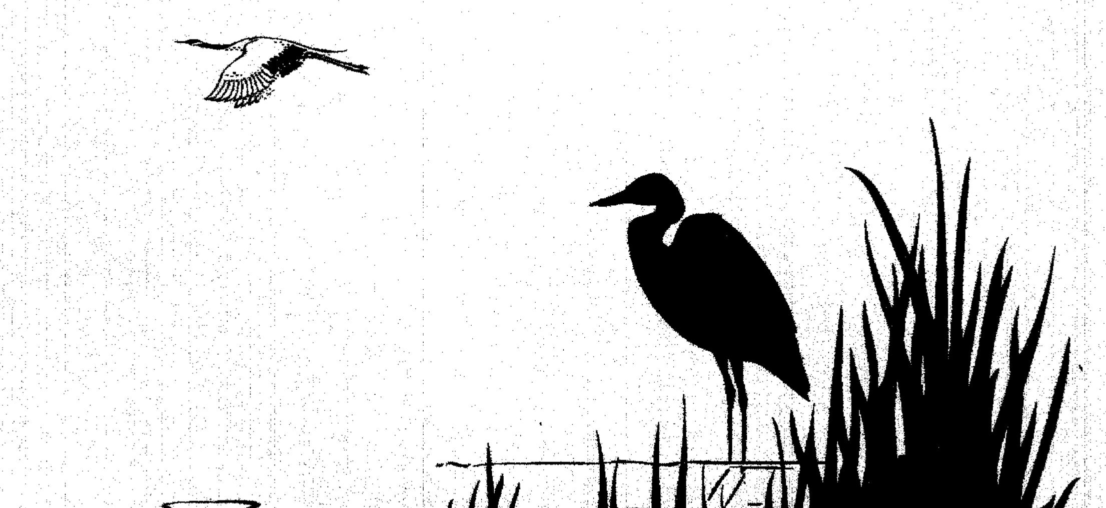
G. Comstock

NEW HAMPSHIRE
DEPARTMENT OF
Environmental
Services

SUGAR RIVER TMDL STUDY

MARCH 1996



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March 1, 1996

Edward J. Schmidt, P.E., Ph.D., Director
Department of Environmental Services
Water Supply & Pollution Control Division
Hazen Drive
Concord, New Hampshire 03301

Re: Total Maximum Daily Load Study

Dear. Dr. Schmidt:

Please find attached the Sugar River Total Maximum Daily Load Study. This report is being submitted in partial fulfillment of the FY95 EPA workplan.

Presently there are no violations of water quality standards in the Sugar River. However, when the City of Claremont approaches the design capacity of its wastewater treatment facility (WWTF), their existing NPDES permit limitations may have to be somewhat lower; that is, if the City continues to discharge to the Sugar River. Another option the City has is to explore the viability of discharging to the Connecticut River.

For the City's convenience, we have also provided modeling in the event another business wishes to occupy the now defunct Coy Paper site. In essence, it gives the City some idea of how a discharge at Coy Paper would impact their WWTF.

Cordially,

Raymond P. Carter, P.E., Administrator
Water Quality/Permits & Compliance Bureau

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BACKGROUND

Section 303 (d) of the Clean Water Act (CWA) requires States to identify those surface waters for which technology based controls, such as secondary treatment, are not stringent enough to ensure that surface waters meet their legislated classification and their intended uses. Section 303 (d) further requires that the Total Maximum Daily Load (TMDL) be determined for all waterbodies included on the "303 (d) list" of impaired surface waters.

The New Hampshire 1994 303(d) list of impaired waters included dissolved oxygen (DO) exceedences of the Sugar River near the Town of Newport. Sampling performed in 1995, however, did not indicate any violations. Although there are no known current violations of DO standards, results of a Wasteload Allocation (WLA) study of the Sugar River conducted by the New Hampshire Department of Environmental Services (DES) in 1993 indicated the potential for future DO violations downstream of the Coy Paper dam in Claremont. In 1993, point sources downstream of the dam included the Coy Paper Company Wastewater Treatment Facility (WWTF) and the Claremont WWTF.

Since the WLA was completed, the Coy Paper Company has gone out of business. Subsequent modeling, however, indicated that even without Coy Paper discharging, there is still a potential, in the future, for the Claremont WWTF to violate DO standards, assuming it is discharging at its current secondary effluent limits and plant design flow. At the present time, the Claremont WWTF is discharging at approximately 50 percent of its design flow and at better than secondary limits. Therefore, although there are no known existing violations of DO, it was nevertheless decided to conduct a TMDL for the Sugar River downstream of the Coy Paper dam because of the potential for future DO violations caused by the Claremont WWTF.

PURPOSE

The primary purpose of this report, is to establish the Total Maximum Daily Load (TMDL) for DO, for the potentially impaired segment of the Sugar River, and, in accordance with the CWA, to allocate the maximum daily load among point sources, nonpoint sources, and a margin of safety (MOS).

Another important purpose of this report, was to develop the basis for discharge limits for the Claremont WWTF for the following conditions:

- Option 1 (existing conditions), which assumes that the Coy Paper WWTF is not discharging, and
- Option 2 * (possible future conditions), which assumes that the Coy Paper Company Facility is bought and resumes discharging.

*	*This option is included merely for the convenience of the City. It is believed such information would be useful to the City of Claremont for planning purposes, as it would show the impact that a new discharge located at the Coy Paper Facility could have on the allowable effluent limits for the Claremont WWTF. In essense prior to any new discharge, the City should assess whether the discharge will impact the WWTF's permit limitations, and if so, how would the wastewater discharge loading be apportioned between the new discharge and the City. For the purposes of this study, it was assumed that if the discharge at the Coy Paper WWTF was reactivated, it would have the same effluent limits as the old Coy Paper NPDES permit. This assumption was simply for illustration purposes only.*

Finally, this report also addresses the remaining isolated exceedances of water quality standards in the Sugar River that were noted on the 1994 303(d) list of impaired waters.

METHODOLOGY

The study area was divided into two reaches for modeling purposes. Reach 1, which includes the Coy Paper WWTF, extends from the Coy Paper dam downstream to the Claremont WWTF. Reach 2 includes the segment of the Sugar River from the Claremont WWTF to the Connecticut River.

The majority of parameters used in the model were based on the 1993 WLA. DO was modeled for dry and wet conditions. For dry weather modeling, the river flow was set equal to the 7Q10 low flow. For wet weather modeling the river flow was assumed to be equal to the summer average flow, which is the average daily flow that occurs between July 1 and September 30. Wet weather modeling included the pollutant loading of nonpoint sources such as stormwater.

TMDLs and proposed discharge limits were developed for the 5-day carbonaceous oxygen demand ($CBOD_5$) and ammonia nitrogen (NH_3-N) as both of these pollutants can significantly reduce the concentration of DO in a receiving water.

Based on modeling, TMDLs were developed for dry and wet weather conditions in both reaches. Proposed permit limits for the WWTFs were based on the condition which resulted in the lowest allowable TMDL.

Allocation of the TMDLs for $CBOD_5$ and NH_3-N was conducted for wet weather conditions. Based on estimated background conditions, loads were allocated among point sources, nonpoint sources and a margin of safety (MOS) to account for uncertainties in the modeling. Load allocations were developed for each reach and option investigated in this study.

The theoretical maximum daily load from nonpoint sources for each option was then checked against estimates of existing nonpoint source loads to determine if existing nonpoint source loads exceed the theoretical maximum daily nonpoint source load. Existing nonpoint source loads were based on existing land use and estimations of pollutant concentrations for each land use.

CONCLUSIONS AND RECOMMENDATIONS

Based on the assumptions and results of this study, the following conclusions and recommendations are made:

- The minimum concentration of DO (i.e., the DO sag) occurs in reach 2.

- The allowable loading of either $CBOD_5$ or NH_3-N in reach 2 is very dependent on the loading and concentration of DO in reach 1. Therefore, increasing the loading at the Coy Paper WWTF reduces the allowable loading which may be discharged from the Claremont WWTF. This assumes that the existing discharge locations for both WWTFs remain unchanged.

- Results of dry and wet weather TMDL modeling are shown below. A comparison of total maximum daily loads in each reach shows that dry weather conditions control since the loadings during dry weather (7Q10 low flow) conditions are all less than the corresponding loadings during wet weather (average flow between July 1 and September 30) conditions.

Dry Weather Versus Wet Weather TMDLS (3)

Parameter	Dry Weather TMDL				Wet Weather TMDL	
	Option 1 (1)		Option 2 (2)			
	Reach 1	Reach 2	Reach 1	Reach 2	Reach 1	Reach 2
$CBOD_5$ (LBS / DAY)	0	953	250	723	684	2789
NH_3-N (LBS / DAY)	0	276	15	246	154	439

Notes:

(1) Option 1 assumes no discharge from the Coy Paper Company and the Claremont WWTF is discharging at new (more stringent) effluent limits.

(2) Option 2 assumes the Coy Paper Company is discharging at its 1992 NPDES permit limits, and the Claremont WWTF is discharging at new (more stringent) effluent limits.

(3) All loadings shown are dependent on background loadings from the river just upstream of the specified reach. Background loadings are not included in the values shown.

- The proposed allocation of the Wet Weather TMDL for each option and reach are shown below.

Allocation of Loads for the Wet Weather TMDL

Source of Loading	Option 1 (1)				Option 2 (2)			
	Reach 1		Reach 2		Reach 1		Reach 2	
	$CBOD_5$ (lbs/day)	NH_3-N (lbs/day)	$CBOD_5$ (lbs/day)	NH_3-N (lbs/day)	$CBOD_5$ (lbs/day)	NH_3-N (lbs/day)	$CBOD_5$ (lbs/day)	NH_3-N (lbs/day)
Point (3) Source (PS)	0	0	953	276	250	15	723	246
Nonpoint (4) Source (NPS)	616	139	1557	119	366	124	1787	149
Margin of (5) Safety (MOS)	68	15	279	44	68	15	279	44
Total (6) (TMDL)	684	154	2789	439	684	154	2789	439

Notes:

(1) Option 1 assumes no discharge from the Coy Paper WWTF and that the Claremont WWTF is discharging at new (more stringent) effluent limits.

(2) Option 2 assumes that the Coy Paper WWTF is discharging at its 1992 permit limits and that the Claremont WWTF is discharging at new (more stringent) effluent limits.

(3) Point source loadings are based on the proposed maximum day permit loadings for the Coy Paper and/or Claremont WWTFs. The Coy Paper WWTF is located at the beginning of Reach 1 and the Claremont WWTF is located at the beginning of Reach 2.

(4) Nonpoint Source Loadings are equal to the Total TMDL minus the sum of the Point Source Loading and the Margin of Safety {i.e, NPS = Total - (PS + MOS)}.

(5) The Margin of Safety (MOS) is equal to 10 percent of the Total TMDL

(6) Loadings shown for the Total TMDL are over and above the assumed background loading in the river upstream of each reach.

- A comparison of Existing NPS loads (see table below) to the allocated NPS loadings presented in the previous table shows that existing NPS loads are well below the allowable maximum daily NPS load in either reach.

Existing NPS Loads

Reach #1		Reach #2	
$CBOD_5$ lbs/day	NH_3-N lbs/day	$CBOD_5$ lbs/day	NH_3-N lbs/day
27	9	8	11

- Proposed WWTF discharge limits for summer and winter conditions, were developed for each option, and are shown on the following pages. With regards to these limits, the following conclusions and recommendations are made:

    - The proposed discharge limits for the Claremont WWTF, for either option, are more stringent than the City's current NPDES permit limits which are based on technology limits for secondary treatment.

    - Based on sampling results over the past two years, it appears that the Claremont WWTF can currently meet the proposed summer limits for $CBOD_5$ and NH_3-N. This is believed to be primarily due to the fact that the WWTF is currently treating only 50 percent of it's design flow.

    - The City may have to install a mixer or other means of meeting the proposed minimum effluent DO concentration of 7 mg/l. If this limit can not be met, additional modeling should be conducted at lower effluent DO concentrations. This, however, would result in lower limits for $CBOD_5$ and/or NH_3-N.

    - As flows to the Claremont WWTF approach the plant's design capacity, the City may have to make future improvements to the WWTF to meet the proposed limits. There is a possibility however, that the Claremont WWTF could continue discharging at its current NPDES permit limits, if it's discharge was relocated directly to the Connecticut River (downstream of the Sugar River confluence). Additional modeling would be needed, however, to confirm this assumption.

    - A comparison of options 1 and 2 shows that if the Coy Paper Company is bought and the discharge is reactivated with effluent limits equal to the old NPDES permit for Coy Paper, it reduces the allowable effluent limits at the Claremont WWTF. It is recommended that the City take this into consideration if plans are made to reactivate the discharge at the Coy Paper Facility. If effluent limits are considered for the discharge at the former Coy Paper Company, which are different from those assumed in this study, additional modeling would have to be conducted to determine new limits for the Claremont WWTF.

- This study also addressed other isolated exceedances of water quality standards in the Sugar River which were included on the State's 1994 303(d) list. These included water quality violations of copper, lead and toxics (based on failure of a Whole Effluent Toxicity (WET) test of the river water). Sampling was conducted in 1995 to confirm these exceedances. No violations of copper or lead were found. Failure of WET tests were attributed to a naturally occurring fungus in the river water.

<u>OPTION #1</u>
Proposed WWTF Effluent Discharge Limits

Summer (June 1 - October 31)

WWTF	Parameter	mg / l			lbs / day		
		Average Monthly	Average Weekly	Maximum Daily	Average Monthly	Average Weekly	Maximum Daily
Coy Paper (No discharge)		---	---	---	---	---	---
Claremont (3.94 MGD)	DO	No	less than	7.0 mg/l			
	$CBOD_5$	25	28	29	822	920	954
	NH_3-N	6.8	---	8.4	223	---	276

Winter (November 1 - May 31)

WWTF	Parameter	mg / l			lbs / day		
		Average Monthly	Average Weekly	Maximum Daily	Average Monthly	Average Weekly	Maximum Daily
Coy Paper (No discharge)		—	—	—	—	—	—
Claremont (3.94 MGD)	DO	No	less than	7.0 mg/l			
	$CBOD_5$	25	28	29	822	920	954
	NH_3-N	11.4		12.3	375		404

Assumes no discharge from Coy Paper

OPTION #2

Proposed WWTF Effluent Discharge Limits

Summer (June 1 - October 31)

WWTF	Parameter	mg / l			lbs / day		
		Average Monthly	Average Weekly	Maximum Daily	Average Monthly	Average Weekly	Maximum Daily
Coy Paper (0.9 MGD)	Flow (1)			0.9 MGD			
	DO	No	less than	6.0 mg/l			
	BOD_5 (1)				295		300
	NH_3-N	2		2			15
Claremont (3.94 MGD)	DO	No	less than	7.0 mg/l			
	$CBOD_5$	19	21	22	624	690	723
	NH_3-N	6.3		7.4	207		243

Winter (November 1 - May 31)

WWTF	Parameter	mg / l			lbs / day		
		Average Monthly	Average Weekly	Maximum Daily	Average Monthly	Average Weekly	Maximum Daily
Coy Paper (0.9 MGD)	Flow (1)			0.9 MGD			
	DO	No	less than	6.0 mg/l			
	BOD_5 (1)				295		300
	NH_3-N	2		2			15
Claremont (3.94 MGD)	DO	No	less than	7.0 mg/l			
	$CBOD_5$	25	27	28	822	887	921
	NH_3-N	8.5		9.2	279		302

Notes:

(1) Values are based on the 1992 NPDES permit for Coy Paper. $CBOD_5$ values used in the model were assumed equal to 83 % (25/30) of the BOD_5.

