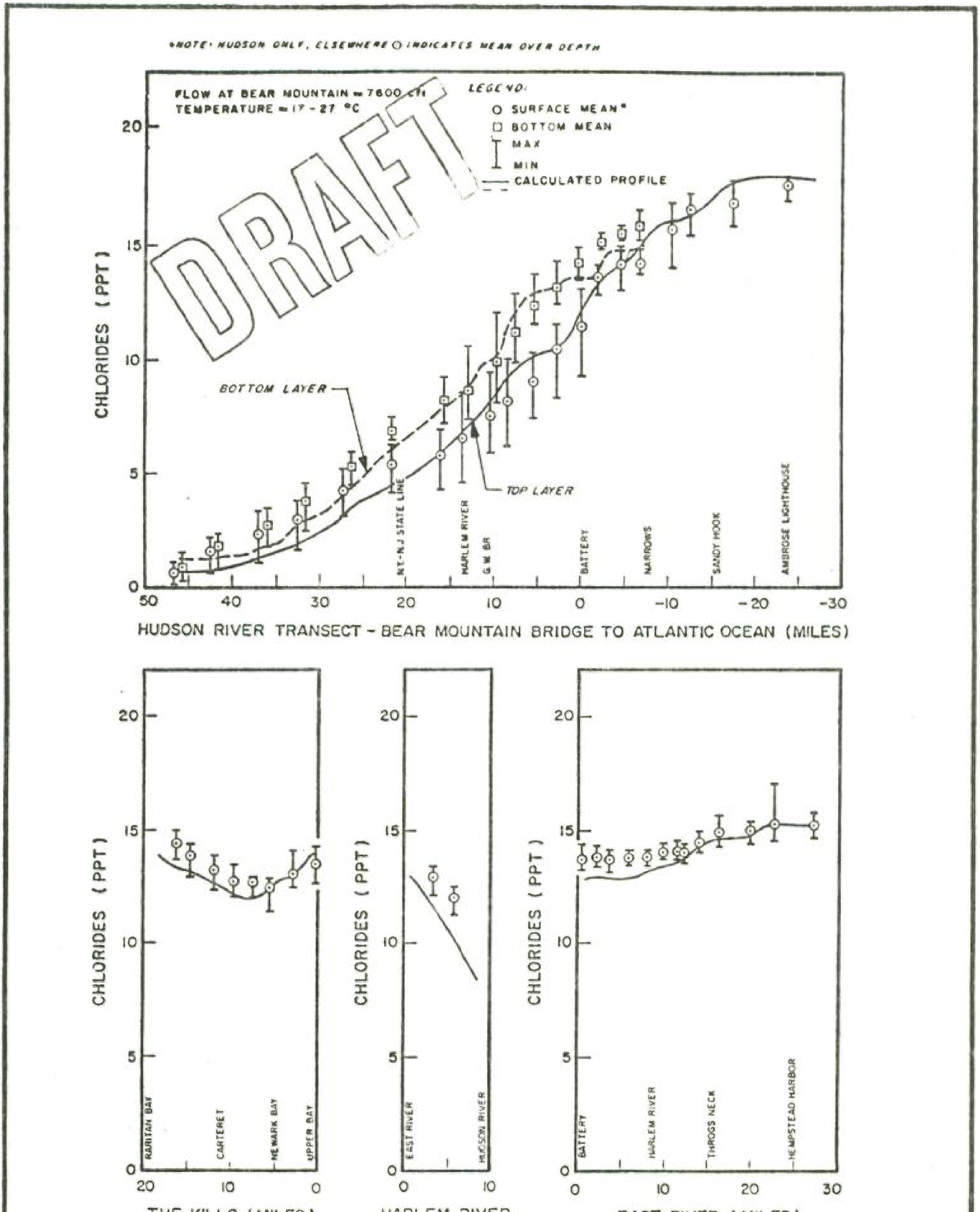

FIGURE 2-6
COMPARISON OF OBSERVED AND CALCULATED CHLORIDES PROFILES
(JULY 5-29, 1977)

DRAFT

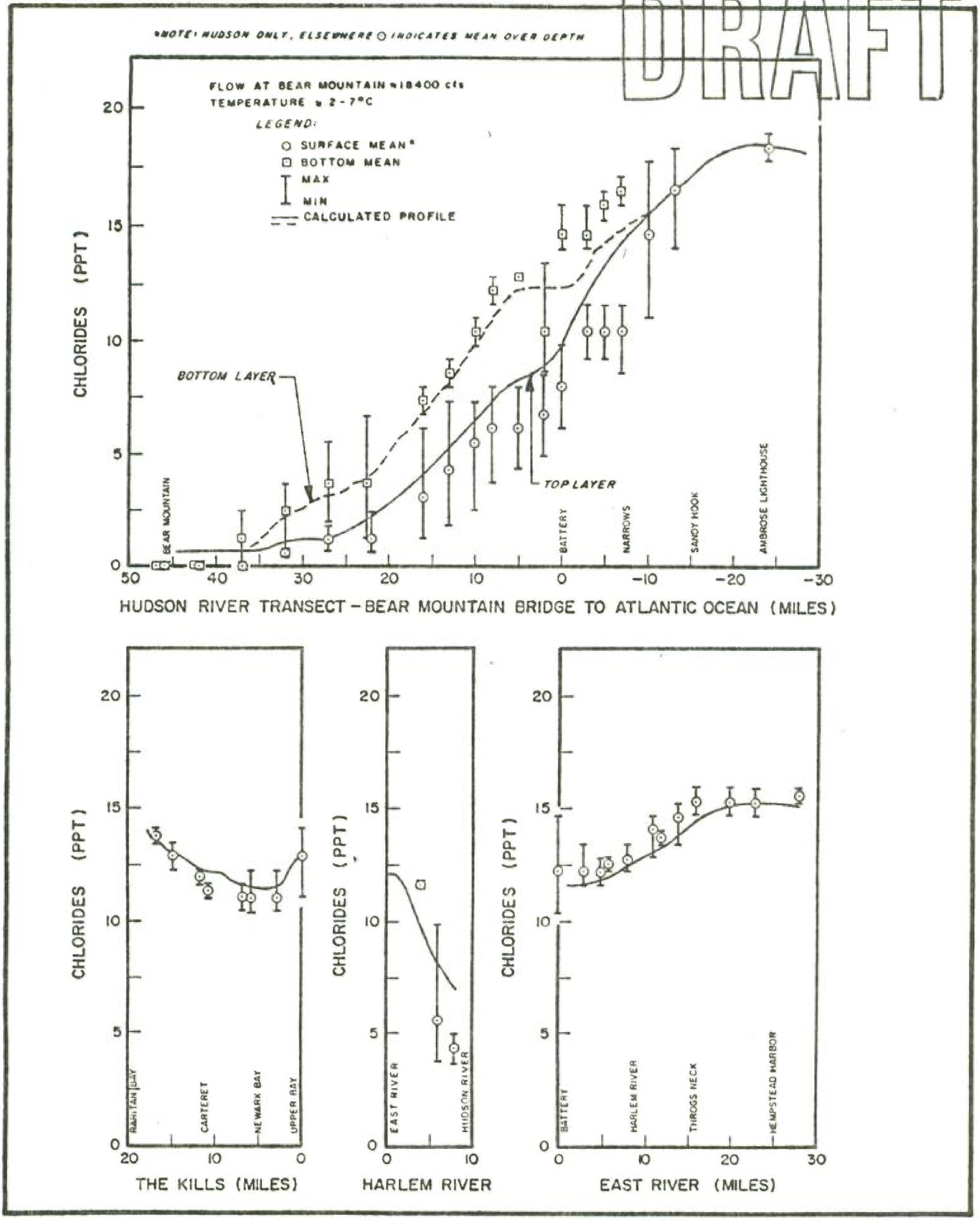

FIGURE 2-7
COMPARISON OF OBSERVED AND CALCULATED CHLORIDES PROFILES
(NOVEMBER 29 TO DECEMBER 17, 1976)

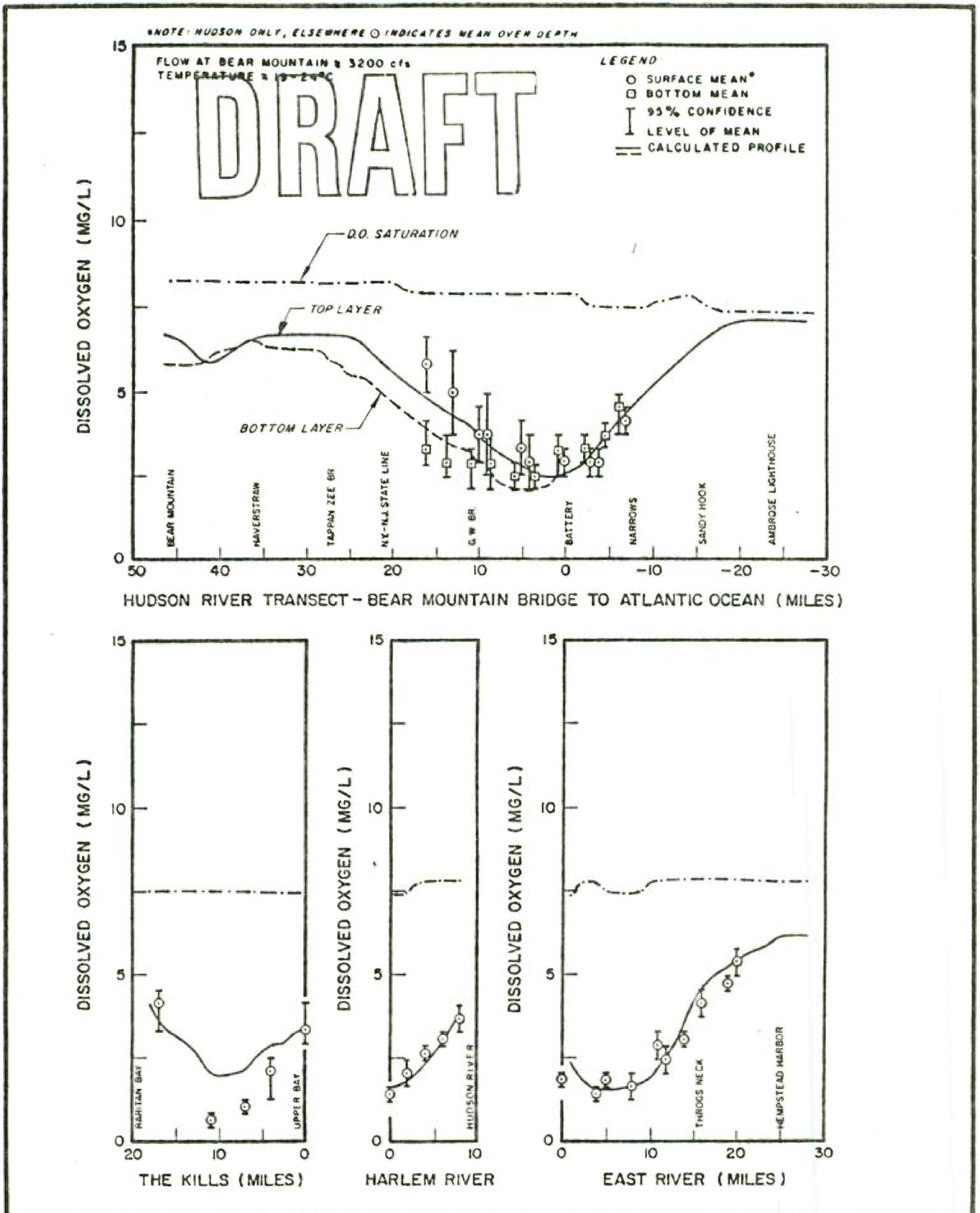

FIGURE 2-8
COMPARISON OF OBSERVED AND CALCULATED DISSOLVED OXYGEN PROFILES
(JUNE 8 TO SEPTEMBER 14, 1965)