SECTION I

INTRODUCTION

SECTION I
INTRODUCTION

1.1 BACKGROUND

Section 303 (d) (1) (A) of the Clean Water Act (CWA) requires each state to identify waters for which secondary or technology effluent limitations are not stringent enough to meet water quality standards. Further, Section 303 (d) (1) (C) requires each state to establish a Total Maximum Daily Load (TMDL), for such waters identified in section 303 (d) (1) (A).

In 1994, the Sugar River was included on the New Hampshire 303(d) list of impaired waters because of isolated exceedances of dissolved oxygen (DO) water quality standards near the Town of Newport. A copy of the State's 1994 303(d) list is provided in Appendix A. Sampling performed in 1995, however, did not verify any DO violations. Although there are no known current violations of DO standards, results of a Wasteload Allocation (WLA) study of the Sugar River conducted by the New Hampshire Department of Environmental Services (DES) in 1993 indicated the potential for future DO violations downstream of the Coy Paper dam in Claremont. In 1993, point sources downstream of the dam included the Coy Paper Company Wastewater Treatment Facility (WWTF) and the Claremont WWTF.

Since the 1993 WLA was completed, the Coy Paper Company has gone out of business. Subsequent modeling, however, indicated that even without Coy Paper discharging, there is still a potential, in the future, for the Claremont WWTF to violate DO standards, assuming it is discharging at its current secondary effluent limits and plant design flow. At the present time, the Claremont WWTF is discharging at approximately 50 percent of its design flow and at better than secondary limits. Therefore, although there are no known existing violations of DO, it was nevertheless decided to conduct a TMDL for the Sugar River downstream of the Coy Paper dam because of the potential for future DO violations caused by the Claremont WWTF.

1.2 PURPOSE / OBJECTIVES

The purpose of this report is to accomplish the following three objectives:

(1) To establish the Total Maximum Daily Load (TMDL) that the Sugar River can assimilate without violating DO water quality standards, and, in accordance with the CWA, to allocate the TMDL among point sources, nonpoint sources, and a margin of safety (MOS).

(2) To develop preliminary discharge limits for the Claremont WWTF, based on the results of the TMDL process, for the following conditions:

- Option 1 (existing conditions), that is the Coy Paper WWTF is not discharging, and

- Option 2 * (possible future conditions), which assumes that the Coy Paper Company Facility is bought and resumes discharging.

* ***It is believed such information would be useful to the City of Claremont for planning purposes, as it would show the impact that a discharge located at the Coy Paper Facility could have on the allowable effluent limits for the Claremont WWTF. For the purposes of this study, it was assumed that if the discharge at the Coy Paper WWTF was reactivated, it would have the same effluent limits as the old Coy Paper NPDES permit. In short, the City should be aware that a discharge at Coy Paper WWTF may impact their WWTF discharge permit, and that they should look at how the wastewater loadings could be apportioned between the new discharger and their WWTF.***

(3) To address the remaining isolated exceedances of water quality standards in the Sugar River that were noted on the 1994 303(d) list of impaired waters. As shown in Appendix A , these include occasional water quality violations of copper, lead, and toxics (based on failure of Whole Effluent Toxicity (WET) tests of the river water).

SECTION II

STUDY AREA

SECTION II
STUDY AREA

2.1 WATERSHED CHARACTERISTICS

General: The Sugar River is approximately 27 miles long and is located in the Connecticut River Basin. As shown on Figure II-1, the Sugar River originates at the outlet of Lake Sunapee and flows through the towns of Sunapee, Newport and the City of Claremont where it discharges to the Connecticut River. The Sugar River has a total drainage area of approximately 275 square miles and a total change in elevation, from Lake Sunapee (1,092 feet) to the confluence of the Connecticut River (290 feet), of about 802 feet.

Dams: There are numerous dams in the Sugar River watershed which serve to regulate flow in the river. Of the 31 reported dams, 16 are active and 15 are classified as inactive, which means that the dams are breached or in ruins and water is not impounded. Major dams along the main stem of the Sugar River, include the following:

- Lake Sunapee Dam - Sunapee
- Wendall Marsh Dam - Sunapee
- Sugar River Mill Dam - Newport
- Monadnock Mills Dam - Claremont
- Claremont Paper Co. Dam - Claremont
- Woolen Mill Dam - Claremont
- Coy Paper Co. Dam - Claremont

Land Use: The majority of the Sugar River watershed is rural. The banks of the river mainly consist of forested land with a scattering of houses, farms, and cleared areas, except where the river flows through the City of Claremont. An estimate of the percentage of various land uses in the Sugar River watershed, based on land use maps prepared by the DES Geographic Information System (GIS), is presented below:

- 87% rural - (i.e. forested and undeveloped)
- 10% active agriculture
- 3% urban

2.2 POTENTIAL POINT SOURCES OF POLLUTION

As shown on Figure II-1 and, as summarized in the list below, there are six wastewater treatment facilities located on the Sugar River, all of which represent potential point sources (PS) of pollution. Three of the wastewater treatment facilities are municipal and three are industrial. A copy of the effluent limits from the NPDES permit for each facility is provided in Appendix B.

- The **Sunapee WWTF**, is an oxidation ditch WWTF with a design capacity of 0.64 MGD.

- The **Newport WWTF**, is an aerated lagoon WWTF with a design capacity of 1.30 MGD.

- The **Claremont WWTF**, is an activated sludge WWTF with a design capacity of 3.94 MGD.

- The **Dorr Woolen WWTF**, located in Newport, NH, is an industrial WWTF with a design capacity of 1.0 MGD.

- The **Strum Ruger WWTF**, is an industrial facility in Newport, NH, which discharges non-contact cooling water to the Sugar River and has a design capacity of approximately 1.0 MGD.

- The **Coy Paper Co. WWTF**, is located in Claremont, NH, and, in 1992, had a permitted design flow of approximately 1.0 MGD. As previously mentioned, this facility is not currently discharging because the Coy Paper Company has gone out of business. In the future, however, there may be a possibility that the Coy Paper Company could be bought and the discharge located at this site could be reactivated, thus the reason this option was studied.

2.3 POTENTIAL NONPOINT SOURCES (NPS) OF POLLUTION

Nonpoint Pollution is generated from diffuse sources rather than a single point source discharge. Nonpoint Source (NPS) Pollution can enter a surface water via the groundwater or as runoff when it rains. Examples of potential nonpoint sources of pollution are given below:

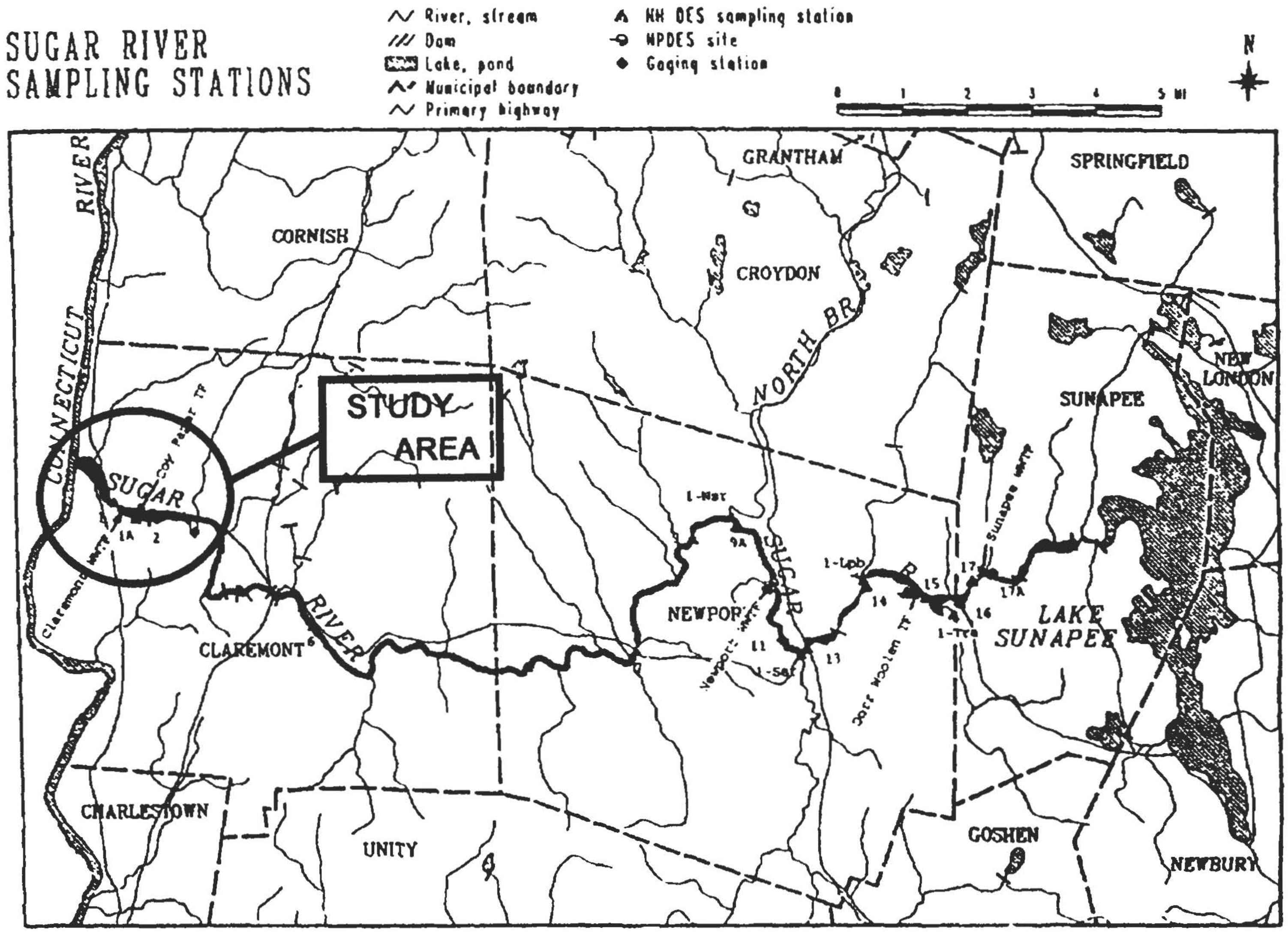
- Stormwater runoff
- Construction
- Agriculture
- Landfills and junkyards
- Silviculture
- Septage and subsurface disposal systems
- Storage tanks
- Hydromodification

This study focused primarily on NPS pollution from stormwater runoff. As stormwater washes over land pollutants from lawns, parking lots, city streets, farm fields, or construction sites, are conveyed to the receiving water. As will be explained later in the section entitled "Methodology", estimates of NPS pollutant loadings from stormwater were based on local literature values of pollutant concentration for various land uses.

2.4 FOCUS AREA OF THE TMDL

As shown on Figure II-1, the focus area of this TMDL is from the Coy Paper dam in Claremont, downstream to the confluence of the Sugar River with the Connecticut River. As mentioned in Section 1.1, this river segment was selected because it is where modeling predicted a potential for future DO violations when the Claremont WWTF reaches its design flow and discharges at secondary limits.

Figure II-1
Map of Sugar River Basin



SECTION III

METHODOLOGY

SECTION III
METHODOLOGY

3.1 OVERALL APPROACH

The overall approach used to complete this study is presented below:

- Select a dissolved oxygen model
- Determine river reaches
- Select model input for dry and wet weather TMDL modeling
- Establish acceptable target DO values for TMDL modeling
- Allocate the wet weather TMDL among point , nonpoint sources, and a margin of safety.
- Develop preliminary discharge limits for the Claremont WWTF.

Each of the above steps is discussed in the following sections.

3.2 DISSOLVED OXYGEN (DO) MODEL

The use of mathematical models to determine the concentration of DO in a river began in the 1920s. The model selected for this TMDL study was EPA's dissolved oxygen deficit model (Ref. #11). The model is shown below which accounts for the effects of reaeration, carbonaceous and nitrogenous oxygen demand, photosynthesis, respiration as well as sediment oxygen demand.

DO MODEL EQUATION

$$D = Do\, e^{-Kat} + [Kd/(Ka - Kd)](Lo - Lrd/Kd)(e^{-Kdt} - e^{-Kat}) + [Kn/(Ka - Kn)](No - Nrd/Kn)(e^{-Knt} - e^{-Kat}) + [(R + Sb + Lrd + Nrd - P)/Ka](1 - e^{-Kat})$$

Where:

D	=	DO deficit at a specified location (mg/l)
Do	=	initial DO deficit (mg/l)
Ka	=	reaeration rate (1/day)
Kd	=	rate of decay of CBOD (1/day)
Lo	=	initial ultimate CBOD (mg/l)
Lrd	=	mass rate of CBOD entering reach per unit volume of river water (mg/l/day)
No	=	initial ultimate NBOD (mg/l)
Kn	=	decay rate of NBOD (1/day)
Nrd	=	mass rate NBOD entering reach per unit volume of river water (mg/l/day)
R	=	oxygen utilization rate due to respiration (mg/l/day)
P	=	oxygen production rate due to photosynthesis (mg/l/day)
Sb	=	sediment oxygen demand (mg/l/day)

Parameter values used as model input for this study, and the rational for their selection, are presented in Section 3.4.

3.3 REACHES

The assimilative capacity of a river varies with the size and characteristics of each reach of the river. Reaches are defined between all major point loads or whenever the river geometry, hydraulic conditions or biochemical processes are expected to change significantly.

Modeling for this study focused on the area downstream of the Coy Paper dam as this was the segment of the river where modeling predicted the potential for future DO violations. It was not considered necessary to start further upstream because of the dam serves to enhance the assimilative capacity of the river. Furthermore, the 1993 WLA showed that the impact of upstream WWTFs did not extend down to the Coy dam.

Similar to the 1993 WLA , the area downstream of the Coy Paper dam was divided into two reaches. Reach 1 is approximately 0.24 miles long and extends from the Coy Paper WWTF to just upstream of the Claremont WWTF. Reach 2 is approximately 1.55 miles long and is from the Claremont WWTF to the Connecticut River confluence. A description of the reaches and other information needed for the TMDL is provided in Table III-1. A schematic of the reaches is shown in Figure III-1.