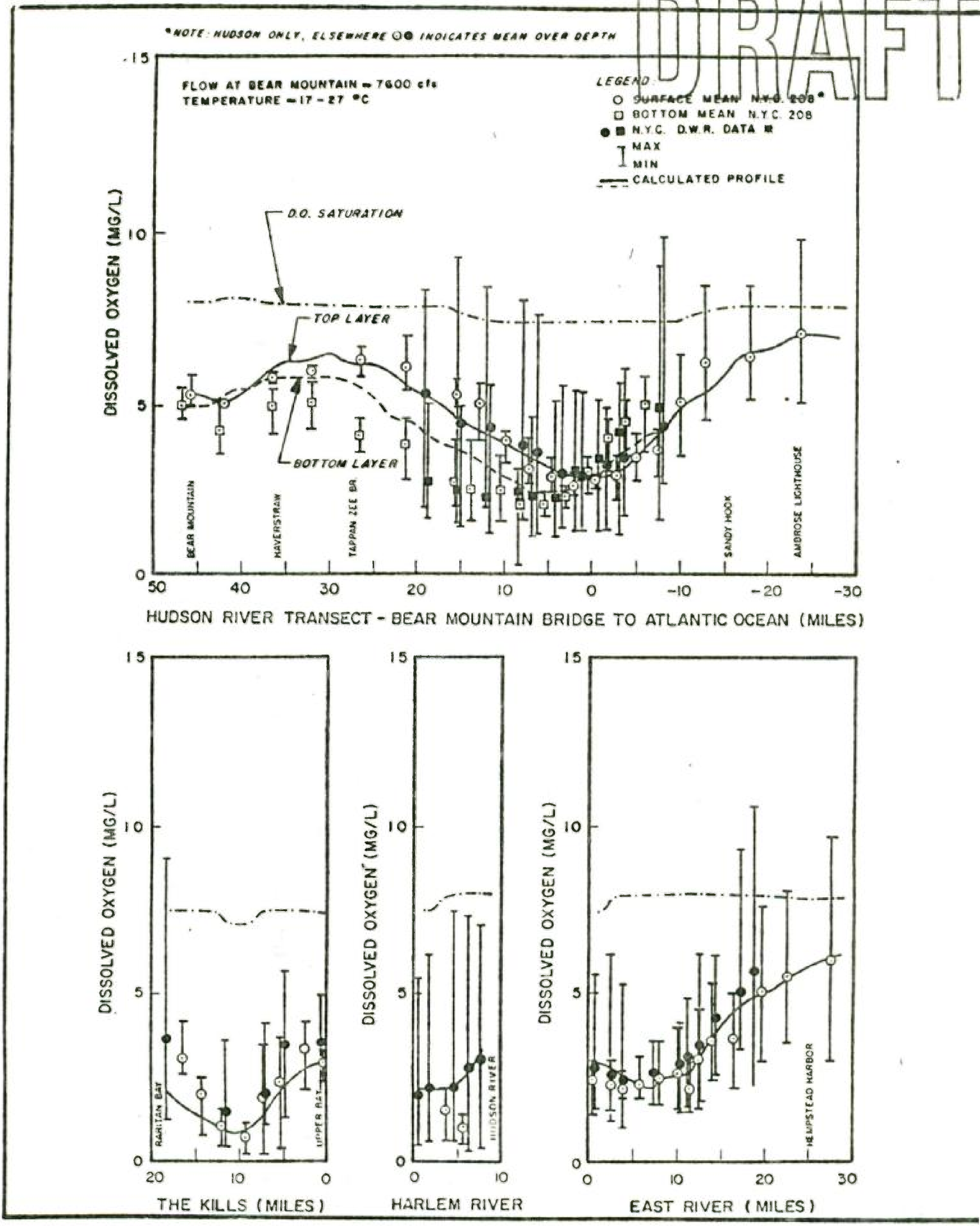

FIGURE 2-9

COMPARISON OF OBSERVED AND CALCULATED DISSOLVED OXYGEN PROFILES

(JUNE 15 TO SEPTEMBER 28, 1977)

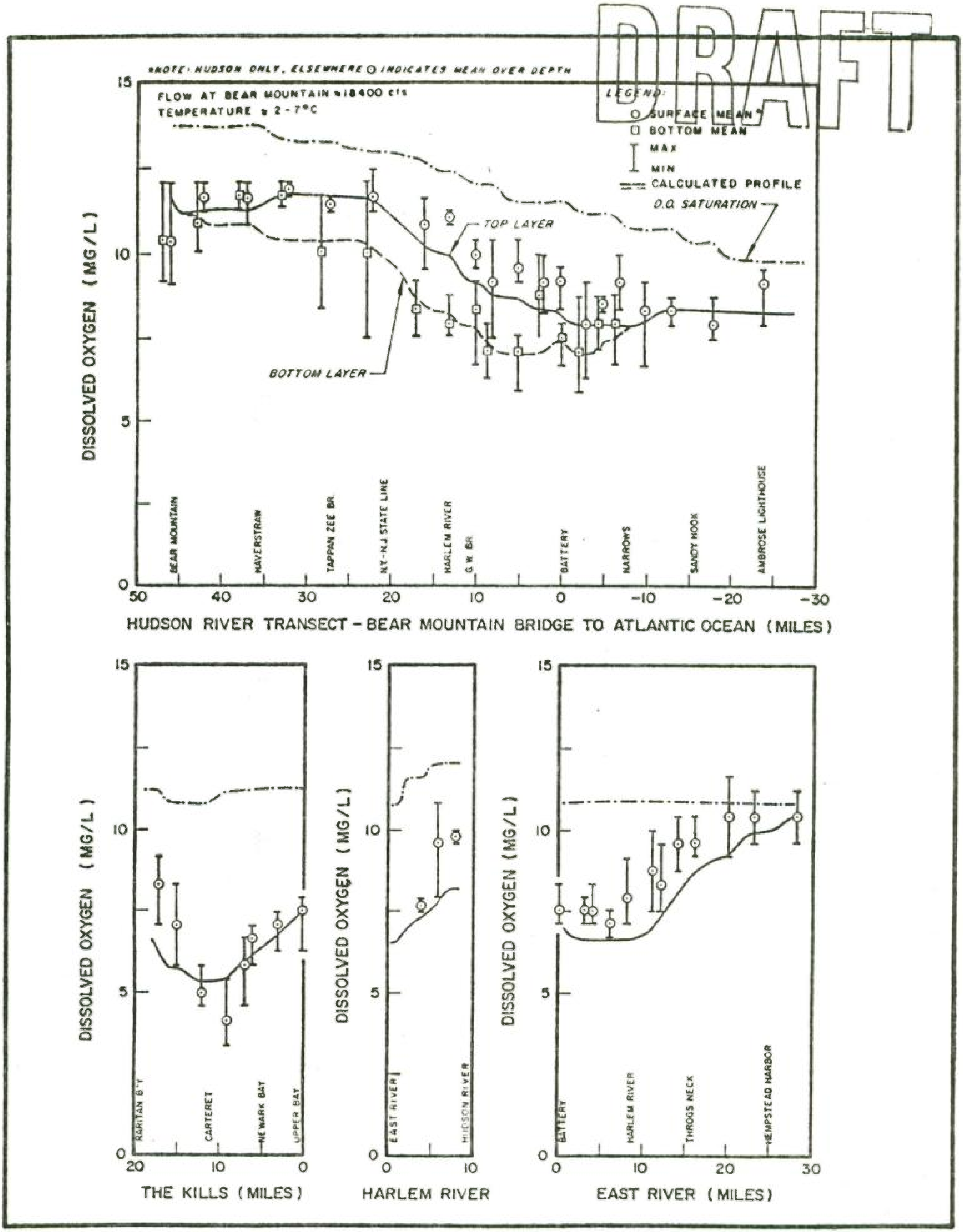

FIGURE 2-10
COMPARISON OF OBSERVED AND CALCULATED DISSOLVED OXYGEN PROFILES
(NOVEMBER 29 TO DECEMBER 17, 1976)

Figure 2-5, 2-6 and 2-7 compare representative model calculated profiles for salinity or chlorides with data as reported in the 208 Study. Calculated profiles and data are shown for various waterways of interest as indicated on the diagrams. For the Hudson River, two calculated profiles are shown: top and bottom layer. Hudson River flows range from 3,200 cfs to 18,400 cfs at Bear Mountain as noted. The degree of vertical stratification in the Hudson River, increasing with flow, is apparent. Agreement between calculations and data is good.

Figures 2-8, 2-9 and 2-10 compare representative model calculations for dissolved oxygen with data as reported in the 208 Study for the same periods as for the transport calibrations. In order to calculate the distributions shown on the diagram, carbonaceous BOD values are input to the model for the following classes of wastewater loadings:

1) municipal (POTW) discharges from New York and New Jersey
2) raw discharges from Manhattan and the Red Hook sections of Brooklyn
3) industrial discharges
4) bypasses and leakage
5) combined sewer overflow and storm drainage averaged over the periods of data collection

DRAFT

In addition, the benthal oxygen demand as depicted on Figure 2-4 exerts an additional effect on the harborwide oxygen balance. In all cases, the baseline carbonaceous oxidation coefficient was taken as 0.25/day at 20°C and adjusted to the harborwide average water temperature distributions for the respective periods. No harborwide instream nitrification was detected nor included in the calculations except for a small section of the Raritan River. Dissolved oxygen saturation values were assigned throughout the harbor from local water temperature and salinity.