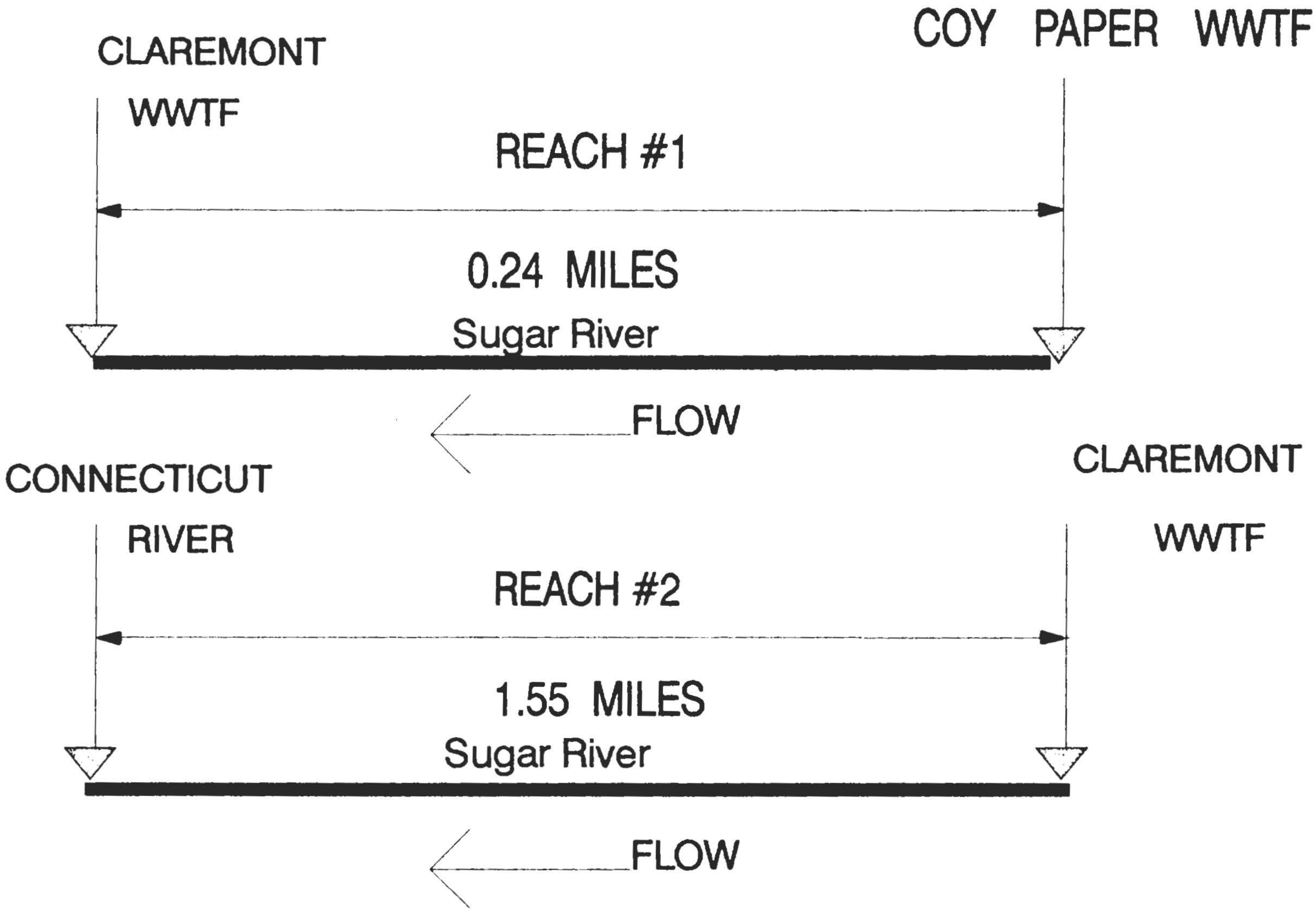
Table III-1
Reach Characteristics

Reach	Description	River Miles	Urban Area sq. miles	Rural Area sq. miles	Agric.Area sq. miles
1	Coy Paper Dam to Claremont WWTF	0.24	0.75	1.47	0.48
2	Claremont WWTF to Connecticut River	1.55	0.03	3.30	0.57

3.4 MODEL INPUT FOR DRY AND WET WEATHER TMDL MODELING

Values used as model input for dry and wet weather TMDLs are presented in Tables III-2, III-3 and III-4. Tables III-2 and III-3 show the dry weather model input for summer and winter conditions for options 1 and 2. As discussed in Section 1.2, option 1 assumes that only the Claremont WWTF is discharging while option 2 assumes that both the Coy Paper WWTF and the Claremont WWTF are discharging.

Figure III-1
Schematic of Reaches



As will become evident, most parameters are based on the values used in the 1993 WLA Study which modeled the majority of the Sugar River from the outlet of Lake Sunapee to it's confluence with the Connecticut River. Copies of pertinent sections of the 1993 WLA are provided in Appendix H.

The 1993 WLA study included extensive field measurements and water quality sampling which was used to calibrate and verify the DO model. In most cases, the parameters used for dry weather are the same as the model run in the 1993 WLA for 7Q10 low flow conditions. Similarly most of the wet weather model parameters are also based on the 1993 WLA. However, for wet weather, the calibrated model based on sampling conducted on June 23 and 24, 1992 was used, because the flow on that day (120 cfs) was very close to the flow used to model wet weather conditions (153 cfs). This is further discussed below.

Upstream River Conditions (UPFLOW, UPDO, UPCBOD, UPNBOD):

***UPFLOW*:** The upstream flow for reach 1 for dry weather modeling was assumed to be equal to the 7Q10 low flow of 39.9 cfs, which is the average river flow over seven consecutive days that is not exceeded more than once every 10 years on the average. It is based on data from the USGS gage on the Sugar River in West Claremont. The flow at the gage was prorated by drainage area to derive the 7Q10 flow for reach 1. The UPFLOW value for reach 2 is equal to the UPFLOW value for reach 1 plus the DISCHARGE FLOW for reach 1.

For wet weather modeling, the upstream flow for reach 1 was set equal to the summer average flow, which is the average daily flow which occurs in July, August and September. The value of 149 cfs was also based on flow data from the gage in West Claremont, which was then prorated by drainage area. Calculations are shown below:

Summer Average flow at West Claremont gage:	=	149 cfs
Drainage area to West Claremont gage	=	270 sm
Yield	=	0.556 cfs/sm
Drainage area to reach 1	=	270.95 sm
Summer Average flow at reach 1	=	270.95 x 0.556 = 150.64 cfs

***UPDO*:** Dry and wet weather background river DO concentrations for reach 1 were based on the 1993 WLA study. As part of the 1993 WLA, sampling was conducted just downstream of the Coy Paper Dam. The dry weather UPDO value is the same as that used in the 1993 WLA for 7Q10 conditions. The UPDO value for wet weather was based on the measured percent saturation in the 1993 WLA, on June 23, 1992, when the river flow was close to the summer average flow. UPDO values for reach 2 were set equal to the theoretical DO at the end of reach 1, based on modeling.

***UPCBOD and UPNBOD*:** Dry and wet weather background conditions for reach 1 were obtained from the 1993 WLA study. UPCBOD and UPNBOD values for dry weather were based on 1993 WLA, 7Q10 model runs. Reach 2 UPCBOD and UPNBOD values were set equal to the model values at the end of reach 1. UPCBOD and UPNBOD values for the wet weather condition were based on calibrated model runs for June 23-24, 1992.

Discharger Parameters (FLOW, DO, UCBOD, NBOD):

***FLOW*:** Flows used for the Claremont WWTF and the Coy Paper WWTF, were based on the design flows used in the most recent NPDES permit for each facility (see Appendix B).

***DO*:** As part of the 1993 WLA study, the effluent from the Claremont WWTF and Coy Paper WWTF were sampled. When modeling reach 1, the concentration of DO (mg/l) from the Coy Paper WWTF was set to 6.0 mg/l. Since the Claremont WWTF will need stricter effluent limits, when discharging at their design flow, the DO of the effluent was set equal to 7.0 mg/l.

***UCBOD*:** As shown in Appendix B, Coy Paper's NPDES permit includes a limit for BOD_5 and not $CBOD_5$. Based on federal technology limits for secondary treatment, $CBOD_5$ was assumed to be equal to 83% (25/30) of BOD_5. To convert from $CBOD_5$ to UCBOD, $CBOD_5$ values were multiplied by 1.6. UCBOD values for the Claremont WWTF were adjusted in the model until the minimum desired DO level was achieved.

***NBOD*:** NBOD values were based on NH_3-N concentrations multiplied by 4.57, which represents the amount of oxygen needed to oxidize 1 mg/l of NH_3-N to nitrate (NO_3). In addition to exerting an oxygen demand, NH_3-N can also be toxic to aquatic life. Therefore, the maximum NBOD concentration for either the Coy Paper WWTF or the Claremont WWTF, was based on the State Water Quality Standards for NH_3-N (which is temperature dependent), and the dilution factor. The equations used to calculate the allowable effluent concentration of NH_3-N based on toxicity is shown below. Results are presented in Table III-5 which shows the maximum allowable effluent concentration of NH_3-N (base on chronic toxicity) and NBOD for the Coy Paper and Claremont WWTFs for warm (25° C) and cold (15° C) temperatures.

$$\mathbf{D.F. = [(Qr + Qp) / Qp] * .90}$$

Maximum effluent NH_3-N = D.F. x WQS for NH_3-N
Where:

D.F.	=	dilution factor with 90% of assets
Qr	=	river flow
Qp	=	WWTF flow
WQS	=	Water Quality Standard

Table III-2
Model Input for Dry Weather TMDL

Option #1 (Temperature = 25° C)

Parameter	Reach #1	Reach #2	Parameter	Reach #1	Reach #2
Upstream Conditions			Ka - 1/day	2.1	10.6
7Q10 Flow - cfs	39.9	39.9	Kd - 1/day	7.0	2.4
UP DO - mg/l	7.9	*	Kn - 1/day	0.5	2.1
UP UCBOD- mg/l	3.0	*	R - mg/l/day	0.085	0.05
UP NBOD - mg/l	1.1	*	P - mg/l/day	0	0
Discharge conditions	Coy	Claremont	Saturation Cs - mg/l	8.16	8.16
Discharge flow - cfs	NIO	6.10	River Velocity - fps	0.47	0.51
Discharge DO - mg/l	NIO	7.0	Sb or SOD - mg/l/day	0	0
Discharge UCBOD - mg/l	NIO	* *	Starting mile	1.79	1.55
Discharge NBOD - mg/l	NIO	* *	Ending mile	1.55	0

Option #1 (Temperature = 15° C)

Parameter	Reach #1	Reach #2	Parameter	Reach #1	Reach #2
Upstream Conditions			Ka - 1/day	1.66	8.4
7Q10 Flow - cfs	39.9	39.9	Kd - 1/day	5.56	1.91
UP DO - mg/l	9.65	*	Kn - 1/day	0.32	1.67
UP UCBOD- mg/l	3.0	*	R - mg/l/day	0.085	0.05
UP NBOD - mg/l	1.1	*	P - mg/l/day	0	0
Discharge conditions	Coy	Claremont	Saturation Cs - mg/l	9.964	9.964
Discharge flow - cfs	NIO	6.10	River Velocity - fps	0.47	0.51
Discharge DO - mg/l	NIO	7.0	Sb or SOD - mg/l/day	0	0
Discharge UCBOD - mg/l	NIO	* *	Starting mile	1.79	1.55
Discharge NBOD - mg/l	NIO	* *	Ending mile	1.55	0

Notes:

NIO = Not in Operation
* = Value was based on model values at the end of reach 1.
* * = Value was adjusted until the model predicted the desired minimum DO.

Table III-3
Model Input for Dry Weather TMDL

Option #2 (Temperature = 25° C)

Parameter	Reach #1	Reach #2	Parameter	Reach #1	Reach #2
Upstream Conditions			Ka - 1/day	2.1	10.6
7Q10 Flow - cfs	39.9	41.29	Kd - 1/day	7.0	2.4
UP DO - mg/l	7.9	*	Kn - 1/day	0.5	2.1
UP UCBOD- mg/l	3.0	*	R - mg/l/day	0.085	0.05
UP NBOD - mg/l	1.1	*	P - mg/l/day	0	0
Discharge conditions	Coy	Claremont	Saturation Cs - mg/l	8.16	8.16
Discharge flow - cfs	1.39	6.1	River Velocity - fps	0.47	0.51
Discharge DO - mg/l	6.0	7.0	Sb or SOD - mg/l/day	0	0
Discharge UCBOD - mg/l	53	* *	Starting mile	1.79	1.55
Discharge NBOD - mg/l	9.0	* *	Ending mile	1.55	0

Option #2 (Temperature = 15° C)

Parameter	Reach #1	Reach #2	Parameter	Reach #1	Reach #2
Upstream Conditions			Ka - 1/day	1.66	8.4
7Q10 Flow - cfs	39.9	41.29	Kd - 1/day	5.56	1.91
UP DO - mg/l	9.65	*	Kn - 1/day	0.32	1.67
UP UCBOD- mg/l	3.0	*	R - mg/l/day	0.085	0.05
UP NBOD - mg/l	1.1	*	P - mg/l/day	0	0
Discharge conditions	Coy	Claremont	Saturation Cs - mg/l	9.964	9.964
Discharge flow - cfs	1.39	6.1	River Velocity - fps	0.47	0.51
Discharge DO - mg/l	6.0	7.0	Sb or SOD - mg/l/day	0	0
Discharge UCBOD - mg/l	53	* *	Starting mile	1.79	1.55
Discharge NBOD - mg/l	9.0	* *	Ending mile	1.55	0

Notes:

* = Value was based on model values at the end of reach 1.

* * = Value was adjusted until the model predicted the desired minimum DO.

Table III-4
Model Input for Wet Weather TMDL

(Temperature = 25° C)

Parameter	Reach #1	Reach #2	Parameter	Reach #1	Reach #2
Upstream Conditions			Ka - 1/day	2.0	10.
7Q10 Flow - cfs	150.64	153.54	Kd - 1/day	7.0	2.4
UP DO - mg/l	7.3	*	Kn - 1/day	0.5	2.1
UP UCBOD- mg/l	3.0	*	R - mg/l/day	0.085	0.05
UP NBOD - mg/l	0.5	*	P - mg/l/day	0	0
Discharge conditions			Saturation Cs - mg/l	8.16	8.16
Discharge flow - cfs	2.9	8.28	River Velocity - fps	0.91	0.92
Discharge DO - mg/l	7.0	7.0	Sb or SOD - mg/l/day	0	0
Discharge UCBOD - mg/l	* *	* *	Starting mile	1.79	1.55
Discharge NBOD - mg/l	* *	* *	Ending mile	1.55	0

Notes:

* = Value was based on model values at the end of reach 1.

* * = Value was adjusted until the model predicted the desired minimum DO.

Table III-5
Discharge Values for Maximum Ammonia and NBOD

Facility	WWTF Flow cfs	River Flow cfs	Temp. C	Dilution Factor	In-stream WQS NH_3-N mg/l	Effluent Chronic Limit mg/l	Effluent NBOD mg/l
Coy Paper	1.39	39.9	25	26.7	1.01	27.0	123.4
			10		2.21	59.0	269.6
Claremont	6.10	41.29	25	6.99	1.01	7.06	32.3
			10		2.21	15.45	70.60

The NBOD values used in the model were DO controlled and were well below the maximum values shown in Table III-5, which were based on NH_3-N toxicity. As shown in Table III-3, a NBOD of 9.0 mg/l was assumed for the Coy Paper WWTF. This was based on sampling performed for the 1993 WLA, which indicated effluent NH_3-N concentration of about 2.0 mg/l. NBOD values for the Claremont WWTF were adjusted until the desired minimum DO level was achieved.

Mass Rate of CBOD and NBOD (Lrd and Nrd):

The DO equation shown in section 3.2, includes the parameters Lrd and Nrd which stand for the mass rate of CBOD and NBOD respectively, that enter each reach per unit volume of river water. Similar to the 1993 WLA, Lrd and Nrd was assumed to be equal to zero in this study.

Reaeration Rate Coefficient (K_a):

The main sources of dissolved oxygen for a river or stream are reaeration from the atmosphere and dams, dissolved oxygen in tributaries and photosynthesis. K_a is the rate at which oxygen is transferred from the atmosphere to the river. Factors which can affect K_a include depth, velocity, turbulence, temperature and the amount of oxygen in the river.

Dry weather values of K_a (temperature 25° C) for each reach were obtained from modeling in the 1993 WLA conducted under 7Q10 conditions. Wet weather K_a values (temperature 25° C) were based on the calibrated model in the 1993 WLA for data taken on June 23 and 24, 1992. For temperature of 15° C, K_a values were adjusted using the coefficients and equations used in the 1993 WLA.

Deoxygenation Rate Coefficient (K_d):

The reduction of BOD in a river is a function of settling, biochemical oxidation and absorption by bottom deposits. The rate of removal of BOD is defined as the deoxygenation rate coefficient (K_l). K_l can generally be expressed as:

$$K_l = K_s + K_d + K_b$$

where:

K_l	=	total removal rate of BOD
K_s	=	settling losses
K_d	=	biochemical oxidation
K_b	=	absorption from bottom deposits

As explained in the 1993 WLA, K_s is not considered to be a significant factor in the Sugar River because the existing wastewater treatment facilities contribute relatively low levels of total suspended solids. Further, much of the tributary area to the Sugar River is undeveloped. Therefore, K_s can be dropped from the general equation.

Similar to the 1993 WLA, it was assumed that any BOD samples obtained would reflect the effects of not only the biochemical oxidation but also bottom absorption losses. Thus, the K_b rate is inherently included in the overall K_d rate factor. In this study, K_1 was assumed to be equal to K_d.

Dry weather values of K_d (temperature 25° C) for each reach were obtained from modeling in the 1993 WLA conducted under 7Q10 conditions. Wet weather K_d values (temperature 25° C) were based on the calibrated model in the 1993 WLA for data taken on June 23 and 24, 1992. For temperature of 15° C, K_d values were adjusted using the coefficients and equations used in the 1993 WLA.

Nitrification Rate Coefficient (K_n):

The rate at which nitrification (K_n) occurs is an important element in the DO model. Although, nitrification causes a drain on DO, it does not represent a permanent loss of oxygen. This is because nitrate oxygen is available as "stored dissolved oxygen", a reserve asset that is again available when the DO is depleted.

Nitrification is a two step process in which ammonia (NH_3) is transformed into nitrites (NO_2^-) and nitrates (NO_3^-). The process begins with ammonium conversion to nitrite by *Nitrosomonas* bacteria, which is followed by nitrite conversion to nitrate by *Nitobacter* bacteria. The relatively slow growth rate of *Nitrosomonas* bacteria limits the nitrification process. Both organisms are most efficient at temperatures of 14 to 35° C, pHs of 8.0 to 8.5.

Dry weather values of K_n (temperature 25° C) for both reaches were obtained from modeling conducted as part of the 1993 WLA for 7Q10 conditions. Wet weather K_n values (temperature 25° C) were based on the calibrated model in the 1993 WLA for data taken on June 23 and 24, 1992. For temperature of 15° C, K_n values were adjusted using the coefficients and equations used in the 1993 WLA.

Photosynthesis/Respiration (P and R):

The presence of aquatic plants in a water body can have a profound effect on the DO resources and the variability of the DO throughout a day or from day to day. During photosynthic cell synthesis, algae produce DO, whereas algal respiration consumes DO. Photosynthesis, which is dependent on sun light, occurs only during daylight hours while respiration occurs continuously. The two principal issues associated with the photosynthesis and respiration components on DO are (a) the degree to which the net effect of photosynthesis and respiration contributes to the average DO resources and (b) the expected diurnal variability in DO as a result of the presence of aquatic plants.

Since DO sampling, for the Sugar River WLA, was conducted in the early morning hours, the photosynthesis rate was assumed to be zero. Respiration rates must be calculated since respiration occurs around the clock. The equation (Ref. #11) used to determine the respiration rate (R) is shown below.

Respiration equation

$$\mathbf{R = a_o D_p A}$$

where:

$a_o = 0.133$ mg O_2/ug Chlor a

D_p is the rate of algae as determined by the following relationship:

$$D_p = 0.1\ (1.08)^{T-20} = 0.1(1.08)^{25-20} = 0.147$$

A = chlorophyll "a" measurement

Dry weather values of P and R for reaches 1 and 2 were obtained from modeling conducted as part of the 1993 WLA for 7Q10 conditions. Wet weather P and R values were based on the calibrated model in the 1993 WLA for data taken on June 23 and 24, 1992.

Sediment Oxygen Demand (SOD or Sb):

Oxygen demand by benthic sediments and organisms can represent a large fraction of oxygen consumption in surface waters. The rate at which dissolved oxygen is removed from the water column due to the decomposition of organic material in the sediments is known as the sediment oxygen demand. The major factors affecting SOD are: temperature, available oxygen, makeup of the biological community, organic and physical characteristics of the sediment, current velocities over the sediments and chemistry of the interstitial water.

The SOD rate used in the 1993 WLA study and this TMDL was assumed to be negligible (SOD = 0). This assumption is based on the relatively high velocities in the Sugar River and the fact that no significant organic deposits were observed in the sediments.

DO Saturation Value (Cs):

The DO saturation values for dry (summer and winter) and wet weather modeling were obtained from the 1993 WLA. These values were based on a temperature of 15 and 25 degrees Celsius and were adjusted for salinity and elevation, using equations obtained from reference #11.

Velocity (V):

The velocities for dry weather modeling are based on modeling conducted as part of the

1993 WLA for 7Q10 conditions . Wet weather velocities were based on the calibrated model in the 1993 WLA for data taken on June 23 and 24, 1992.

3.5 TARGET DO VALUES FOR TMDL MODELING

Use of the DO model to determine TMDLs involves an iterative process. Known parameters are first input in the model. Variable parameters (usually the discharge CBOD and NBOD) are then adjusted until the model predicts a minimum DO that corresponds to the allowable minimum DO. For this study, the minimum allowable DO (i.e., the "target DO") for TMDL modeling was set equal to 75 percent of the DO saturation value. This target DO was selected because State law (RSA 485-A:8,II), requires Class B waters to maintain a dissolved oxygen level of at least 75 percent of saturation.

3.6 ALLOCATION OF THE WET WEATHER TMDL

Once the wet weather TMDL for each reach was determined, it was then necessary to allocate the total load among point sources (PS), and nonpoint sources (NPS). In addition, federal law requires that the allocation include a margin of safety (MOS) to account for uncertainties in modeling.

Before proceeding it is important to understand that the TMDL as defined herein, is the additional load (i.e., the load over and above the background load in the river), that can be added to a river at a specified location. This is consistent with the way that loadings have been historically reported in WLA studies. It is also important to realize that the TMDL as defined herein is dependent on background river loadings assumed in the model. That is, for example, if lower river background loadings were input into the model, the TMDL would increase. For this study, the following procedure was used to allocate the wet weather TMDL.

- First, the MOS was determined. This was assumed to be 10 percent of the TMDL.
- The point source (PS) maximum daily load was then determined. This was set equal to the maximum daily loading used in the model for the WWTF in each reach.
- Lastly, the allowable nonpoint source (NPS) loading was determined. This was assumed equal to the remaining loading (NPS = TMDL - PS - MOS).

Allocations were performed for options 1 and 2. An example of how the allocation for option 1 was calculated is provided in Appendix C.

3.7 ESTIMATION OF EXISTING NONPOINT SOURCE LOADINGS

Once the allocation of the wet weather TMDL was determined, it was desired to compare the allocated NPS load to existing NPS loads. The following procedure was used to determine existing NPS loads. An example calculation is provided in Appendix D.

- Calculate the summer average flow to the beginning of the reach.
- Determine the drainage area for the reach.
- Determine the square miles of rural, agricultural, and urban areas.
- Using loadings from Table III-6, calculate the weighted CBOD and NH_3-N concentrations.
- Calculate mass loading {flow (MGD) x weighted concentration x 8.34 }

Table III-6
Runoff Loadings Based on Land Use [5,6]

LAND USE	CBOD (mg/l)	NH_3-N (mg/l)
RURAL	———	0.19
AGRICULTURAL	5.0	5.04
URBAN - HIGH	30.0	1.00
URBAN - MEDIUM	26.0	0.75
URBAN - LOW	11.0	0.50

3.8 DETERMINATION OF PRELIMINARY DISCHARGE LIMITS FOR THE CLAREMONT WWTF

As discussed in Section 1.2 , it was desired to develop preliminary discharge limits for the Claremont WWTF for both options 1 and 2, as it is believed this information may be useful to the City of Claremont for planning purposes. To do so, it was first necessary to compare the dry and wet weather TMDLs. The condition which resulted in the lowest allowable TMDL was considered to be the most stringent and was used to develop preliminary discharge limits ($CBOD_5$ and NH_3-N) for the Claremont WWTF.

SECTION IV

RESULTS AND DISCUSSIONS

SECTION IV
RESULTS AND DISCUSSION

4.1 TMDL RESULTS

Results of modeling to determine dry and wet weather TMDLs revealed the following (Appendix E contains copies of the modeling output):

- The major nonpoint source (NPS) of potential pollution is stormwater runoff. No other major NPSs were identified.
- The minimum concentration of DO (i.e., the DO sag) occurs in reach 2.
- The allowable loading of either $CBOD_5$ or NH_3-N in reach 2 is very dependent on the loading and concentration of DO in reach 1.
- Based on the assumptions and methods used in this study, results of modeling indicates that the dry weather TMDL for option 1 and 2 are as follows:

Table IV-1
Option #1
Dry Weather TMDL

Parameter	Reach #1	Reach #2
$CBOD_5$ (lbs/day)	0	953
NH_3-N (lbs/day	0	276

Table IV-2
Option #2
Dry Weather TMDL

Parameter	Reach #1	Reach #2
$CBOD_5$ (lbs/day)	250	723
NH_3-N (lbs/day	15	246

- Based on the assumptions and methods used in this study, Table IV-3 shows the wet weather TMDL. As previously mentioned, the TMDL in reach 2 is highly dependent on the TMDL assumed for reach #1. Because of the dependency of reach 2 on reach 1, there are many possible combinations of loadings, one of which is presented in Table IV-3 below.

Table IV-3
Wet Weather TMDL

Parameter	Reach #1	Reach #2
$CBOD_5$ (lbs/day)	684	2789
NH_3-N (lbs/day)	154	439

- A comparison of the dry weather TMDL for either option 1 or 2, to the wet weather TMDL, indicates that the dry weather TMDL is lower. Therefore dry weather conditions control, as they are more stringent.

4.2 TMDL ALLOCATION RESULTS

The method used to allocate the wet weather TMDL was described in Section 3.6. Results are presented in Table IV-4.

Table IV-4
Allocation of Loads for the Wet Weather TMDL

Source of Loading	Option 1 (1)				Option 2 (2)			
	Reach 1		Reach 2		Reach 1		Reach 2	
	$CBOD_5$ (lbs/day)	NH_3-N (lbs/day)	$CBOD_5$ (lbs/day)	NH_3-N (lbs/day)	$CBOD_5$ (lbs/day)	NH_3-N (lbs/day)	$CBOD_5$ (lbs/day)	NH_3-N (lbs/day)
Point (3) Source (PS)	0	0	953	276	250	15	723	246
Nonpoint (4) Source (NPS)	616	139	1557	119	366	124	1787	149
Margin of (5) Safety (MOS)	68	15	279	44	68	15	279	44
Total (6) (TMDL)	684	154	2789	439	684	154	2789	439

Notes:

(1) Option 1 assumes no discharge from the Coy Paper WWTF and that the Claremont WWTF is discharging at new (more stringent) effluent limits.

(2) Option 2 assumes that the Coy Paper WWTF is discharging at its 1992 permit limits and that the Claremont WWTF is discharging at new (more stringent) effluent limits.

(3) Point source loadings are based on the proposed maximum day discharge loadings for the Coy Paper and/or Claremont WWTFs. The Coy Paper WWTF is located at the beginning of Reach 1 and the Claremont WWTF is located at the beginning of Reach 2.

(4) Nonpoint Source Loadings are equal to the Total TMDL minus the sum of the Point Source Loading and the Margin of Safety {i.e, NPS = Total - (PS + MOS)}.

(5) The Margin of Safety (MOS) is equal to 10 percent of the Total TMDL

(6) Loadings shown for the Total TMDL are over and above the assumed background loading in the river upstream of each reach.

4.3 EXISTING NPS LOADING vs PROPOSED NPS TMDL

- The method used to estimate existing NPS loads due to stormwater runoff was provided in Section 3.7. Results are shown in Table IV-5.

Table IV-5
Existing NPS Loading Due to Stormwater Runoff

Reach #1		Reach #2	
$CBOD_5$ lbs/day	NH_3-N lbs/day	$CBOD_5$ lbs/day	NH_3-N lbs/day
27	9	8	11

- A comparison of Table IV-5 to the NPS loads in Table IV-4 indicates that existing NPS loadings are well below the theoretical TMDL for NPSs. Thus the Sugar River is below its theoretical NPS loading capacity for wet weather conditions.

4.4 PRELIMINARY DISCHARGE LIMITS FOR THE CLAREMONT WWTF

Preliminary discharge limits for the Claremont WWTF for periods of warm and cold temperatures are presented in the tables below. Limits were based on dry weather conditions (i.e., river at 7Q10 low flow) as this was determined to be the controlling condition (see Section 4.1). Table IV-6 shows the proposed limits for option 1 which assumes that only the Claremont WWTF is discharging. Proposed limits for option 2 are shown in Table IV-7, which assumes that both the Coy Paper WWTF and the Claremont WWTF are discharging. With regards to these limits the following conclusions can be made.

- The proposed discharge limits for the Claremont WWTF, for either option, are more stringent than the City's current NPDES permit limits which are based on technology limits for secondary treatment.

- Based on sampling results over the past two years, it appears that the Claremont WWTF can currently meet the proposed summer limits for $CBOD_5$ and NH_3-N. This is believed to be primarily due to the fact that the WWTF is currently treating only 50 percent of it's design flow.

- The City may have to install a mixer or other means of meeting the proposed minimum effluent DO concentration of 7 mg/l. If this limit can not be met, additional modeling should be conducted at lower effluent DO concentrations. This, however, would result in lower limits for $CBOD_5$ and/or NH_3-N.

- As flows to the Claremont WWTF approach the plant's design capacity, the City may have to make future improvements to the WWTF to meet the proposed limits. There is a possibility however, that the Claremont WWTF could continue discharging at its current NPDES permit limits, if it's discharge was relocated directly to the Connecticut River (downstream of the Sugar River confluence). Additional modeling would be needed, however, to confirm this assumption.

- A comparison of options 1 and 2 shows that if the Coy Paper Company is bought and the discharge is reactivated with effluent limits equal to the old NPDES permit for Coy Paper, it reduces the allowable effluent limits at the Claremont WWTF. It is recommended that the City take this into consideration if plans are made to reactivate the discharge at the Coy Paper Facility. If effluent limits are considered for the discharge at the former Coy Paper Company, which are different from those assumed in this study, additional modeling would have to be conducted to determine new limits for the Claremont WWTF.