As with salinity/chlorides, stratification for dissolved oxygen in the Hudson River is pronounced. Figures 2-8 and 2-9 compare calculations and data for summer periods during 1965 and 1977. Figure 2-10 shows similar results for a late fall condition during 1976. Model results generally compare favorably with observed data.

Shouldn't there be discussion of years picked & their characteristics?

Variability of Dissolved Oxygen

In the preceding diagrams, the calculated distributions are intended to represent mean tidal average dissolved oxygen conditions for the indicated periods and are properly compared with the estimated mean of the data points. It is observed, however, that some variation occurs about the calculated mean dissolved oxygen value at each location. This is of some pertinence as applicable water quality standards for dissolved oxygen are written as minimum values.

ISC continuous monitor data from various locations throughout New York Harbor were examined to assess the degree of variability of dissolved oxygen. Data collected during the summer period of various years of record from 1973 through 1976 were analyzed. Dissolved oxygen deficit values were calculated from the data and corrected for tidal effects. The data were analyzed statistically assuming a normal probability distribution, examples of which are shown on Figure 2-11 for a monitor in the lower East River. From this and similar information for other monitoring sites throughout the harbor, it was determined that the seasonal mean dissolved oxygen deficit plus 1.Ø mg/l encompassed most of the observed data with high probability. Table 2-2 summarizes the data analysis and shows the amount of data exceeding this level for the various harbor monitoring sites. The table indicates that daily mean deficit values exceeding the seasonal mean plus 1.Ø mg/l were observed in less than Ø.Ø1 to 6.4% of the observations.

1981 Verification

Prior to the analysis of planning alternatives, the New York Harbor Water Quality Model was tested with more recent data

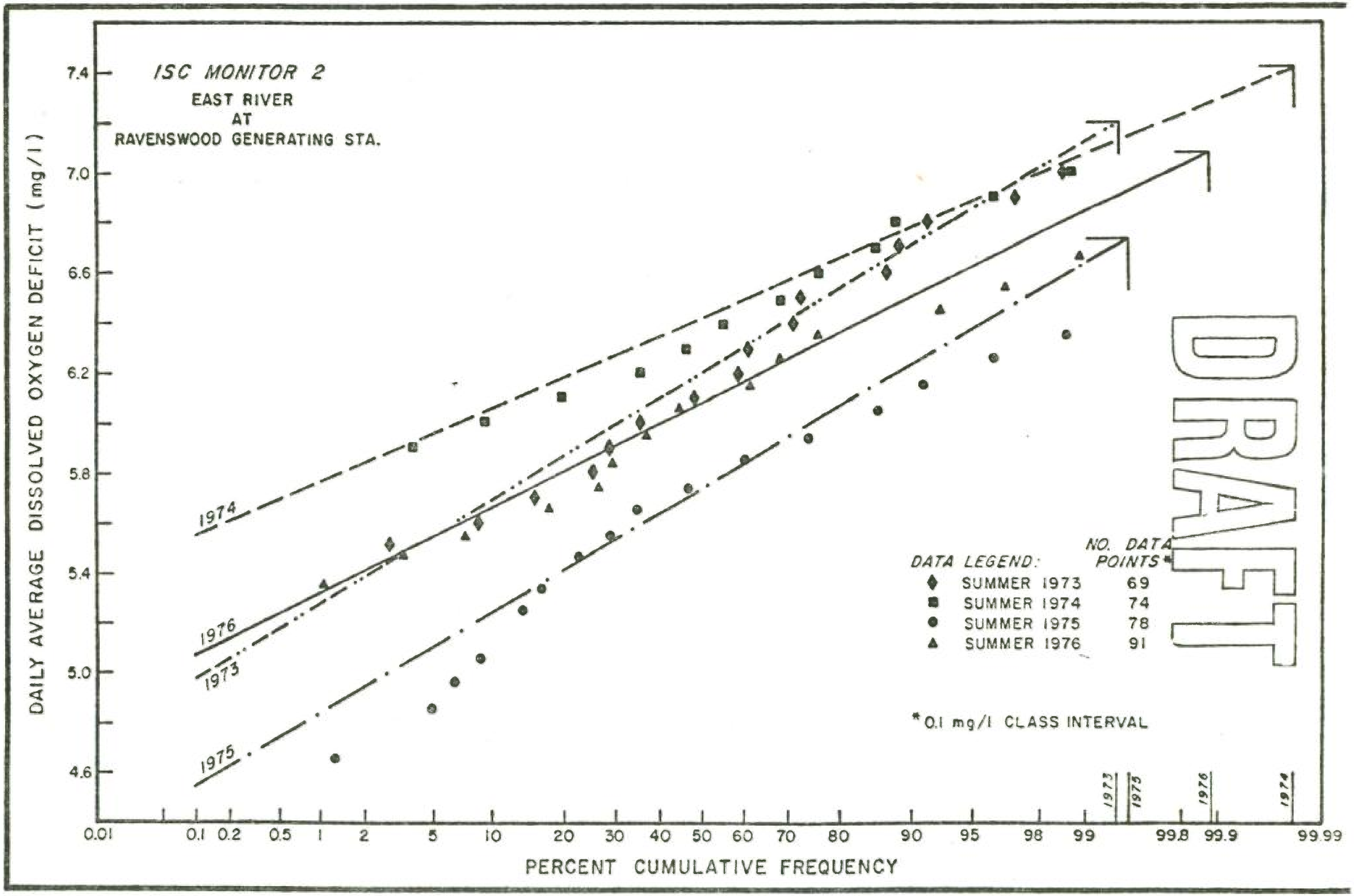

FIGURE 2-11
PROBABILITY PLOT OF SUMMER DAILY AVERAGE DISSOLVED OXYGEN DEFICIT - ISC MONITOR 2

DRAFT

TABLE 2-2

SUMMARY OF ISC MONITOR DISSOLVED OXYGEN DEFICIT STATISTICS FOR JUNE THROUGH SEPTEMBER

ISC Monitor	Year	Mean D.O. Deficit	Std. Dev. D.O. Deficit	No. of Daily Observations	% Exceeding*
1 - Mid-Arthur Kill	1974	5.134	0.330	21	0.1
	1975	4.780	0.320	23	0.09
	1976	4.947	0.484	64	2.0
2 - Lower East River	1973	6.202	0.397	69	0.6
	1974	6.415	0.286	74	0.02
	1975	5.739	0.383	78	0.5
	1976	6.083	0.327	91	0.1
3 - Throgs Neck	1973	5.472	0.610	66	5.1
	1974	4.600	0.452	64	1.4
	1975	5.044	0.471	35	1.7
	1976	5.297	0.576	37	4.1
4 - Raritan River	1973	5.331	0.655	22	6.4
	1974	5.210	0.408	31	0.7
	1975	5.113	0.406	22	0.7
6 - Narrows	1973	6.819	0.344	58	0.2
	1974	7.002	0.284	34	0.02
	1975	6.576	0.249	35	<0.01
	1976	6.639	0.322	41	0.09
7 - Kill Van Kull	1974	6.825	0.253	44	<0.01
	1975	6.733	0.303	57	0.05
	1976	6.948	0.241	43	<0.01

*Percentage of daily means exceeding the seasonal mean deficit plus 1.0 mg/l.

DRAFT

collected during the summer of 1981. Data were obtained from the City of New York routine harbor monitoring program and ISC boat runs. The Hudson River freshwater flow at Bear Mountain for the period of interest was taken as approximately 6,500 cfs. Average rainfall in the metropolitan area was determined to be approximately 0.12 inches/day close to the long term average. Temperature throughout the harbor was similar to conditions in the 1965 verification period and was used in the calculations. Boundary conditions were also taken as similar to the summer of 1965 and were assigned as shown in Table 2-3:

TABLE 2-3

BOUNDARY CONDITIONS

Location of Boundary	BOD (mg/l)	Dissolved Oxygen Deficit (mg/l)
Ocean	0.5	0.0
East River	0.5	1.0
Hudson River	2.0	1.5
Raritan River	1.0	1.0
Hackensack River	1.0	1.0
Passaic River	1.0	1.0
South River	1.0	1.0

DRAFT

Wastewater inputs from municipal and industrial sources were specified by the Steering Committee and are tabulated in Appendix 1. Combined sewer overflow and storm drainage were estimated on the basis on the average rainfall using the techniques from the 208 Study. Other conditions are specified in Table 2-4 which is taken in part from minutes of a meeting with the Steering Committee.

Figures 2-12 and 2-13 compare model calculations with observed data for salinity and dissolved oxygen respectively. In the analysis, the two-layer flow distribution in the Hudson River was interpolated from previous results. No other model modifications were made except to update input information to 1981 conditions as discussed above. Agreement between observed data and calculated results is favorable.

DRAFT

TABLE 2-4

NOTES CONCERNING MODEL TESTING WITH 1981 HARBOR DATA

1. The 1981 input loads for BOD were reviewed and some adjustments were made. For those sources that were in the NYC 208 runs but had not data available for 1981, the attendees determined whether the source still existed and, if so, whether to use NYC 208 loads.

2. The leakage loads for 1981 are to be determined using the same formulas used in the NYC 208 but using 1981 data.

3. The benthic loads are to be the same as for the NYC 208.

4. The deficit loads are to be the same as for the NYC 208.

5. The bypass values for 1981 for NYC were reviewed and will be used in the model runs.

6. It will be assumed that there is no nitrification.

7. The temperatures for 1981 were compared with those for the NYC 208 1965 verification period. There was essentially no difference in the temperatures for the 2 years compared; therefore, it was agreed to use the 1965 verification temperatures.

8. The boundary conditions will be the same as used for the NYC 208.

9. The 1981 runs will be done using the 1981 Hudson River flow at Bear Mountain (approximately 6,500 cfs).

10. For those model runs using the Rainfall/Runoff Model to calculate 1981 CSO loads, the 1981 rainfall will be used. This value is approximately 0.12 inches/day (approximately 3 times the values used for the NYC 208).

11. The following assumptions were made for raw sewage inputs:

    Tottenville - 1.5 MGD @ 100 mg/l
    Red Hook - 53 MGD @ 125 mg/l
    North River - 150 MGD @ 100 mg/l

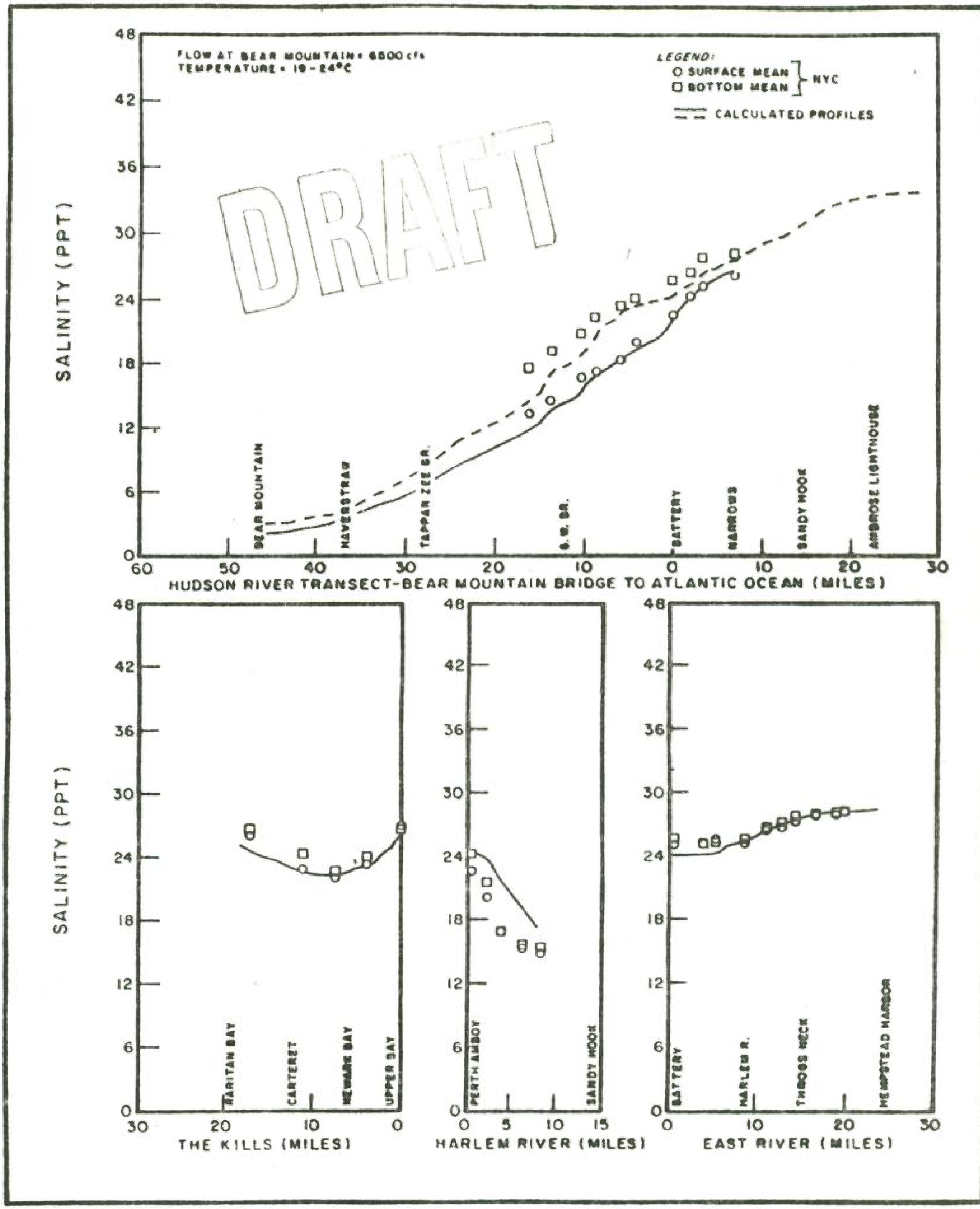

FIGURE 2-12

OBSERVED AND CALCULATED SALINITY PROFILES
SUMMER 1981

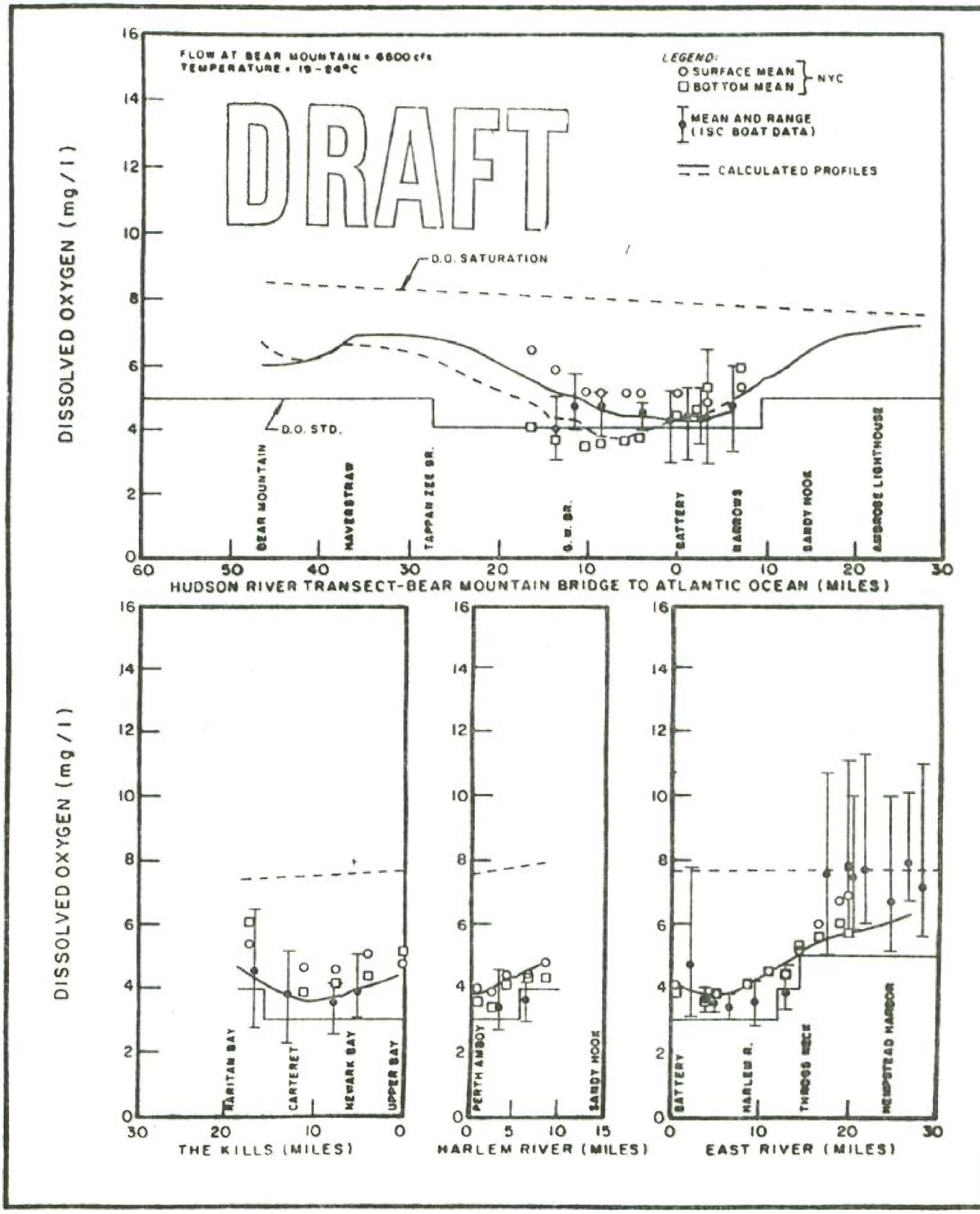

FIGURE 2-13

OBSERVED AND CALCULATED DISSOLVED OXYGEN PROFILES
SUMMER 1981

DRAFT

SECTION 3

SPECIFICATIONS FOR ANALYSIS

In order to achieve the primary objectives of the study, a number of runs were specified by the steering Committee for execution on the New York Harbor Water Qualtiy Model. These runs were designed to assess the effects of various wastewater loading conditions on harbor dissolved oxygen distributions at present and in the future, and to test model sensitivity to various factors which impact the oxygen balance. In all, forty model runs were specified by the Steering Committee, as indicated on Table 3-1. Further detailed information on the specifications of the model runs is presented in Table 3-2 as developed by discussion with the Steering Committee. A summary of the major specifications for the model projections follows.

General

A principal objective of the study work is to project water quality conditions in New York Harbor under a variety of practical loading conditions in order to assess those combinations which will achieve and maintain water quality standards for dissolved oxygen. A variety of loading schemes was therefore

DRAFT

TABLE 3-1

NEW YORK HARBOR WATER QUALITY STEERING COMMITTEE

STEADY STATE MODEL RUNS AS OF NOVEMBER 22, 1982

RUN NO.	YEAR	SEASON	B O D I N P U T S: MUNICIPALS	INDUSTRIALS	CSO's	BENTHIC	COMMENTS (1)
1	1990	Summer	ST	BPT	R/R Model	Yes	(3)
2	1990	Winter	ST	BPT	R/R Model	Yes	(3),(10)
3	1990	Summer	30 mg/l	BPT	None	Yes	(4)
4	1990	Summer	30 mg/l	BPT	R/R Model	Yes	(4)
5	1990	Summer	45 mg/l	BPT	R/R Model	Yes	(5)
6	1990	Summer	ST	None	None	No	(3)
7	1990	Summer	None	BPT	None	No	
8	1990	Winter	30 mg/l	BPT	R/R Model	Yes	T=10°C
9	1990	Summer	ST	BPT	R/R Model	Yes	(6)
10	1990	Summer	ST	BPT	R/R Model	Yes	(7)
11	1990	Winter	ST	BPT	R/R Model	Yes	(7)
12	1981	Summer	ST	BPT	R/R Model	Yes	K = 0.5xK
13	1981	Summer	ST	BPT	R/R Model	Yes	K = 1.5xK
14	1981	Summer	ST	BPT	R/R Model	Yes	T = T+5 deg. F
15	1981	Summer	ST	BPT	R/R Model	Yes	T = T-5 deg. F
16	1990	Summer	None	None	None	Yes	
17		Summer	None	None	R/R Model	No	
18		Summer	None	None	R/R Model	No	K = 0.5xK
19		Summer	None	None	R/R Model	No	K = 1.5xK
20		Summer	None	None	2xR/R Model	No	
21		Summer	None	None	2xR/R Model	No	K = 0.5xK
22		Summer	None	None	2xR/R Model	No	K = 1.5xK