Table IV-6
<u>OPTION #1</u>
Proposed WWTF Effluent Discharge Limits

Summer (June 1 - October 31)

WWTF	Parameter	mg / l			lbs / day		
		Average Monthly	Average Weekly	Maximum Daily	Average Monthly	Average Weekly	Maximum Daily
Coy Paper (No discharge)		---	---	---	---	---	---
Claremont (3.94 MGD)	DO	No	less than	7.0 mg/l			
	$CBOD_5$	25	28	29	822	920	954
	NH_3-N	6.8	---	8.4	223	---	276

Winter (November 1 - May 31)

WWTF	Parameter	mg / l			lbs / day		
		Average Monthly	Average Weekly	Maximum Daily	Average Monthly	Average Weekly	Maximum Daily
Coy Paper (No discharge)		---	---	---	---	---	---
Claremont (3.94 MGD)	DO	No	less than	7.0 mg/l			
	$CBOD_5$	25	28	29	822	920	954
	NH_3-N	11.4		12.3	375		404

Table IV-7
OPTION #2
Proposed WWTF Effluent Discharge Limits

Summer (June 1 - October 31)

WWTF	Parameter	mg / l			lbs / day		
		Average Monthly	Average Weekly	Maximum Daily	Average Monthly	Average Weekly	Maximum Daily
Coy Paper (0.9 MGD)	Flow (1)			0.9 MGD			
	DO	No	less than	6.0 mg/l			
	BOD_5 (1)				295		300
	NH_3-N	2		2			15
Claremont (3.94 MGD)	DO	No	less than	7.0 mg/l			
	$CBOD_5$	19	21	22	624	690	723
	NH_3-N	6.3		7.4	207		243

Winter (November 1 - May 31)

WWTF	Parameter	mg / l			lbs / day		
		Average Monthly	Average Weekly	Maximum Daily	Average Monthly	Average Weekly	Maximum Daily
Coy Paper (0.9 MGD)	Flow (1)			0.9 MGD			
	DO	No	less than	6.0 mg/l			
	BOD_5 (1)				295		300
	NH_3-N	2		2			15
Claremont (3.94 MGD)	DO	No	less than	7.0 mg/l			
	$CBOD_5$	25	27	28	822	887	921
	NH_3-N	8.5		9.2	279		302

Notes:

(1) Values are based on the 1992 NPDES permit for Coy Paper. $CBOD_5$ values used in the model were assumed equal to 83 % (25/30) of the BOD_5.

4.5 RESULTS OF SAMPLING TO CONFIRM OTHER WATER QUALITY EXCEEDANCES ON THE 303 (d) LIST

In addition to DO, the New Hampshire 1994 303 (d) list (see Appendix A) also included the following water quality exceedances in the Sugar River.

- Copper
- Lead
- Toxics (based on failure of a Whole Effluent Toxicity (WET) test of the river water).

In the summer of 1995, sampling was conducted to confirm these violations. Results of this sampling effort are provided in Appendix F.

The results indicate no violations of copper or lead. With regard to the WET tests, failure was attributed to a naturally occurring fungus in the river, and not toxics, as originally assumed. Because no violations were found in 1995, the above violations will be removed from the State's 303(d) list of potentially impaired waters.

APPENDIX A

STATE OF NEW HAMPSHIRE'S 1994 303 (d) LIST

WATER BODY NAME/ID#/ LOCATION	USE CLASS	OVERALL USE SUPPORT AND MILES AFFECTED	DATA BASIS	ASSESSMENT BASIS	WQS VIOLATED	PROBABLE SOURCE	INDIVIDUAL USE SUPPORT AND MILES AFFECTED	REQUIRED ACTION AND COMMENTS	FILE # DATA SOURCE
MIREY BROOK NHR80201050-00.0100. WINCHESTER	B	PS 1.0	MONITORED	93-1MIR-3-1	D.O.	UNKNOWN	PS 1.0	INVESTIGATE SOURCE. (AROUND RTE. 10 CROSSING UPSTREAM OF ASHUELOT RIVER CONFLUENCE).	0929 1993 AMBIENT SURVEY
SUGAR RIVER NHR80104100-00.0109 CLAREMONT	B		MONITORED	W.E.T. FOR CLAREMONT WWTF	TOXICS	UNKNOWN	PS 1.0	INVESTIGATE SOURCE. WET SAMPLE FOR DILUTION WATER TAKEN 15 FEETABOVE CLAREMONT WWTF OUTFALL WHICH IS BELOW FORMER COY PAPER OUTFALL.	0216 WHOLE EFFLUENT. TOXICITY TEST FOR CLAREMONT WWTF.
SUGAR RIVER NHR80104100-00.0100. NEWPORT	B		MONITORED	92-9A SGR7-1, 92-14 SGR-7-2	D.O.	UNKNOWN	PS 2.0	INVESTIGATE SOURCE. (FROM NORTH BRANCH RIVER CONFLUENCE UPSTREAM IN NEWPORT- 1.0 MI.; AND FROM LONG POND BROOK CONFLUENCE UPSTREAM 1.0 MI.)	0961 1992 AMBIENT SURVEY; 1992 WASTELOAD ALLOCATION STUDY
SUGAR RIVER NHR80104100-00.0100. NEWPORT	B	PS 1.2	MONITORED	92-15SGR-1-1	COPPER	UNKNOWN	PS 1.2	INVESTIGATE SOURCE. (FROM LONG POND BROOK CONFLUENCE UPSTREAM TO MAPLE ST.).	0962 1992 AMBIENT SURVEY;
SUGAR RIVER NHR80104100-00.0100. NEWPORT	B	PS 1.0	MONITORED	92-13SGR-1-1	LEAD	UNKNOWN	PS 1.0	INVESTIGATE SOURCE. (FROM SOUTH BRANCH SUGAR RIVER CONFLUENCE UPSTREAM).	0963 1992 AMBIENT SURVEY
WILD AMMONOOSUC RIVER NHR80101270-00.0100. BATH	B	PS 1.0	MONITORED	92-1WAM-2-1	ZINC	UNKNOWN	PS 1.0	INVESTIGATE SOURCE. (FROM CONFLUENCE WITH AMMONOOSUC RIVER UPSTREAM).	0931 1992-AMBIENT SURVEY

APPENDIX B

EXISTING NPDES PERMITS

AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Federal Clean Water Act, as amended, (33 U.S.C. §§1251 et seq.; the "CWA"),

Sunapee Sewer Commission
Town of Sunapee Water Pollution Control Facility

is authorized to discharge from a facility located at

Route 11
Sunapee, NH

to receiving waters named

Sugar River

in accordance with effluent limitations, monitoring requirements and other conditions set forth herein.

This permit shall become effective on date of signature.

This permit and the authorization to discharge expire at midnight, five years from effective date.

This permit supersedes the permit issued on May 8, 1979.

This permit consists of 5 pages in Part I including effluent limitations, monitoring requirements, etc., and 19 pages in Part II including General Conditions and Definitions.

Signed this 17th day of April, 1986

Final Permit
4/17/86 - 4/17/91

David A. Fierra

Director
Water Management Division
Environmental Protection Agency
Boston, MA

REGION I

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. During the period beginning on the effective date and lasting through expiration, the permittee is authorized to discharge from outfall serial number 001 (Treatment Plant Effluent).

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations kg/day (lbs/day) Average Monthly	Average Weekly	Maximum Daily	(specify units) Average Monthly	Average Weekly	Maximum Daily	Monitoring Requirement Measurement Frequency	Sample Type
Flow-m^3/Day (MGD)	-	-	-	-	-	-	Continuous recording	
BOD	73 (160)	109 (240)	121 (267)	30 mg/l	45 mg/l	50 mg/l	2/month[1]	8-hr comp.
TSS	73 (160)	109 (240)	121 (267)	30 mg/l	45 mg/l	50 mg/l	2/month[1]	8-hr comp.
Settleable Solids	-	-	-	-	0.1 ml/l	0.3 ml/l	Daily	Grab
pH				(See A.1.a on page 3)			Daily	Grab
Total Coliform	-	-	-	240/100ml	240/100ml	240/100ml	2/Month	Grab
Chlorine Residual	-	-	-	(See A.1.f on page 3)			2/Daily	Grab

Footnote
(1) Influent and effluent sampling required.

AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Federal Clean Water Act, as amended, (33 U.S.C. §§1251 et seq.; the "CWA"),

Town of Newport
(Dorr Woolen)

is authorized to discharge from the facility located at

Guild Road

to receiving waters named Sugar River

in accordance with effluent limitations, monitoring requirements and other conditions set forth herein.

This permit shall become effective 30 days from date of signature.

This permit and the authorization to discharge expires at midnight, five years from date of issuance.

This permit supersedes the permit issued on July 29, 1985.

This permit consists of 6 pages in Part I including effluent limitations, monitoring requirements, etc., and 19 pages in Part II including General Conditions and Definitions.

Signed this 30th day of Sep 1991

Director
Water Management Division
Environmental Protection Agency
Region I
Boston, MA

REGION I

Part I

Permit No. NH0100307

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. During the period beginning on the effective date and lasting through the expiration date, the permittee is authorized to discharge from outfall serial number 001 -treated wastewater to the Sugar River . (See Attachment A for location).
Such discharge shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations kg/day (lbs/day) Average Monthly	Average Weekly	Maximum Daily	(Specify Units) Average Monthly	Average Weekly	Maximum Daily	Monitoring Requirements Measurement Frequency	Sample Type
Flow (mgd)				1.0 mgd		Report	Continuous	Continous
BOD	102(225)		205(450)*				1/week	Composite
TSS	114(250)		330(725)				1/Week	Composite
COD	751(1652)		1502(3304)				1/week	Composite
Total Chromium	(1.47)		(2.94)				2/month	Composite
Total Sulfide	(2.94)		(5.88)				2/month	Composite
Total Phenol	(1.47)		(2.94)				2/month	Composite
Oil and Grease						15 mg/l	1/month	Grab
Phosphrous						Report mg/l	1/month	Composite
Ammonia				5.67mg/l[2]		Report mg/l	2/month	Composite
Lc^{50}(See Att B, see footnote 1)			100%				1/Quarter	Composite
C-NOEC(See Att B, See footnote 1)			16.5% or greater					
pH (S.U.)						6.5 to 8.0	1/day	Grab

* Daily maximum BOD is limited to 335lbs/day from June 1 until October 31 each year.
The pH shall be within the range of 6.5 to 8.0 or as naturally occurs in the receiving stream (see Permit Condition I.C.1.a.)
There shall be no discharge of floating solids or visible foam in other than trace amounts.

1. The permitee shall conduct chronic and acute toxicity tests using ceriodaphnia and fathead minnows (see attachment B) once per quarter for the months of March, June, September and December. Toxicity tests shall be taken during dry weather conditions. Reporting of results shall be within 45 days of sampling, i.e. the March toxicity sample results must be submitted by May 15.

2. State certification requirement resulting from 90% of the streams assets.

Permit No. NH0000680
Application No.

AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Federal Water Pollution Control Act, as amended, (33 U.S.C. 1251 et. seq; the "Act"),

STURM, RUGER & COMPANY, INC.

is authorized to discharge from a facility located at

GUILD ROAD
NEWPORT, NEW HAMPSHIRE 03773

to receiving waters named

SUGAR RIVER
CLASS B

in accordance with effluent limitations, monitoring requirements and other conditions set forth in Parts I, II, and III hereof.

This permit shall become effective 30 days from date of signature

This permit and the authorization to discharge shall expire at midnight, July 1, 1978

Signed this 21st day of June, 1973

(As signed by) John A. S. McGlennon
Regional Administrator
Environmental Protection Agency

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning effective date of this permit and lasting through July 1, 1978 (Uncontaminated Cooling) the permittee is authorized to discharge from outfall(s) serial number(s) 001 and 002 (Water only)

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations kg/day (lbs/day) Daily Avg	Daily Max	Other Units (Specify) Daily Avg	Daily Max	Monitoring Requirements Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	—	—	155(.041)	—	One Day Each Quarter	Average
001 Temperature °C(°F)	—	—	—	27.5(82)	" "	Max. of 4 Grabs
002 Flow-m^3/Day (MGD)	—	—	91(.024)		" "	Average
Temperature °C(°F)	—	—	—	29(84)	" "	Max. of 4 Grabs

Total Flow (001&002)
Not to exceed 68,000 gpd

The pH shall not be less than 6.5 standard units nor greater than 8.0 standard units and shall be monitored one day each quarter, report range of 4 grabs

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): Points of discharge

The permittee shall not at any time, either alone or in conjunction with any person or persons, cause directly or indirectly the discharge of any waste into the said receiving waters except waste that has been treated in such a manner as will not lower the Class B quality or interfere with the uses assigned to said waters by the New Hampshire Legislature (Chapter 210, Laws of 1951).

AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Federal Clean Water Act, as amended, (33 U.S.C. §1251 *et seq.*; the "CWA"),

Town of Newport New Hampshire
Newport Wastewater Treatment Facility

is authorized to discharge from the facility located at

Putnam Road
Newport, NH 03773

to receiving waters named: the Sugar River

in accordance with effluent limitations, monitoring requirements and other conditions set forth herein.

This permit shall become effective thirty (30) days from the date of issuance.

This permit and the authorization to discharge expire at midnight, five (5) years from the effective date.

This permit supersedes the permit issued on September 28, 1989.

This permit consists of 8 pages in Part I which includes effluent limitations, monitoring requirements, etc., 9 pages in Attachment A, as well as 35 pages in Part II which includes General Conditions and Definitions.

Signed this 13th day of July, 1995

David A. Fierra

Director
Water Management Division
U.S. Environmental Protection Agency
Region I
Boston, Massachusetts

EFFECTIVE 08/12/95 → 03/12/00

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS:

1. During the period beginning on the effective date of the permit and lasting through the expiration date, the permittee is authorized to discharge from outfall serial number 001: treated domestic and municipal wastewater to the Sugar River.

a. Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations kg/day (lbs/day)[1]			Other Units In Specified Units			Monitoring Requirements	
	Average Monthly	Average Weekly	Maximum Daily	Average Monthly	Average Weekly	Maximum Daily	Measurement Frequency	Sample Type
Flow, MGD	---	---	---	Report	---	Report	Continuous	Recorder
BOD_5	148(325)	222(488)	246(542)	30 mg/l	45 mg/l	50 mg/l[1]	Weekly	Grab
TSS	148(325)	222(488)	246(542)	30 mg/l	45 mg/l	50 mg/l[1]	Weekly	Grab
pH (standard units)[1]				[see Part I.A.2. on Page 4]			Daily	Grab
Escherichia coli[1,2]	---	---	---	126/100 ml	---	406/100 ml	3/Week	Grab
Total Residual Chlorine[3]	---	---	---	0.092 mg/l	---	0.158 mg/l	Daily when in use	Grab
Whole Effluent Toxicity								
(LC_{50})[4]	---	---	---	---	---	100%[4]	Quarterly[6]	Comp-24
C-NOEC[5]	---	---	---	---	---	≥12%[5]	Quarterly[6]	Comp-24
Total Ammonia	---	---	---	Report[7]	---	Report[7]	2/Month[7]	Grab

b. The permittee shall sample the final effluent at a location that provides a representative sample of the effluent prior to mixing with any other stream.

DESIGNATIONS OF SUPERSCRIPTS 1-7 are addressed on page 3 of the permit.

AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Federal Clean Water Act, as amended, (33 U.S.C. §§1251 et seq.; the "CWA"),

Coy Paper Company, Inc.

is authorized to discharge from a facility located at

Plains Road
Claremont, NH 03743

to receiving waters named

Sugar River

in accordance with effluent limitations, monitoring requirements and other conditions set forth herein.

This permit shall become effective (30) thirty days from the date of issuance.

This permit and the authorization to discharge expires (5) five years from the date of issuance.

This permit supersedes the permit issued on September 18, 1986.

This permit consists of eight pages in Part I including effluent limitations, monitoring requirements, etc., Attachment A, and 22 pages in Part II including General Conditions and Definitions.