DRAFT

TABLE 3-1 (Continued)

NEW YORK HARBOR WATER QUALITY STEERING COMMITTEE

STEADY STATE MODEL RUNS AS OF NOVEMBER 22, 1982

RUN NO.	YEAR	SEASON	B O D I N P U T S: MUNICIPALS	INDUSTRIALS	CSO's	BENTHIC	COMMENTS (1)
23	1990	Summer	ST for NJ; NY input is "0"	BPT for NJ; NY input is "0"	R/R Model	Yes	
24	1990	Summer	ST for NJ; NY input is "0"	BPT for NJ; NY input is "0"	2xR/R Model	Yes	
25	1990	Summer	ST for NY; NJ input is "0"	BPT for NY; NJ input is "0"	R/R Model	Yes	(3)
26	1990	Summer	ST for NY; NJ input is "0"	BPT for NY; NJ input is "0"	2xR/R Model	Yes	(3)
27	1981	Summer	No Treatment; Loads based on influents	None	None	No	(2)
28	1981	Summer	Actual loads	Actual loads	None	No	(2)
29	1981	Summer	Actual loads	Actual loads	R/R Model	Yes	(2)
30	1981	Summer	Actual loads upgraded for treatment underway	Actual Loads	R/R Model	Yes	(6)
31	1981	Summer	None	None	According to formula	No	See Page 5
32	1981	Summer	None	None	According to formula	No	See Page 5
33	1981	Summer	None	None	According to formula	No	See Page 5
34	1981	Summer	None	None	According to formula	No	See Page 5

DRAFT

TABLE 3-1 (Continued)

NEW YORK HARBOR WATER QUALITY STEERING COMMITTEE

STEADY STATE MODEL RUNS AS OF NOVEMBER 22, 1982

RUN NO.	YEAR	SEASON	BOD INPUTS: MUNICIPALS	BOD INPUTS: INDUSTRIALS	BOD INPUTS: CSO's	BOD INPUTS: BENTHIC	COMMENTS (1)
35	1981	Summer	Actual loads	Actual loads	According to formula	Yes	See Page 5
36	1981	Summer	NONE	NONE	HQI Formula	No	NY only at 150 mg/l
37	1981	Summer	None	NONE	HQI Formula	No	NJ only at 150 mg/l
38	1981	Summer	NONE	NONE	HQI Formula	No	NY only at 225 mg/l
39	1981	Summer	NONE	NONE	HQI Formula	No	NJ only at 225 mg/l
40	1990	Winter	30 mg/l	BPT	R/R	YES	T=15°C
41	1981	Summer	NONE	NONE	NONE	NO	BOUNDARY CONDITIONS ONLY

Notes: (1) General notes

ST = Secondary Treatment = 85 % BOD removal or 30 mg/l of BOD, whichever is more stringent

Wherever vertical segmentation exists in the model area, the values for each vertical segment shall be shown individually; there shall be no averaging between vertical segments covering the same surface area.

All runs using the R/R Model for the CSO inputs shall use the 1981 Hudson River summer flow at Bear Mountain (approximately 6,500 cfs) and the average 1981 summer rainfall (approximately 0.12 inches per day).

All summer runs shall use the 1981 Hudson River summer flows and summer rainfall.

The leakage loads for 1981 are to be determined using the same formulas used in the NYC 208 but using 1981 data.

The benthic loads are to be the same as for the NYC 208.

The deficit loads are to be the same as for the NYC 208.

It will be assumed that there is no nitrification.

DRAFT

TABLE 3-1 (Continued)

NEW YORK HARBOR WATER QUALITY STEERING COMMITTEE

STEADY STATE MODEL RUNS AS OF NOVEMBER 22, 1982

Notes: (1) General notes (continued)

The 1965 summer verification temperatures will be used in the summer model runs.

The boundary conditions will be the same as used for the NYC 208.

Use the following values for raw sewage inputs for the 1981 runs: Tottenville - 1.5 MGD @ 100+ mg/l, Red Hook - 53 MGD @ 125 mg/l, and North River - 150 MGD @ 100 mg/l.

(2) Raw sewage values: Red Hook = 125 mg/l; North River = 100 mg/l

(3) Secondary treatment values for Red Hook and North River = 15 mg/l

(4) Red Hook and North River at 30 mg/l.

(5) Red Hook and North River at 45 mg/l.

(6) Red Hook and North River at 65 mg/l.

(7) Use secondary treatment but use 60 % BOD removal for the following STP's: North River, Red Hook, Newtown Creek, Hunts Point, Bowery Bay, Wards Island, Passaic Valley, and each Hudson County STP treated separately (do not assume that they will go to a Hudson County Utilities Authority STP).

(8) Use the 1981 Hudson River flow at Bear Mountain (approximately 6,500 cfs).

(9) Use the 1981 rainfall value (approximately 0.12 inches/day).

(10) Winter flows and temperatures are to be determined.

DRAFT

TABLE 3-2

NOTES CONCERNING MODEL RUNS

1. The 1981 input loads for BOD were reviewed and some adjustments were made. For those sources that were in the NYC 208 runs but had not data available for 1981, the attendees determined whether the source still existed and, if so, whether to use NYC 208 loads.

2. The leakage loads for 1981 are to be determined using the same formulas used in the NYC 208 but using 1981 data.

3. The benthic loads are to be the same as for the NYC 208.

4. The deficit loads are to be the same as for the NYC 208.

5. The bypass values for 1981 for NYC were reviewed and will be used in the model runs.

6. It will be assumed that there is no nitrification.

7. The temperatures for 1981 were compared with those used for the NYC 208 1965 verification period. There was essentially no difference in the temperatures for the 2 years compared; therefore, it was agreed to use the 1965 verification temperatures.

8. The boundary conditions will be the same as used for the NYC 208.

9. The 1981 runs will be done using the 1981 Hudson River flow at Bear Mountain (approximately 6,500 cfs).

10. For those model runs using the Rainfall/Runoff Model to calculate 1981 CSO loads, the 1981 rainfall will be used. This value is approximately 0.12 inches/day (approximately 3 times the value used for the NYC 208).

11. The following assumptions were made for raw sewage inputs:

    Tottenville - 1.5 MGD @ 100 mg/l
    Red Hook - 53 MGD @ 125 mg/l
    North River - 150 MGD @ 100 mg/l

12. The following changes and/or assumptions were made regarding the model runs:

DRAFT

Runs 12 through 15 will be done using 1981 data. these are sensitivity runs on K an T and the year that they are run on does not really matter. This change allows HydroQual to perform 4 more runs with the data already supplied.

Runs 17 through 22 will be done using the 1981 rainfall of 0.12 inches per day and the 1981 Bear Mountain flow of approximately 6,500 cfs.

Runs 27 through 29 will be done using the following raw sewage values: Red Hook - 125 mg/l; North River - 100 mg/l.

Run 30 will be done using 65 mg/l for Red Hook and North River.

13. The CSO formula adopted for runs 31-35 is as follows:

Formula 1: CSO Load = $(X-I) \times 0.85 \times F1 + 0.5 \times I_{RR} \times F2$

Formula 2: CSO Load = $0.5 \times I \times F2$

For Formula 1 & 2: X = theoretical influent concentration to STP

I = actual influent concentration to STP

I_{RR} = BOD concentration of stormwater runoff assumed to be 25 mg/l

F1 = dry weather flow to STP

F2 = Rainfall/Runoff flow for CSO using the 1981 summer average rainfall of approximately 0.12 inches per day

All CSO loads are to be distributed as they are in the Rainfall/Runoff Model.

Use Formula 1 for New York City and Yonkers drainage basins.

Use Formula 2 for New Jersey drainage basins.

Use actual influent concentratins to STP's from Pages 1 & 4 of backup material supplied with 1990 inputs. These are the 1981 STP influent concentrations.

For Red Hook use an influent concentration of 125 mg/l at 53 MGD; for North River use an influent concentration of 100 mg/l at 150 MGD.

DRAFT

14. Runs 36-39 are the counterparts to runs 31-34 with the CSO's calculated using the following formula developed by HQI:

$$\text{CSO Load} = I \times F1 + (X-I) \times F1 + I_{RR} \times F2$$

Note: In New Jersey (terms defined as above), X = I

15. Runs 2 and 11, which simulate winter conditions, include the November-December 1976 freshwater flow (18,400 cfs) and temperature conditions used in the validatin of the water quality model during the NYC 208 Study. Rainfall was assumed to be 0.12 inches/day.

16. Runs 8 and 40 include BPT industrial loads, 30 mg/l BOD from STP's, and all other load sources under November-December, 1976 winter conditions. A uniform temperature of 10°C was used in run 8 while a uniform temperatures of 15°C was used in run 40.

17. Deficit and BOD boundary conditions were assigned as 0 for unit response runs.

developed and investigated, particularly for the municipal discharges. Most attention was given to summer conditions, but some attention was also afforded to cold weather conditions in anticipation of requests for seasonal treatment. Other model runs were executed in order to determine the relative significance of the various components (POTW discharges, industrial discharges, combined sewer overflows, sediment oxygen demand, bypass and leakage, etc) which exert an effect on the oxygen balance. Several runs were made to determine the sensitivity of the model response to changes in certain parameters (reaction rates, temperature, loading magnitudes and locations, etc). Finally, a variety of runs was performed using different methods of estimating the average seasonal wastewater loading from combined sewer overflows and storm drainage.

Transport

Two conditions of freshwater flow in the Hudson River at Bear Mountain were considered. The seasonal average flow of 6,500 cfs as determined for model testing with the 1981 data sets was considered to be representative of relatively by characteristic summer conditions and was used for all model projections for that season. A greater Hudson River flow, 18,400 cfs, was selected for winter and other seasonal runs. Dispersion coefficients were taken as developed during the 208 Study and indicated on Figure 2-3.

DRAFT

Reactions

For most model runs, the carbonaceous BOD oxidation coefficient was taken 0.25/day as determined in the 208 Study. This coefficient was varied in certain runs above and below this value by a factor of two for sensitivity purposes. No nitrification was assumed. Sediment oxygen demand was assigned on the basis of the 208 Study as shown on Figure 2-4. All coefficients were adjusted for appropriate temperature conditions.

Temperature

The harborwide temperature regime of 19-24°C used in the summer 1965 verification analysis in the 208 Study was found to be suitable for model testing with the 1981 data set on the basis of year-to-year comparisons with ISC monitor data. This temperature regime was therefore chosen as representative for summer projections. Some sensitivity runs were performed with this temperature regime plus and minus 5°F. The winter temperature regime of 2-7° C observed in the late fall of 1976 was selected as representative of winter conditions. Other model runs were made for constant harborwide temperature conditions of 10°C and 15°C.

DRAFT

Boundary Conditions

The boundary conditions used for the summer 1965 and 1981 verifications for BOD and dissolved oxygen deficit and summarized in Table 2-3 were used for all summer projections.

Wastewater Inputs

Wastewater inputs from municipal and industrial sources for both 1981 and 1990 conditions were specified by the Steering Committee. These waste inputs are tabulated in Appendix 1 for 1981 conditions and Appendix 2 for 1990. For 1990, a variety of treatment conditions were considered for POTWs: secondary treatment (85% BOD removal or 30 mg/l whichever is more stringent), a uniform 30 mg/l effluent for all discharges, a uniform 45 mg/l effluent for all discharges, and some special cases of 65 mg/l at North River and Red Hook, and/or 60% BOD removal at selected plants (North River, Red Hook, Newtown Creek, Hunts Point, Bowery Bay, Wards Island, Passaic Valley, and each Hudson County Plant). Bypass loads were used for 1981 conditions but were considered not to exist for 1990 purposes. Leakage loads for 1981 and 1990 were calculated using 208 methdology but updated with 1981 data. Oxygen deficit loadings are the same as used in the 208 Study. Industrial discharges were assumed to receive best practical treatment. A summary of loadings is presented in Table 3-3.

For combined sewer overflows and storm drainage, most runs used estimates of BOD loading for these sources developed from 208 Study techniques (Rainfall/Runoff (R/R) Model). In all cases, an average rainfall value of 0.12 inches/day was taken as representative of normal summer conditions. Some special runs were performed using other estimation formulas developed by the Steering Committee and HydroQual, on the basis of an assumption that particulate organic material is settling in the New York City sewerage system during dry periods. These formulas are detailed in Table 3-2. A summary of BOD loadings from CSO/storm drainage as estimated by the various techniques is presented in Table 3-4.

TABLE 3-3

COMPARISON OF TOTAL POTW WASTE DISCHARGES

Condition	BOD Discharge (lb/day)
1. 1981 Actual Loads	1,470,000
2. 1981 Actual Loads with Planned Treatment	750,000
3. 1990 Loads at ST	372,000
4. 1990 Loads at 30 mg/l	574,000
5. 1990 Loads at 45 mg/l	856,000
6. 1990 Loads at ST and 60% Reduction at Selected Plants (1)	811,000
7. 1990 Loads at ST and 65 mg/l for North River and Red Hook	457,000

(1) North River, Red Hook, Noewtown Creek, Hunes oint, Bowery Bay, Wards Island, Passaic Valley and Hudson County POTW's

(1) Additional Loads: CSO and Storm Runoff: 350,000 lb/day

Other: ~100,000 lb/day

DRAFT

TABLE 3-4

COMPARISON OF TOTAL CSO AND STORMWATER LOADS

	Condition	BOD Discharge (lb/day)
1.	1981 Estimated Actual (R/R Model, 0.12"/day)	350,000
2.	NY Only Using ISC Formula 1 (BOD 225 mg/l)	1,570,000
3.	NY Only Using ISC Formula 1 (BOD = 150 mg/l)	785,000
4.	NJ Only Using ISC Formula 2	95,000
5.	NY Only Using HQI Formula (BOD = 225 mg/l)	473,000
6.	NY Only Using HQI Formula (BOD = 150 mg/l)	282,000
7.	NJ Only Using HQI Formula (BOD = 225 mg/l)	188,000
8.	NJ Only Using HQI Formula (BOD = 150 mg/l)	151,000

SECTION 4

RESULTS OF ANALYSIS

The results of all analyses with the New York Harbor Water Quality Model are presented in the Appendix. Appendix 3 presents graphical presentations of model results for dissolved oxygen, dissolved oxygen deficit, and BOD, in order. In all cases, results are plotted for the Hudson River, the Kills, the Harlem River and the East River. In special cases of interest, results are plotted on additional transects of interest in Raritan Bay and along Rockaway Beach. Model results are tabulated in Appendix 4.

It is to be noted that model results, particularly the calculated and plotted dissolved oxygen distributions, are intended to estimate mid-tidal conditions and the seasonal average dissolved oxygen value at any location. Variations about the projected values are to be expected and will occur. This must be considered in comparing the results (seasonal averages) with water quality standards developed as absolute minimums (never less than). As indicated previously, deducting 1.0 mg/l from the calculated dissolved oxygen value will account for a large portion of observed variability. Some additional

DRAFT

variability will remain, however, due to variations in dissolved oxygen saturation, a function of short term temperature and salinity fluctuations.

While all results are contained in the Appendices, some particularly pertinent results are recompiled and presented as follows:

Figure 4-1 presents calculated dissolved oxygen results for 1981 summer conditions. The profiles shown for the Hudson River are for the critical lower layer. Two conditions are presented: actual loads for 1981 (as calculated for model testing with the 1981 summer data), and actual 1981 loads upgraded for treatment underway (30 mg/l at Passaic Valley and 65 mg/l at North River and Red Hook). Dissolved oxygen saturation values and the minimum water quality standards are shown. As evident from the data of Figure 2-13, water quality standards are clearly violated in the Hudson River with the 1981 actual loads and marginally in compliance elsewhere except a portion of the East River. Water quality is improved by the upgraded treatment such that standards would be achieved everywhere, at least marginally, allowing for a 1.0 mg/l variability except for a small section of the upper East River.

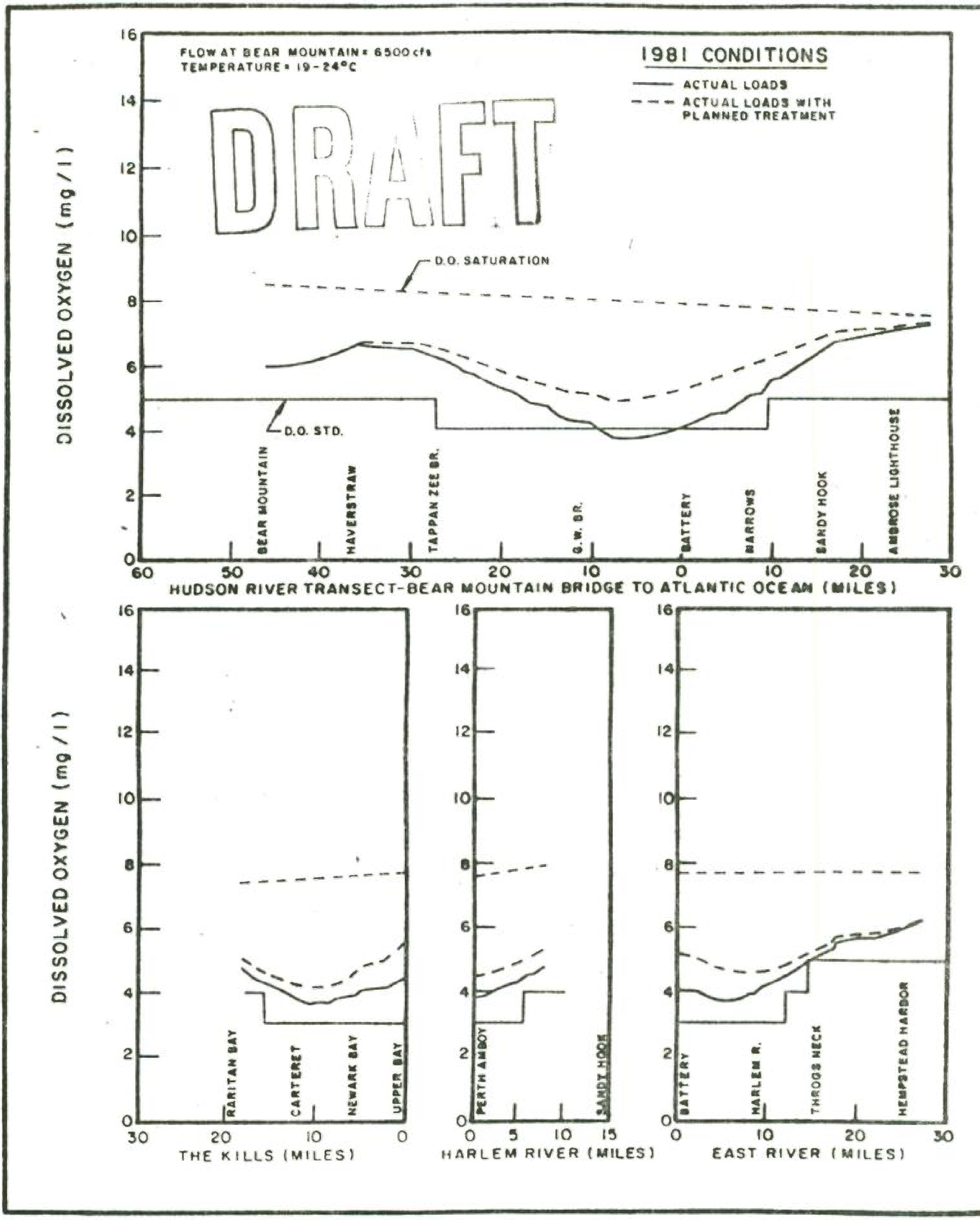

FIGURE 4-1

PROJECTED DISSOLVED OXYGEN PROFILES

DRAFT

Figure 4-2 summarizes projected 1990 summer conditions for dissolved oxygen in New York Harbor assuming secondary treatment at all municipal sources. Average summer dissolved oxygen in the lower layer of the Hudson River and in the Kills is projected to be approximately 1.5 mg/l above standards. Allowing for 1.0 mg/l of variability around the projections would provide an approximate minimum value 0.5 mg/l above the standard at these locations. Conditions would be somewhat better in the lower East River, approximately 1.0 mg/l above the standard, and marginal in a section of the upper East River.