Signed this 26th day of June, 1992

David A. Fierra

Director
Water Management Division
Environmental Protection Agency
REGION I
Boston, MA

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. During the period beginning on the effective date and lasting through the expiration date the permittee is authorized to discharge from outfall serial number 001 to the Sugar River. This discharge shall be limited and monitored by the permittee as specified below:

Effluent Characteristics	Discharge Limitations					Monitoring Requirements	
	Average Monthly	Maximum Daily	Average Monthly	Maximum Daily	Minimum Daily	Measurement Frequency	Sample Type
	in lbs/day		in mg/L				
Flow (mgd)[1]	Report	Report	—	—	—	Continuous	Recorder
BOD and TSS for Production Level 1 (Current Production):							
BOD	295	300	Report[5]	Report[5]	—	2/Month	24-Hour Composite
TSS	235	350	Report[5]	Report[5]	—	2/Month	24-Hour Composite
pH (standard units)[2]	—	8.0	—	—	6.5	Continuous	Recorder
LC50[3]	—	100 %	—	—	—	4/Year[4]	24-Hour Composite
Phosphorous[5]	—	—	—	Report	—	4/Year	24-Hour Composite
Monthly Production[6]	Report	—	—	—	—	1/Quarter	Report
BOD and TSS for Production Level 2 (See Part I.C on page 6):							
BOD	300[7]	300[7]	Report[5]	Report[5]	—	2/Month	24-Hour Composite
TSS	285[7]	350[7]	Report[5]	Report[5]	—	2/Month	24-Hour Composite

Footnotes: 1-7. See page 3.
There shall be no discharge of floating solids or visible foam in other than trace amounts.
Samples taken in compliance with the monitoring requirements specified above shall be taken at the following locations:
Outfall 001 - Representative location of process flow to Sugar River.

AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Federal Clean Water Act, as amended, (33 U.S.C. §1251 et seq.; the "CWA"),

City of Claremont, New Hampshire

is authorized to discharge from the facility located at

Plains Road
Claremont, New Hampshire

to receiving waters named

Sugar River

in accordance with effluent limitations, monitoring requirements and other conditions set forth herein.

This permit shall become effective 30 days after signature.

This permit and the authorization to discharge expire five years from effective date.

This permit supersedes permit NH0101257 issued July 29, 1986.

This permit consists of 10 pages in Part I and 22 pages in Part II including General Conditions and Definitions.

Signed this 23rd day of April, 1992

Effective 5/23/92 - 5/23/97

[signature]
Director
Water Management Division
U.S. Environmental Protection Agency
Region I
Boston, Massachusetts

PART I

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. During the period beginning on the effective date and lasting through the expiration date, the permittee is authorized to discharge effluent to the Sugar River from outfall serial number 001. Such discharges shall: (1) be limited and monitored by the permittee as specified below; and (2) not cause a violation of the water-quality standards of the receiving waters.

	Discharge Limitations					Monitoring Requirement	
	(lbs/day)[2]		Concentrations				
Parameter	Average Monthly	Maximum Daily	Average Monthly	Average Weekly	Maximum Daily	Measurement Frequency	Sample Type
Flow[1]	—	—	—	—	—	Continuous Recording	
BOD[1]	976	1627	30 mg/L	45 mg/L	50 mg/L[2]	3 Weekly	24-hr. comp.
TSS[1]	976	1627	30 mg/L	45 mg/L	50 mg/L[2]	3 Weekly	24-hr. comp.
pH(SU)[1,2]	[See Part I.A.2]					Daily	Grab
Escherichia coli[2]	—	—	126/100 mL	—	406/100 mL	3 Weekly	Grab
Total Residual Chlorine[2,3]	—	—	—	—	77 µg/L	**See Part I.A.4.**	
Saturday, Sunday, Holidays						Daily	Grab
All Other Days						Twice Daily	Grab
Ammonia (NH_3)[2]	—	—	Report mg/L	—	Report mg/L	Weekly	Grab
Whole Effluent Toxicity	[See Part I. A. 3 for test species.]						
NOEC[4]	—	—	—	—	≥ 15% effluent	Quarterly	24-hour comp.
LC_{50}[4]	—	—	—	—	≥100% effluent	Quarterly	24-hour comp.

Footnotes on next page.

APPENDIX C

ALLOCATION EXAMPLE - OPTION #1

Allocation example - option #1

Wet Weather TMDL

Parameter	Reach #1	Reach #2
$CBOD_5$ (lbs/day)	684	2789
NH_3-N lbs/day	154	439

Option #1 - Coy Paper WWTF not in operation, Claremont WWTF operating.

Allocation for reach #1:

1). Determine MOS - (10%) of assets:

$CBOD_5$ (MOS) = 684 x .10 = 68 lbs/day
NH_3-N (MOS) = 154 x .10 = 15 lbs/day

2). No Point Sources (PS) in reach #1. Therefore no allocation to PS is necessary.

3). Allowable Nonpoint Source (NPS) loading is equal to remaining load.

$CBOD_5$ (NPS) = 684 - 68 = 616 lbs/day
NH_3-N (NPS) = 154 - 15 = 139 lbs/day

4). NPS loadings determined through the allocation process must be checked against actual NPS loadings based on land use.

Allocation for reach #2:

1). Determine MOS - (10%) of assets:

$CBOD_5$ (MOS) = 2789 x .10 = 279 lbs/day
NH_3-N (MOS) = 439 x .10 = 44 lbs/day

2). Claremont WWTF is the Point Source (PS) in reach #2. Based on dry weather modeling total load from Claremont WWTF is as follows:

$CBOD_5$ = 953 lbs/day
NH_3-N = 276 lbs/day

3). Allowable Nonpoint Source (NPS) loading is equal to remaining load.

$$CBOD_5 \ (NPS) = 2789 - (279 + 953) = 1557 \ \text{lbs/day}$$
$$NH_3\text{-}N \ (NPS) = 439 - (44 + 276) = 119 \ \text{lbs/day}$$

4). NPS loadings determined through the allocation process must be checked against actual NPS loadings based on land use.

APPENDIX D

NONPOINT SOURCE LOADING CALCULATIONS

NONPOINT SOURCE LOADING CALCULATION

The calculation of the NPS loading is based on the drainage area, land use classifications, incremental portion of the summer average flow and the pollutant loadings based on land use. In this example the NPS loading will be calculated for reach 1 (Coy Paper WWTF to the Claremont WWTF).

1. The drainage area contributing to reach 1 was obtained from USGS topographical maps and was calculated to be 2.70 square miles.

2. Based on GIS land use maps, the drainage area partitioned into the three land use classifications as follows:

   - 0.75 square miles of urban areas (low)
   - 1.47 square miles of rural areas
   - 0.48 square miles of agricultural areas

3. The incremental portion of the summer average flow contributing to reach 1 was calculated to be 1.51 cfs (1.0 MGD). Section 3.4 explains various model inputs for the TMDL, one of the inputs was UPFLOW. The yield was calculated to be 0.556 cfs/square mile. Based on this yield the incremental portion of the summer average flow is calculated as follows:

   - 2.70 square miles x 0.556 cfs/square mile = 1.51 cfs

4. Pollutant loadings were calculated using the loadings shown in Table III-1. Therefore the weighted pollutant loading concentration was calculated in the following manner.

$CBOD_5$ (mg/l)

$$C_{NPS} = \frac{0.75(11) + 1.47(0) + 0.48(5)}{2.70}$$

$$= 3.94 \text{ mg/l} \times (.8333) = 3.28 \text{ mg/l}$$

Note ... $CBOD_5 = .8333 \times BOD_5$

NH_3-N (mg/l)

$$C_{NPS} = \frac{0.75(.5) + 1.47(.19) + 0.48(5.04)}{2.70}$$

$$= 1.14 \text{ mg/l}$$

5. Therefore, the calculated mass loading in pounds per day is:

$CBOD_5$ (lbs/day) = (3.28 mg/l) (1.0 MGD) (8.345)

$= 27$ lbs/day

NH$_3$-N (lbs/day) $= (1.14$ mg/l$)$ $(1.0$ MGD$)$ (8.345)

$= 9$ lbs/day

APPENDIX E

MODELING OUTPUT

wet weather

```
*** RIVER MODEL PROGRAM ** EPA (600/6/82-004a) ***
    PC BASIC,   DESDORM1.BAS - LAST REVISED 3/95

INPUT FILE.. c:\model\sugar6

RIVER ...... Sugar                     MODELER .. JHerrick
REACH ......  1                        DATE ..... 12/13/95

COMMENTS.... Coy Paper WWTF to Claremont WWTF

UP FLOW (cfs) ..    150.64            DISCHARGE FLOW (cfs) ..    2.9
UP DO (mg/l) ...    7.3               DISCHARGE DO (mg/l) ...    7
UP UCBOD (mg/l).    3                 DISCHARGE UCBOD (mg/l).    70
UP NBOD (mg/l) .    .5                UCBOD/CBOD5............    1.6
                                      DISCHARGE NBOD (mg/l) .    45
                                      NBOD/NH3-N.............    4.57

DILUTION X 0.9 ......    47.65034     DISCHARGE CBOD5 (mg/l).    43.75
                                      DISCHARGE NH3-N (mg/l).    9.846827

REAERATION Ka ..    2                 SOD Sb ................    0
BOD DECAY Kd ...    7                 SOLUBILITY Cs .........    8.16
NBOD DECAY Kn ..    .5                VELOCITY (fps) ........    .91
CBOD FLUX Lrd ..    0                 WATER TEMPERATURE (C)..    25
NBOD FLUX Nrd ..    0                 STARTING MILE .........    1.79
RESPIRATION R ..    .085              ENDING MILE ...........    1.55
PHOTOSYNTHESIS P    0

MIN. DO (75% Cs).....    6.119        INITIAL CBOD (Lo) .....    4.2654
MIN. DO (90% ASSETS).    6.238        INITIAL NBOD (No) .....    1.3404
INITIAL DO MIX.......    7.294334     ENDING  CBOD (Le) .....    3.8103
INITIAL DO DEFICIT...    .8656        ENDING  NBOD (Ne) .....    1.3296
```

RIVER MILE	DISTANCE (miles)	DEFICIT (mg/l)	DISSOLVED OXYGEN (mg/l)
1.79	0	.8656	7.294334
1.778	.012	.887	7.272
1.766	.024	.909	7.25
1.755	.035	.933	7.226
1.744	.046	.956	7.203
1.733	.057	.977	7.181
1.722	.068	1.001	7.158
1.71	.08	1.022	7.137
1.698	.092	1.044	7.115
1.686	.104	1.065	7.093
1.674	.116	1.088	7.071
1.663	.127	1.109	7.05
1.652	.138	1.13	7.028
1.641	.149	1.151	7.008
1.63	.16	1.172	6.986
1.619	.171	1.192	6.967
1.608	.182	1.215	6.944
1.597	.193	1.236	6.923
1.586	.204	1.254	6.904
1.575	.215	1.276	6.883
1.564	.226	1.296	6.863
1.553	.237	1.315	6.843

wet weather

*** RIVER MODEL PROGRAM ** EPA (600/6/82-004a) ***
PC BASIC, DESDORM1.BAS - LAST REVISED 3/95

INPUT FILE.. c:\model\sugar6a

RIVER ...... Sugar
REACH 2

MODELER .. JHerrick
DATE 12/13/95

COMMENTS.... Claremont WWTF to the Connecticut River

UP FLOW (cfs) .. 152.15
UP DO (mg/l) ... 6.84
UP UCBOD (mg/l). 3.8
UP NBOD (mg/l) . 1.3

DISCHARGE FLOW (cfs) .. 8.28
DISCHARGE DO (mg/l) ... 7
DISCHARGE UCBOD (mg/l). 100
UCBOD/CBOD5........... 1.6
DISCHARGE NBOD (mg/l) . 45
NBOD/NH3-N............ 4.57

DILUTION X 0.9 ...... 17.43804

DISCHARGE CBOD5 (mg/l). 62.5
DISCHARGE NH3-N (mg/l). 9.846827

REAERATION Ka .. 10
BOD DECAY Kd ... 2.4
NBOD DECAY Kn .. 2.1
CBOD FLUX Lrd .. 0
NBOD FLUX Nrd .. 0
RESPIRATION R .. .05
PHOTOSYNTHESIS P 0

SOD Sb 0
SOLUBILITY Cs 8.16
VELOCITY (fps) .... .92
WATER TEMPERATURE (C).. 25
STARTING MILE 1.55
ENDING MILE 0

MIN. DO (75% Cs)..... 6.119
MIN. DO (90% ASSETS). 6.192
INITIAL DO MIX....... 6.848258
INITIAL DO DEFICIT... 1.3117

INITIAL CBOD (Lo) 8.765
INITIAL NBOD (No) 3.5554
ENDING CBOD (Le) 6.846
ENDING NBOD (Ne) 2.864

RIVER MILE	DISTANCE (miles)	DEFICIT (mg/l)	DISSOLVED OXYGEN (mg/l)
1.55	0	1.3117	6.848258
1.464	.086	1.394	6.764
1.378	.172	1.472	6.687
1.292	.258	1.542	6.616
1.207	.343	1.61	6.549
1.122	.428	1.669	6.49
1.037	.513	1.723	6.435
.951	.599	1.773	6.387
.8649999	.685	1.819	6.34
.7789999	.771	1.86	6.299
.693	.857	1.896	6.263
.6069999	.943	1.929	6.23
.5209999	1.029	1.958	6.201
.4349999	1.115	1.983	6.177
.3499999	1.2	2.005	6.154
.2639999	1.286	2.025	6.134
.1789999	1.371	2.04	6.118
9.299994E-02	1.457	2.056	6.102
7.999897E-03	1.542	2.066	6.092
-7.800007E-02			

option #1
summer
Dry weather

*** RIVER MODEL PROGRAM ** EPA (600/6/82-004a) ***
PC BASIC, DESDORM1.BAS - LAST REVISED 3/95

INPUT FILE.. c:\model\sugar11

RIVER ...... Sugar
REACH 1

MODELER .. JHERRICK
DATE 2/13/96

COMMENTS.... OPTION #1 - COY WWTF TO CLAREMONT WWTF

UP FLOW (cfs) .. 39.9
UP DO (mg/l) ... 7.9
UP UCBOD (mg/l). 3
UP NBOD (mg/l) . 1.1

DISCHARGE FLOW (cfs) .. .1
DISCHARGE DO (mg/l) ... 7.9
DISCHARGE UCBOD (mg/l). .1
UCBOD/CBOD5........... 1.6
DISCHARGE NBOD (mg/l) . .1
NBOD/NH3-N............ 4.57

DILUTION X 0.9 360

DISCHARGE CBOD5 (mg/l). .0625
DISCHARGE NH3-N (mg/l).
2.188184E-02

REAERATION Ka .. 2.1
BOD DECAY Kd ... 7
NBOD DECAY Kn .. .5
CBOD FLUX Lrd .. 0
NBOD FLUX Nrd .. 0
RESPIRATION R .. .085
PHOTOSYNTHESIS P 0