Figure 4-3 shows the component parts of the dissolved oxygen depressions shown in Figure 4-2. Dissolved oxygen deficit is plotted in the waterways of interest, and in the lower critical layer of the Hudson River. Under these conditions, it is observed that of the total projected deficit of 2.0 mg/l in the Hudson River, approximately 0.5 mg/l is due to municipal and industrial discharges combined, with the balance due to other background effects, principally benthal demand, 0.7 mg/l, and boundary conditions, 0.5 mg/l. CSO/stormwater effects are estimated at approximately 0.3 mg/l. Similar distributions are observed in the other waterways with benthal demand being particularly dominant in the Kills and the assumed boundary condition pronounced in the East River.

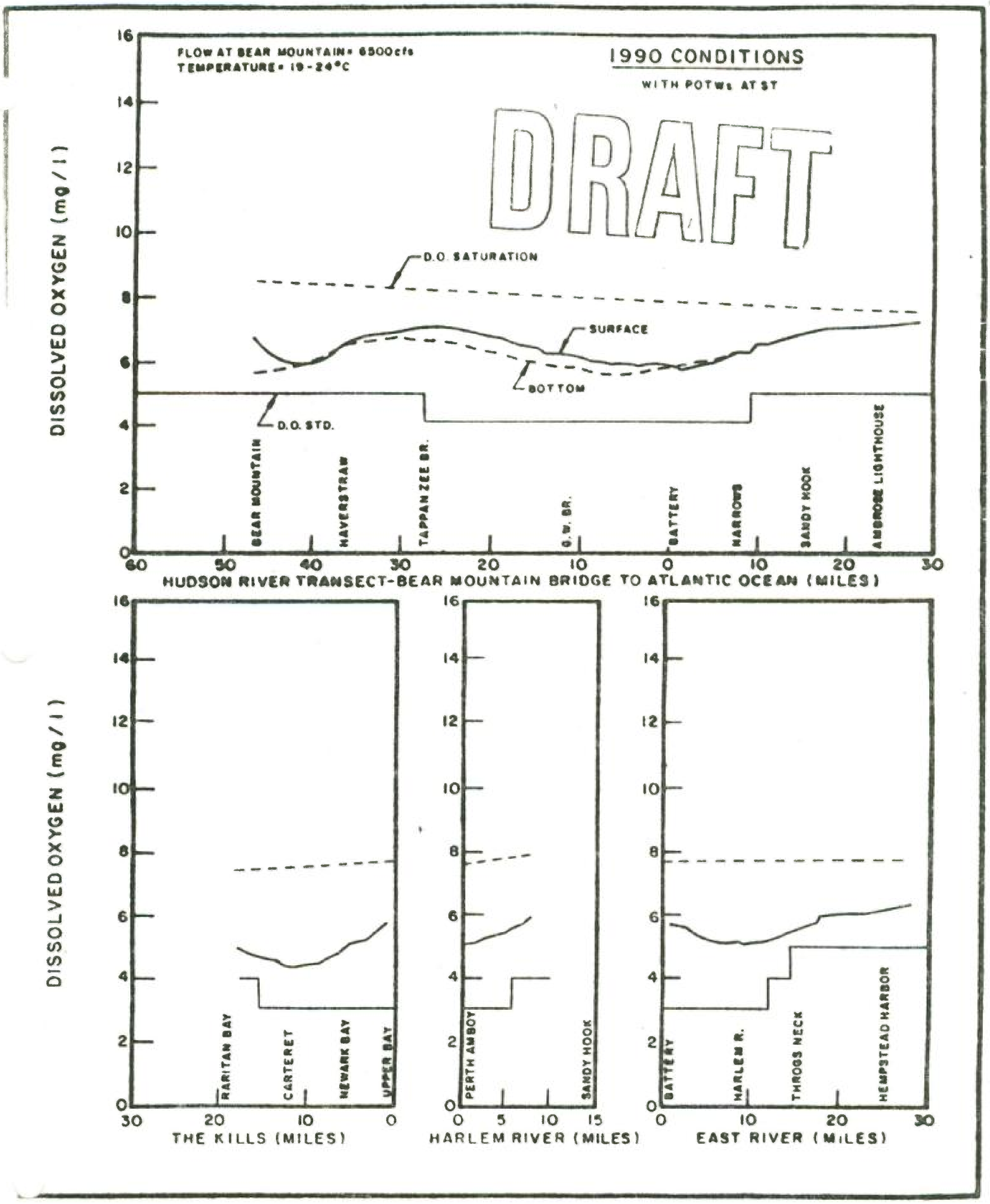

FIGURE 4-2

PROJECTED DISSOLVED OXYGEN PROFILES

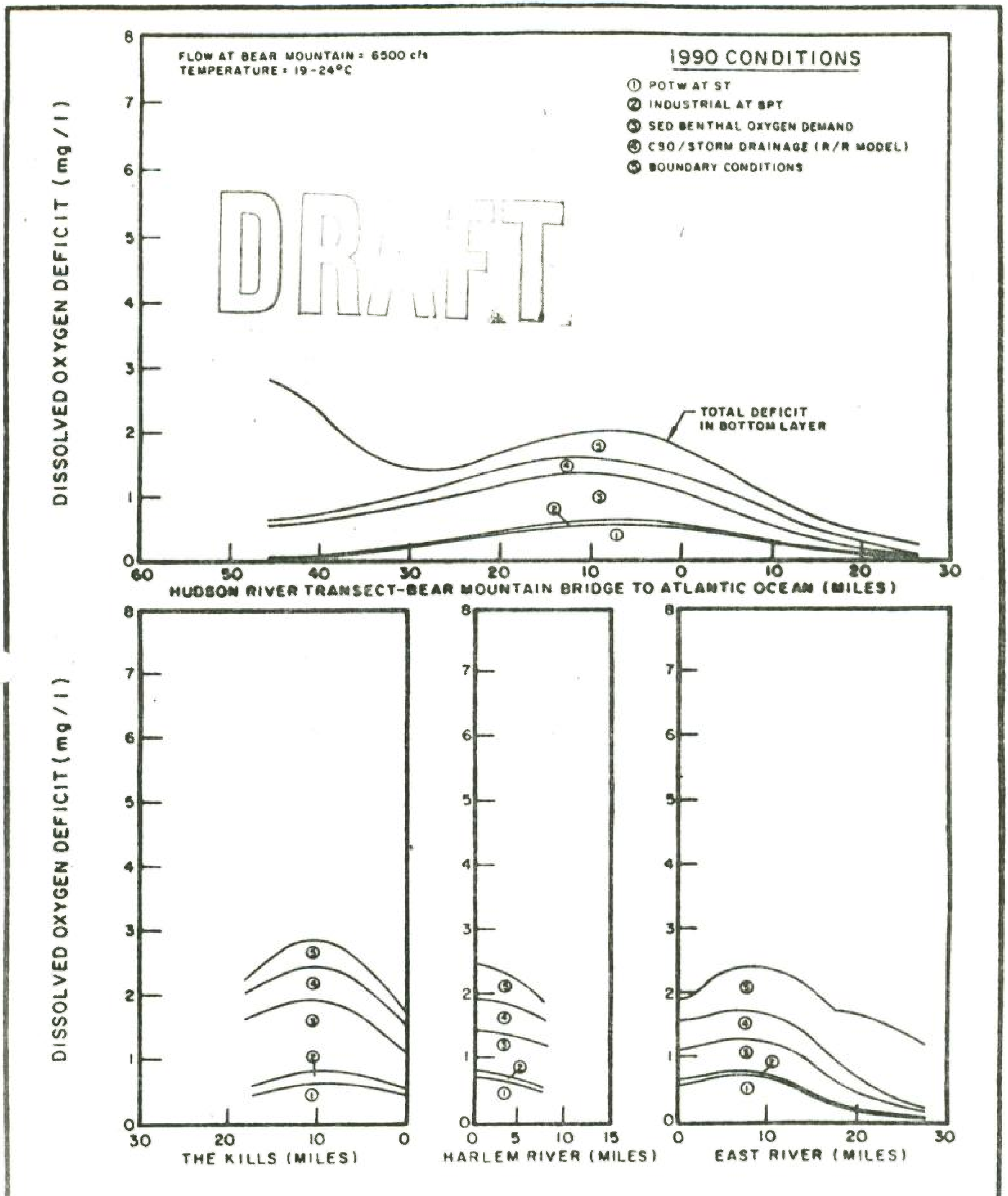

FIGURE 4-3

PROJECTED COMPONENT DISSOLVED OXYGEN DEFICIT PROFILES

Figure 4-4 and 4-5 shows projected summer dissolved oxygen with 1990 conditions for a variety of treatment options. In the Hudson, lower layer dissolved oxygen values are shown. On each diagram, secondary treatment at all municipal sources is shown for reference. In Figure 4-4 the effect of uniform effluent quality for BOD of 30 mg/l and 45 mg/l for all municipal sources is displayed. In Figure 4-5, other treatment options are shown including all municipal sources at secondary except North River and Red Hook at 65 mg/l; and all sources at secondary treatment except selected plants as previously described. In general, allowing for 1.0 mg/l of variability, all options achieve or marginally achieve (within 0.1 to 0.2 mg/l) water quality standards for dissolved oxygen except for a portion of the upper East River.

Figure 4-6 shows dissolved oxygen conditions projected for winter conditions with alternative treatment options as indicated. Water quality standards would be maintained under these conditions.

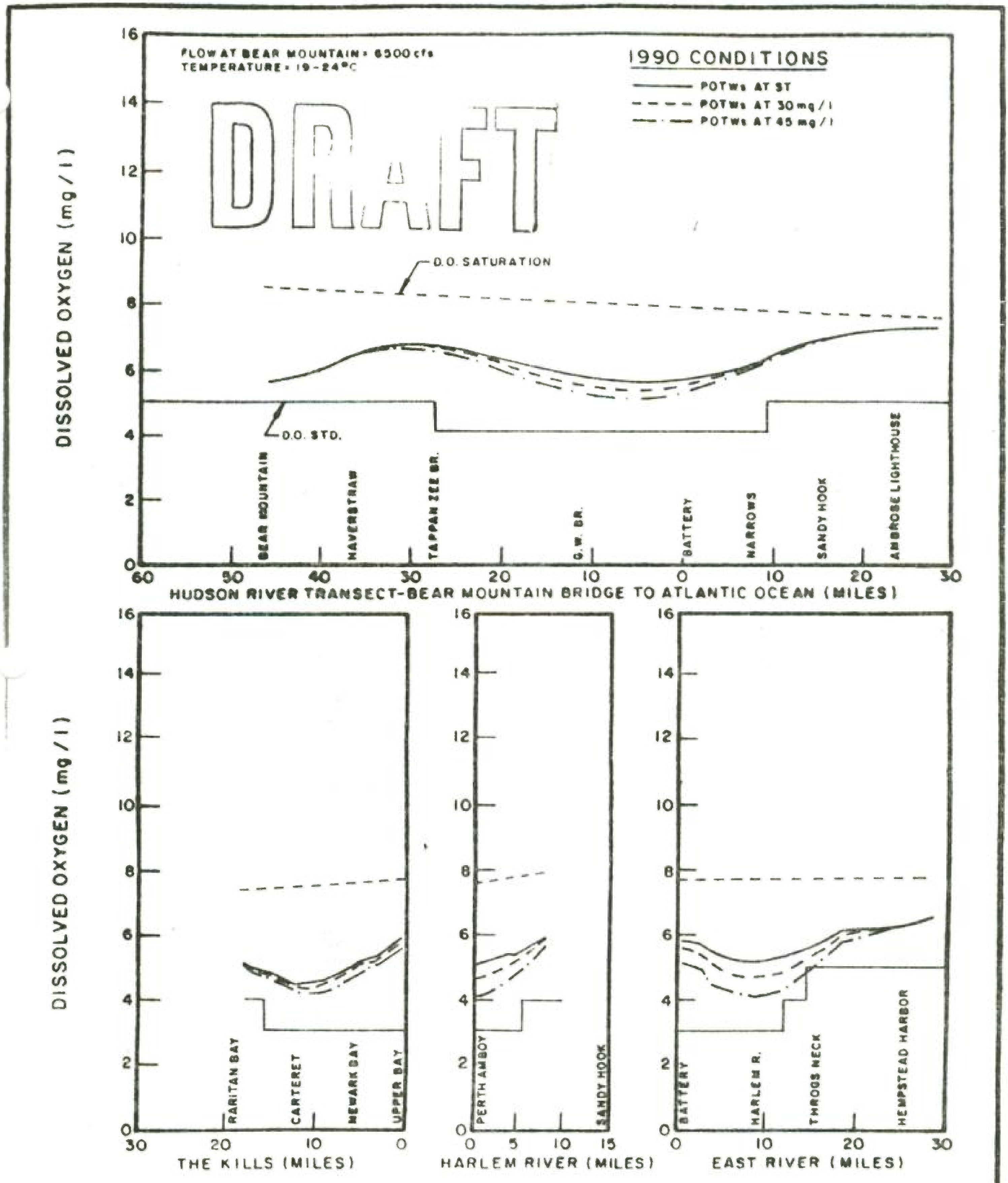

FIGURE 4-4

PROJECTED DISSOLVED OXYGEN PROFILES

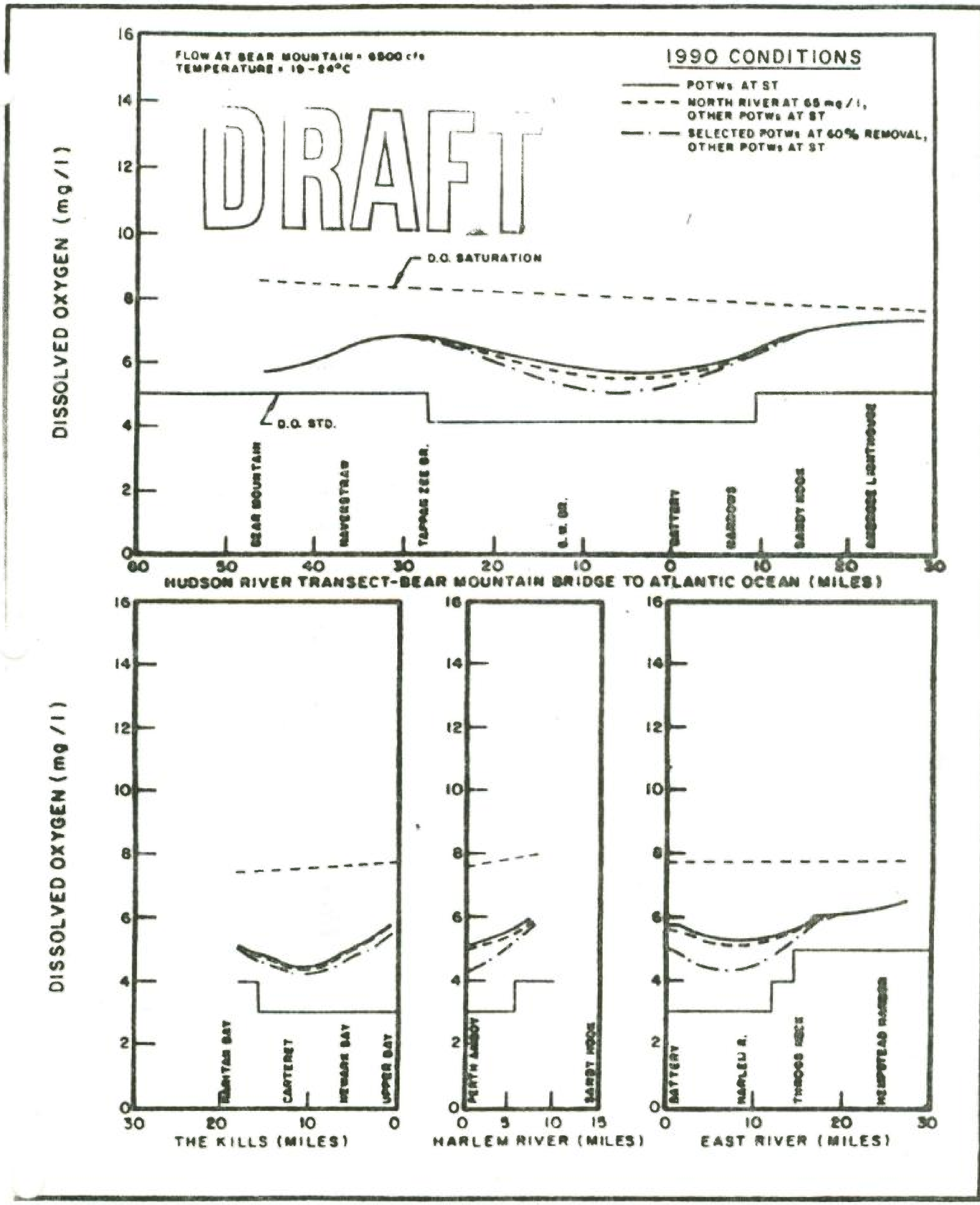

FIGURE 4-5

PROJECTED DISSOLVED OXYGEN PROFILES

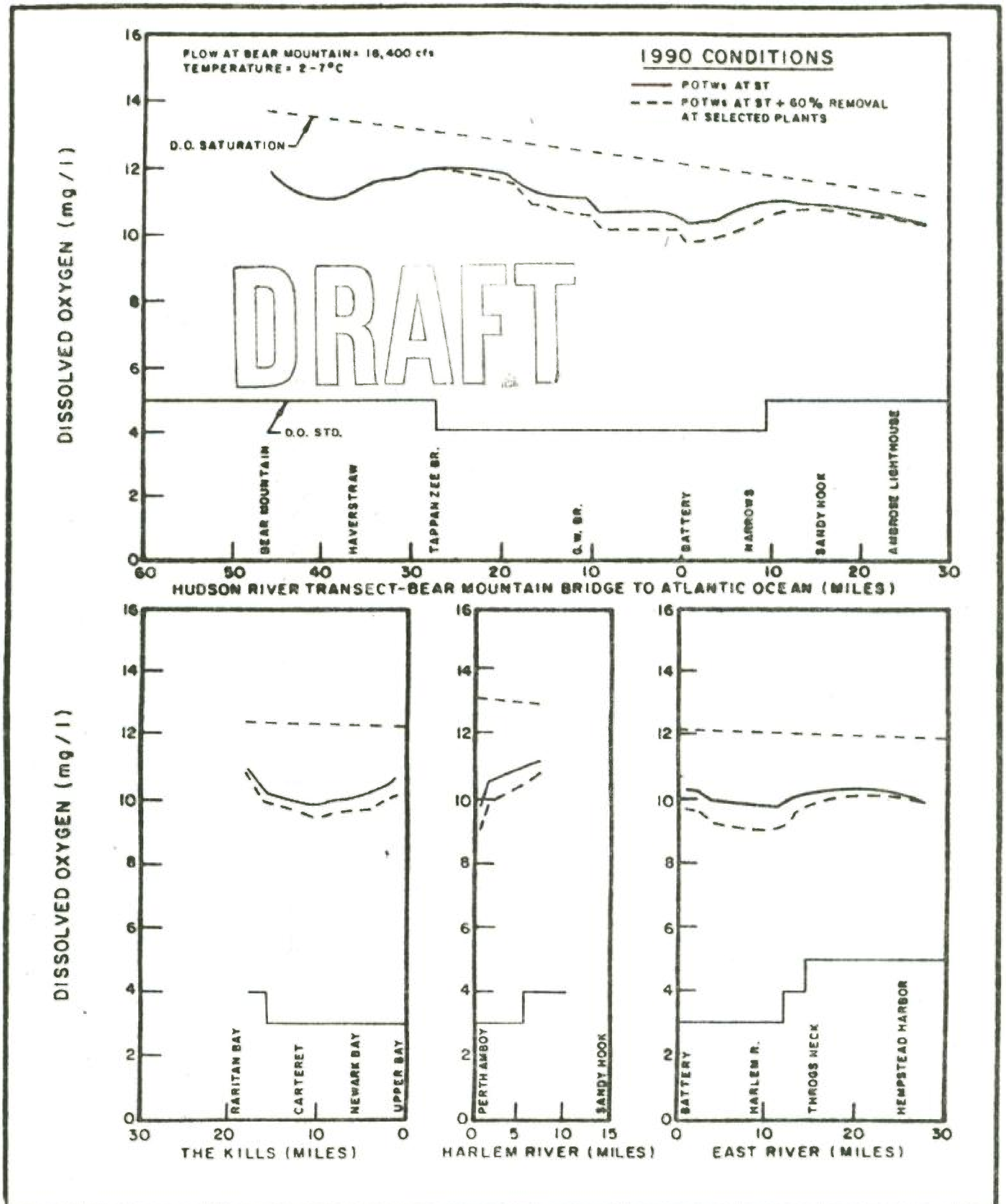

FIGURE 4-6

PROJECTED DISSOLVED OXYGEN PROFILES