SOD Sb 0
SOLUBILITY Cs 8.16
VELOCITY (fps) .... .47
WATER TEMPERATURE (C).. 25
STARTING MILE 1.79
ENDING MILE 1.55

MIN. DO (75% Cs)..... 6.119
MIN. DO (90% ASSETS). 6.298
INITIAL DO MIX....... 7.9
INITIAL DO DEFICIT... .2599

INITIAL CBOD (Lo) 2.9927
INITIAL NBOD (No) 1.0974
ENDING CBOD (Le) 2.4054
ENDING NBOD (Ne) 1.0804

RIVER MILE	DISTANCE (miles)	DEFICIT (mg/l)	DISSOLVED OXYGEN (mg/l)
1.79	0	.2599	7.9
1.778	.012	.293	7.866
1.766	.024	.325	7.833
1.755	.035	.358	7.8
1.744	.046	.392	7.767
1.733	.057	.423	7.736
1.722	.068	.456	7.703
1.71	.08	.486	7.672
1.698	.092	.518	7.64
1.686	.104	.547	7.611
1.674	.116	.578	7.58
1.663	.127	.607	7.552
1.652	.138	.637	7.522
1.641	.149	.666	7.493
1.63	.16	.694	7.465
1.619	.171	.722	7.437
1.608	.182	.748	7.411
1.597	.193	.775	7.383
1.586	.204	.801	7.357
1.575	.215	.827	7.331

option #1
summer
Dry weather

Avg monthly
limits

*** RIVER MODEL PROGRAM ** EPA (600/6/82-004a) ***
PC BASIC, DESDORM1.BAS - LAST REVISED 3/95

INPUT FILE.. C:\MODEL\SUGAR12

RIVER ...... Sugar
REACH 2

MODELER .. JHerrick
DATE 2/13/96

COMMENTS.... OPTION #1 CLAREMONT WWTF TO THE CONNECTICUT RIVER

UP FLOW (cfs) .. 39.9
UP DO (mg/l) ... 7.331
UP UCBOD (mg/l). 2.41
UP NBOD (mg/l) . 1.08

DISCHARGE FLOW (cfs) .. 6.1
DISCHARGE DO (mg/l) ... 7
DISCHARGE UCBOD (mg/l). 40.5
UCBOD/CBOD5........... 1.6
DISCHARGE NBOD (mg/l) . 31.3
NBOD/NH3-N............ 4.57

DILUTION X 0.9 ...... 6.786885

DISCHARGE CBOD5 (mg/l). 25.3125
DISCHARGE NH3-N (mg/l). 6.849015

REAERATION Ka .. 10.6
BOD DECAY Kd ... 2.4
NBOD DECAY Kn .. 2.1
CBOD FLUX Lrd .. 0
NBOD FLUX Nrd .. 0
RESPIRATION R .. .05
PHOTOSYNTHESIS P 0

SOD Sb 0
SOLUBILITY Cs 8.16
VELOCITY (fps) .... .51
WATER TEMPERATURE (C).. 25
STARTING MILE 1.55
ENDING MILE 0

MIN. DO (75% Cs)..... 6.119
MIN. DO (90% ASSETS). 6.2411
INITIAL DO MIX....... 7.287107
INITIAL DO DEFICIT... .8728

INITIAL CBOD (Lo) 7.461
INITIAL NBOD (No) 5.0874
ENDING CBOD (Le) 4.7775
ENDING NBOD (Ne) 3.4443

RIVER MILE	DISTANCE (miles)	DEFICIT (mg/l)	DISSOLVED OXYGEN (mg/l)
1.55	0	.8728	7.287107
1.469	.081	1.047	7.111
1.388	.162	1.2	6.958
1.307	.243	1.335	6.824
1.226	.324	1.449	6.71
1.145	.405	1.546	6.613
1.064	.486	1.629	6.529
.983	.567	1.699	6.46
.902	.648	1.754	6.404
.822	.728	1.802	6.356
.7409999	.809	1.841	6.318
.661	.889	1.87	6.289
.5799999	.97	1.891	6.269
.5	1.05	1.904	6.255
.42	1.13	1.914	6.244
.3399999	1.21	1.919	6.24
.2589999	1.291	1.917	6.241
.1789999	1.371	1.912	6.247
9.799993E-02	1.452	1.904	6.255
1.800001E-02	1.532	1.893	6.266

> target DO

option #1
summer
Dry weather

*** RIVER MODEL PROGRAM ** EPA (600/6/82-004a) ***
PC BASIC, DESDORM1.BAS - LAST REVISED 3/95

INPUT FILE.. C:\MODEL\SUGAR12

MAX NH_3

RIVER ...... Sugar
REACH 2

MODELER .. JHerrick
DATE 2/13/96

COMMENTS.... OPTION #1 CLAREMONT WWTF TO THE CONNECTICUT RIVER

UP FLOW (cfs) .. 39.9
UP DO (mg/l) ... 7.331
UP UCBOD (mg/l). 2.41
UP NBOD (mg/l) . 1.08

DISCHARGE FLOW (cfs) .. 6.1
DISCHARGE DO (mg/l) ... 7
DISCHARGE UCBOD (mg/l). 40.5
UCBOD/CBOD5........... 1.6
DISCHARGE NBOD (mg/l) . 38.4
NBOD/NH3-N............ 4.57

DILUTION X 0.9 ...... 6.786885

DISCHARGE CBOD5 (mg/l). 25.3125
DISCHARGE NH3-N (mg/l). 8.402626

REAERATION Ka .. 10.6
BOD DECAY Kd ... 2.4
NBOD DECAY Kn .. 2.1
CBOD FLUX Lrd .. 0
NBOD FLUX Nrd .. 0
RESPIRATION R .. .05
PHOTOSYNTHESIS P 0

SOD Sb 0
SOLUBILITY Cs 8.16
VELOCITY (fps) .... .51
WATER TEMPERATURE (C).. 25
STARTING MILE 1.55
ENDING MILE 0

MIN. DO (75% Cs)..... 6.119
MIN. DO (90% ASSETS). 6.2411
INITIAL DO MIX....... 7.287107
INITIAL DO DEFICIT... .8728

INITIAL CBOD (Lo) 7.461
INITIAL NBOD (No) 6.0289
ENDING CBOD (Le) 4.7775
ENDING NBOD (Ne) 4.0817

RIVER MILE	DISTANCE (miles)	DEFICIT (mg/l)	DISSOLVED OXYGEN (mg/l)
1.55	0	.8728	7.287107
1.469	.081	1.065	7.093
1.388	.162	1.235	6.924
1.307	.243	1.383	6.776
1.226	.324	1.508	6.651
1.145	.405	1.616	6.542
1.064	.486	1.709	6.449
.983	.567	1.787	6.372
.902	.648	1.85	6.309
.822	.728	1.904	6.255
.7409999	.809	1.948	6.211
.661	.889	1.981	6.178
.5799999	.97	2.006	6.153
.5	1.05	2.023	6.137
.42	1.13	2.034	6.125
.3399999	1.21	2.039	6.119
.2589999	1.291	2.04	6.118
.1789999	1.371	2.036	6.123
9.799993E-02	1.452	2.029	6.13
1.800001E-02	1.532	2.018	6.141

> target DO

option #1
summer
Dry weather
MAY
CBOD5

*** RIVER MODEL PROGRAM ** EPA (600/6/82-004a) ***
PC BASIC,   DESDORM1.BAS - LAST REVISED 3/95

INPUT FILE.. C:\MODEL\SUGAR12

RIVER ...... Sugar
REACH 2

MODELER .. JHerrick
DATE 2/13/96

COMMENTS.... OPTION #1 CLAREMONT WWTF TO THE CONNECTICUT RIVER

UP FLOW (cfs) .. 39.9
UP DO (mg/l) ... 7.331
UP UCBOD (mg/l). 2.41
UP NBOD (mg/l) . 1.08

DISCHARGE FLOW (cfs) .. 6.1
DISCHARGE DO (mg/l) ... 7
DISCHARGE UCBOD (mg/l). 46.85
UCBOD/CBOD5........... 1.6
DISCHARGE NBOD (mg/l) . 31.3
NBOD/NH3-N............ 4.57

DILUTION X 0.9 ...... 6.786885

DISCHARGE CBOD5 (mg/l). 29.28125
DISCHARGE NH3-N (mg/l). 6.849015

REAERATION Ka .. 10.6
BOD DECAY Kd ... 2.4
NBOD DECAY Kn .. 2.1
CBOD FLUX Lrd .. 0
NBOD FLUX Nrd .. 0
RESPIRATION R .. .05
PHOTOSYNTHESIS P 0

SOD Sb 0
SOLUBILITY Cs 8.16
VELOCITY (fps) .... .51
WATER TEMPERATURE (C).. 25
STARTING MILE 1.55
ENDING MILE 0

MIN. DO (75% Cs)..... 6.119
MIN. DO (90% ASSETS). 6.2411
INITIAL DO MIX....... 7.287107
INITIAL DO DEFICIT... .8728

INITIAL CBOD (Lo) 8.3031
INITIAL NBOD (No) 5.0874
ENDING CBOD (Le) 5.3168
ENDING NBOD (Ne) 3.4443

RIVER MILE	DISTANCE (miles)	DEFICIT (mg/l)	DISSOLVED OXYGEN (mg/l)
1.55	0	.8728	7.287107
1.469	.081	1.065	7.093
1.388	.162	1.235	6.923
1.307	.243	1.383	6.776
1.226	.324	1.509	6.649
1.145	.405	1.618	6.541
1.064	.486	1.712	6.447
.983	.567	1.788	6.37
.902	.648	1.851	6.307
.822	.728	1.906	6.253
.7409999	.809	1.948	6.211
.661	.889	1.982	6.177
.5799999	.97	2.006	6.153
.5	1.05	2.023	6.137
.42	1.13	2.034	6.125
.3399999	1.21	2.039	6.119
.2589999	1.291	2.039	6.119
.1789999	1.371	2.035	6.125
9.799993E-02	1.452	2.026	6.132
1.800001E-02	1.532	2.016	6.144

} target DO

Option #1
Winter
Dry weather

*** RIVER MODEL PROGRAM ** EPA (600/6/82-004a) ***
PC BASIC, DESDORM1.BAS - LAST REVISED 3/95

INPUT FILE.. C:\MODEL\SUGARW1

RIVER ...... Sugar
REACH 1

MODELER .. JHERRICK
DATE 2/13/96

COMMENTS.... OPTION #1 - COY WWTF TO CLAREMONT WWTF

UP FLOW (cfs) .. 39.9
UP DO (mg/l) ... 9.65
UP UCBOD (mg/l). 3
UP NBOD (mg/l) . 1.1

DISCHARGE FLOW (cfs) .. .1
DISCHARGE DO (mg/l) ... 7.9
DISCHARGE UCBOD (mg/l). .1
UCBOD/CBOD5........... 1.6
DISCHARGE NBOD (mg/l) . .1
NBOD/NH3-N............ 4.57

DILUTION X 0.9 360

DISCHARGE CBOD5 (mg/l). .0625
DISCHARGE NH3-N (mg/l).
2.188184E-02

REAERATION Ka .. 1.66
BOD DECAY Kd ... 5.56
NBOD DECAY Kn .. .32
CBOD FLUX Lrd .. 0
NBOD FLUX Nrd .. 0
RESPIRATION R .. .085
PHOTOSYNTHESIS P 0

SOD Sb 0
SOLUBILITY Cs 9.964
VELOCITY (fps) .... .47
WATER TEMPERATURE (C).. 15
STARTING MILE 1.79
ENDING MILE 1.55

MIN. DO (75% Cs)..... 7.472
MIN. DO (90% ASSETS). 7.6907
INITIAL DO MIX....... 9.645624
INITIAL DO DEFICIT... .3183

INITIAL CBOD (Lo) 2.9927
INITIAL NBOD (No) 1.0974
ENDING CBOD (Le) 2.516
ENDING NBOD (Ne) 1.0864

RIVER MILE	DISTANCE (miles)	DEFICIT (mg/l)	DISSOLVED OXYGEN (mg/l)
1.79	0	.3183	9.645624
1.778	.012	.344	9.619
1.766	.024	.371	9.592
1.755	.035	.395	9.567
1.744	.046	.422	9.541
1.733	.057	.446	9.517
1.722	.068	.474	9.489
1.71	.08	.497	9.465
1.698	.092	.523	9.439
1.686	.104	.549	9.414
1.674	.116	.571	9.392
1.663	.127	.596	9.368
1.652	.138	.62	9.343
1.641	.149	.643	9.319
1.63	.16	.666	9.297
1.619	.171	.689	9.274
1.608	.182	.711	9.252
1.597	.193	.733	9.229
1.586	.204	.757	9.206
1.575	.215	.777	9.185

Option #1
Winter
Day weather

*** RIVER MODEL PROGRAM ** EPA (600/6/82-004a) ***
PC BASIC, DESDORM1.BAS - LAST REVISED 3/95

INPUT FILE.. c:\model\sugarw2

RIVER ...... Sugar
REACH 2

MODELER .. JHerrick
DATE 2/13/96

COMMENTS.... OPTION #1 CLAREMONT WWTF TO THE CONNECTICUT RIVER

UP FLOW (cfs) .. 39.9
UP DO (mg/l) ... 9.185
UP UCBOD (mg/l). 2.516
UP NBOD (mg/l) . 1.08

DISCHARGE FLOW (cfs) .. 6.1
DISCHARGE DO (mg/l) ... 7
DISCHARGE UCBOD (mg/l). 40
UCBOD/CBOD5........... 1.6
DISCHARGE NBOD (mg/l) . 52
NBOD/NH3-N............ 4.57

DILUTION X 0.9 ...... 6.786885

DISCHARGE CBOD5 (mg/l). 25
DISCHARGE NH3-N (mg/l). 11.37856

REAERATION Ka .. 8.4
BOD DECAY Kd ... 1.91
NBOD DECAY Kn .. 1.67
CBOD FLUX Lrd .. 0
NBOD FLUX Nrd .. 0
RESPIRATION R .. .05
PHOTOSYNTHESIS P 0

SOD Sb 0
SOLUBILITY Cs 9.964
VELOCITY (fps) .... .51
WATER TEMPERATURE (C).. 15
STARTING MILE 1.55
ENDING MILE 0

MIN. DO (75% Cs)..... 7.472
MIN. DO (90% ASSETS). 7.6442
INITIAL DO MIX....... 8.89525
INITIAL DO DEFICIT... 1.0687

INITIAL CBOD (Lo) 7.4867
INITIAL NBOD (No) 7.8324
ENDING CBOD (Le) 5.2508
ENDING NBOD (Ne) 5.7436

RIVER MILE	DISTANCE (miles)	DEFICIT (mg/l)	DISSOLVED OXYGEN (mg/l)
1.55	0	1.0687	8.89525
1.469	.081	1.236	8.726
1.388	.162	1.389	8.574
1.307	.243	1.527	8.435
1.226	.324	1.649	8.314
1.145	.405	1.756	8.206
1.064	.486	1.851	8.112
.983	.567	1.935	8.028
.902	.648	2.008	7.955
.822	.728	2.072	7.891
.7409999	.809	2.125	7.837
.661	.889	2.173	7.79
.5799999	.97	2.21	7.752
.5	1.05	2.243	7.72
.42	1.13	2.269	7.693
.3399999	1.21	2.29	7.672
.2589999	1.291	2.306	7.656
.1789999	1.371	2.316	7.646
9.799993E-02	1.452	2.322	7.64
1.800001E-02	1.532	2.325	7.637

Option #1
Winter

Dry Weather

```
*** RIVER MODEL PROGRAM ** EPA (600/6/82-004a) ***
    PC BASIC,   DESDORM1.BAS - LAST REVISED 3/95

INPUT FILE.. c:\model\sugarw2

RIVER ...... Sugar                    MODELER .. JHerrick
REACH ......  2                       DATE ..... 2/13/96

COMMENTS.... OPTION #1 CLAREMONT WWTF TO THE CONNECTICUT RIVER

UP FLOW (cfs) ..    39.9              DISCHARGE FLOW (cfs) ..    6.1
UP DO (mg/l) ...    9.185             DISCHARGE DO (mg/l) ...    7
UP UCBOD (mg/l).    2.516             DISCHARGE UCBOD (mg/l).    46
UP NBOD (mg/l) .    1.08              UCBOD/CBOD5............    1.6
                                      DISCHARGE NBOD (mg/l) .    56
                                      NBOD/NH3-N.............    4.57

DILUTION X 0.9 ......    6.786885     DISCHARGE CBOD5 (mg/l).    28.75
                                      DISCHARGE NH3-N (mg/l).    12.25383

REAERATION Ka ..    8.4               SOD Sb ................    0
BOD DECAY Kd ...    1.91              SOLUBILITY Cs .........    9.964
NBOD DECAY Kn ..    1.67              VELOCITY (fps) ........    .51
CBOD FLUX Lrd ..    0                 WATER TEMPERATURE (C)..    15
NBOD FLUX Nrd ..    0                 STARTING MILE .........    1.55
RESPIRATION R ..    .05               ENDING MILE ...........    0
PHOTOSYNTHESIS P    0

MIN. DO (75% Cs).....    7.472        INITIAL CBOD (Lo) .....    8.2823
MIN. DO (90% ASSETS).    7.6442       INITIAL NBOD (No) .....    8.3628
INITIAL DO MIX.......    8.89525      ENDING  CBOD (Le) .....    5.8088
INITIAL DO DEFICIT...    1.0687       ENDING  NBOD (Ne) .....    6.1326
```

RIVER MILE	DISTANCE (miles)	DEFICIT (mg/l)	DISSOLVED OXYGEN (mg/l)
1.55	0	1.0687	8.89525
1.469	.081	1.259	8.703
1.388	.162	1.432	8.531
1.307	.243	1.587	8.375
1.226	.324	1.725	8.238
1.145	.405	1.848	8.114
1.064	.486	1.955	8.007
.983	.567	2.052	7.911
.902	.648	2.135	7.828
.822	.728	2.209	7.754
.7409999	.809	2.272	7.691
.661	.889	2.325	7.637
.5799999	.97	2.369	7.593
.5	1.05	2.407	7.556
.42	1.13	2.438	7.524
.3399999	1.21	2.463	7.5
.2589999	1.291	2.482	7.48
.1789999	1.371	2.496	7.467
9.799993E-02	1.452	2.504	7.458
1.800001E-02	1.532	2.509	7.453

Option #2
summer
Dry weather

*** RIVER MODEL PROGRAM ** EPA (600/6/82-004a) ***
PC BASIC, DESDORM1.BAS - LAST REVISED 3/95

INPUT FILE.. C:\MODEL\SUGAR21

RIVER ...... Sugar
REACH 1

MODELER .. JHerrick
DATE 2/13/96

COMMENTS.... OPTION #2 COY WWTF TO CLAREMONT WWTF

UP FLOW (cfs) ..	39.9	DISCHARGE FLOW (cfs) ..	1.39
UP DO (mg/l) ...	7.9	DISCHARGE DO (mg/l) ...	6
UP UCBOD (mg/l).	3	DISCHARGE UCBOD (mg/l).	53
UP NBOD (mg/l) .	1.1	UCBOD/CBOD5...........	1.6
		DISCHARGE NBOD (mg/l) .	9
		NBOD/NH3-N............	4.57
DILUTION X 0.9	26.73453	DISCHARGE CBOD5 (mg/l).	33.125
		DISCHARGE NH3-N (mg/l).	1.969365
REAERATION Ka ..	2.1	SOD Sb	0
BOD DECAY Kd ...	7	SOLUBILITY Cs	8.16
NBOD DECAY Kn ..	.5	VELOCITY (fps)	.47
CBOD FLUX Lrd ..	0	WATER TEMPERATURE (C)..	25
NBOD FLUX Nrd ..	0	STARTING MILE	1.79
RESPIRATION R ..	.085	ENDING MILE	1.55
PHOTOSYNTHESIS P	0		
MIN. DO (75% Cs).....	6.119	INITIAL CBOD (Lo)	4.6832
MIN. DO (90% ASSETS).	6.298	INITIAL NBOD (No)	1.3659
INITIAL DO MIX.......	7.836038	ENDING CBOD (Le)	3.7642
INITIAL DO DEFICIT...	.3239	ENDING NBOD (Ne)	1.3447

RIVER MILE	DISTANCE (miles)	DEFICIT (mg/l)	DISSOLVED OXYGEN (mg/l)
1.79	0	.3239	7.836038
1.778	.012	.372	7.786
1.766	.024	.423	7.736
1.755	.035	.472	7.686
1.744	.046	.521	7.638
1.733	.057	.569	7.59
1.722	.068	.616	7.542
1.71	.08	.663	7.496
1.698	.092	.709	7.449
1.686	.104	.754	7.404
1.674	.116	.8	7.359
1.663	.127	.843	7.315
1.652	.138	.887	7.272
1.641	.149	.93	7.23
1.63	.16	.972	7.187
1.619	.171	1.013	7.145
1.608	.182	1.055	7.104
1.597	.193	1.096	7.063
1.586	.204	1.134	7.024
1.575	.215	1.174	6.986
1.564	.226	1.213	6.946
1.553	.237	1.25	6.908

option #2
summer
Dry weather

*** RIVER MODEL PROGRAM ** EPA (600/6/82-004a) ***
PC BASIC, DESDORM1.BAS - LAST REVISED 3/95

INPUT FILE.. C:\MODEL\SUGAR22

Avg monthly

RIVER	Sugar	MODELER ..	JHerrick
REACH	2	DATE	2/13/96

COMMENTS.... OPTION #2 CLAREMONT WWTF TO THE CONNECTICUT RIVER

UP FLOW (cfs) ..	41.29	DISCHARGE FLOW (cfs) ..	6.1
UP DO (mg/l) ...	6.908	DISCHARGE DO (mg/l) ...	7
UP UCBOD (mg/l).	3.8	DISCHARGE UCBOD (mg/l).	31.5
UP NBOD (mg/l) .	1.3	UCBOD/CBOD5...........	1.6
		DISCHARGE NBOD (mg/l) ..	29
		NBOD/NH3-N............	4.57

DILUTION X 0.9	6.991967	DISCHARGE CBOD5 (mg/l).	19.6875
		DISCHARGE NH3-N (mg/l).	6.345733

REAERATION Ka ..	10.6	SOD Sb	0
BOD DECAY Kd ...	2.4	SOLUBILITY Cs	8.16
NBOD DECAY Kn ..	2.1	VELOCITY (fps)	.51
CBOD FLUX Lrd ..	0	WATER TEMPERATURE (C)..	25
NBOD FLUX Nrd ..	0	STARTING MILE	1.55
RESPIRATION R ..	.05	ENDING MILE	0
PHOTOSYNTHESIS P	0		

MIN. DO (75% Cs).....	6.119	INITIAL CBOD (Lo)	7.3655
MIN. DO (90% ASSETS).	6.1988	INITIAL NBOD (No)	4.8655
INITIAL DO MIX.......	6.919842	ENDING CBOD (Le)	4.7164
INITIAL DO DEFICIT...	1.2401	ENDING NBOD (Ne)	3.2941

RIVER MILE	DISTANCE (miles)	DEFICIT (mg/l)	DISSOLVED OXYGEN (mg/l)
1.55	0	1.2401	6.919842
1.469	.081	1.373	6.786
1.388	.162	1.486	6.672
1.307	.243	1.587	6.572
1.226	.324	1.671	6.488
1.145	.405	1.74	6.42
1.064	.486	1.797	6.361
.983	.567	1.846	6.313
.902	.648	1.883	6.276
.822	.728	1.912	6.246
.7409999	.809	1.934	6.225
.661	.889	1.948	6.211
.5799999	.97	1.957	6.203
.5	1.05	1.96	6.199 ← target DO
.42	1.13	1.958	6.2
.3399999	1.21	1.953	6.205
.2589999	1.291	1.945	6.214
.1789999	1.371	1.932	6.226
9.799993E-02	1.452	1.917	6.241
1.800001E-02	1.532	1.901	6.258

NHDES-WSPCD-96-5

SUGAR RIVER TOTAL MAXIMUM DAILY LOAD STUDY

STATE OF NEW HAMPSHIRE
DEPARTMENT OF ENVIRONMENTAL SERVICES
6 HAZEN DRIVE
CONCORD, N.H. 03301

ROBERT W. VARNEY
COMMISSIONER

G. DANA BISBEE
ASSISTANT COMMISSIONER

EDWARD J. SCHMIDT, P.E., Ph.D., DIRECTOR
WATER SUPPLY AND POLLUTION CONTROL DIVISION

Report Prepared by:
James A. Herrick, P.E.
Sanitary Engineer

MARCH 1996

Printed on Recycled Paper

option #2
summer
Dry weather

MAX CBOD5

*** RIVER MODEL PROGRAM ** EPA (600/6/82-004a) ***
PC BASIC, DESDORM1.BAS - LAST REVISED 3/95

INPUT FILE.. C:\MODEL\SUGAR22

RIVER ...... Sugar
REACH 2

MODELER .. JHerrick
DATE 2/13/96

COMMENTS.... OPTION #2 CLAREMONT WWTF TO THE CONNECTICUT RIVER

UP FLOW (cfs) ..	41.29	DISCHARGE FLOW (cfs) ..	6.1
UP DO (mg/l) ...	6.908	DISCHARGE DO (mg/l) ...	7
UP UCBOD (mg/l).	3.8	DISCHARGE UCBOD (mg/l).	36
UP NBOD (mg/l) .	1.3	UCBOD/CBOD5...........	1.6
		DISCHARGE NBOD (mg/l) .	29
		NBOD/NH3-N............	4.57
DILUTION X 0.9	6.991967	DISCHARGE CBOD5 (mg/l)	22.5
		DISCHARGE NH3-N (mg/l)	6.345733
REAERATION Ka ..	10.6	SOD Sb	0
BOD DECAY Kd ...	2.4	SOLUBILITY Cs	8.16
NBOD DECAY Kn ..	2.1	VELOCITY (fps)	.51
CBOD FLUX Lrd ..	0	WATER TEMPERATURE (C)..	25
NBOD FLUX Nrd ..	0	STARTING MILE	1.55
RESPIRATION R ..	.05	ENDING MILE	0
PHOTOSYNTHESIS P	0		
MIN. DO (75% Cs).....	6.119	INITIAL CBOD (Lo)	7.9447
MIN. DO (90% ASSETS).	6.1988	INITIAL NBOD (No)	4.8655
INITIAL DO MIX.......	6.919842	ENDING CBOD (Le)	5.0873
INITIAL DO DEFICIT...	1.2401	ENDING NBOD (Ne)	3.2941

RIVER MILE	DISTANCE (miles)	DEFICIT (mg/l)	DISSOLVED OXYGEN (mg/l)
1.55	0	1.2401	6.919842
1.469	.081	1.384	6.774
1.388	.162	1.51	6.649
1.307	.243	1.62	6.539
1.226	.324	1.712	6.447
1.145	.405	1.788	6.37
1.064	.486	1.855	6.304
.983	.567	1.907	6.251
.902	.648	1.95	6.21
.822	.728	1.983	6.177
.7409999	.809	2.006	6.152
.661	.889	2.025	6.134
.5799999	.97	2.036	6.123
.5	1.05	2.04	6.118
.42	1.13	2.042	6.118
.3399999	1.21	2.038	6.121
.2589999	1.291	2.029	6.13
.1789999	1.371	2.017	6.142
9.799993E-02	1.452	2.003	6.156
1.800001E-02	1.532	1.986	6.173

target DO.

option #2
summer
Dry Weather

MAX
NH_3

*** RIVER MODEL PROGRAM ** EPA (600/6/82-004a) ***
PC BASIC, DESDORM1.BAS - LAST REVISED 3/95

INPUT FILE.. C:\MODEL\SUGAR22

RIVER ...... Sugar
REACH 2

MODELER .. JHerrick
DATE 2/13/96

COMMENTS.... OPTION #2 CLAREMONT WWTF TO THE CONNECTICUT RIVER

UP FLOW (cfs) ..	41.29	DISCHARGE FLOW (cfs) ..	6.1
UP DO (mg/l) ...	6.908	DISCHARGE DO (mg/l) ...	7
UP UCBOD (mg/l).	3.8	DISCHARGE UCBOD (mg/l).	31.5
UP NBOD (mg/l) .	1.3	UCBOD/CBOD5...........	1.6
		DISCHARGE NBOD (mg/l) .	34
		NBOD/NH3-N............	4.57
DILUTION X 0.9	6.991967	DISCHARGE CBOD5 (mg/l).	19.6875
		DISCHARGE NH3-N (mg/l).	7.439825
REAERATION Ka ..	10.6	SOD Sb	0
BOD DECAY Kd ...	2.4	SOLUBILITY Cs	8.16
NBOD DECAY Kn ..	2.1	VELOCITY (fps)	.51
CBOD FLUX Lrd ..	0	WATER TEMPERATURE (C)..	25
NBOD FLUX Nrd ..	0	STARTING MILE	1.55
RESPIRATION R ..	.05	ENDING MILE	0
PHOTOSYNTHESIS P	0		
MIN. DO (75% Cs).....	6.119	INITIAL CBOD (Lo)	7.3655
MIN. DO (90% ASSETS).	6.1988	INITIAL NBOD (No)	5.5091
INITIAL DO MIX.......	6.919842	ENDING CBOD (Le)	4.7164
INITIAL DO DEFICIT...	1.2401	ENDING NBOD (Ne)	3.7298

RIVER MILE	DISTANCE (miles)	DEFICIT (mg/l)	DISSOLVED OXYGEN (mg/l)
1.55	0	1.2401	6.919842
1.469	.081	1.386	6.773
1.388	.162	1.51	6.649
1.307	.243	1.62	6.539
1.226	.324	1.712	6.447
1.145	.405	1.789	6.37
1.064	.486	1.853	6.306
.983	.567	1.906	6.253
.902	.648	1.948	6.211
.822	.728	1.981	6.177
.7409999	.809	2.006	6.152
.661	.889	2.023	6.135
.5799999	.97	2.036	6.123
.5	1.05	2.041	6.118 — target DO
.42	1.13	2.041	6.118
.3399999	1.21	2.036	6.123
.2589999	1.291	2.029	6.13
.1789999	1.371	2.017	6.142
9.799993E-02	1.452	2.003	6.156
1.800001E-02	1.532	1.986	6.172

option #2
Winter
Dry weather

*** RIVER MODEL PROGRAM ** EPA (600/6/82-004a) ***
PC BASIC, DESDORM1.BAS - LAST REVISED 3/95

INPUT FILE.. C:\MODEL\SUGRW21

RIVER ...... Sugar
REACH 1

MODELER .. JHerrick
DATE 2/13/96

COMMENTS.... OPTION #2 COY WWTF TO CLAREMONT WWTF

UP FLOW (cfs) ..	39.9	DISCHARGE FLOW (cfs) ..	1.39
UP DO (mg/l) ...	9.65	DISCHARGE DO (mg/l) ...	6
UP UCBOD (mg/l).	3	DISCHARGE UCBOD (mg/l).	53
UP NBOD (mg/l) .	1.1	UCBOD/CBOD5...........	1.6
		DISCHARGE NBOD (mg/l) .	9
		NBOD/NH3-N............	4.57
DILUTION X 0.9	26.73453	DISCHARGE CBOD5 (mg/l).	33.125
		DISCHARGE NH3-N (mg/l).	1.969365
REAERATION Ka ..	1.66	SOD Sb	0
BOD DECAY Kd ...	5.56	SOLUBILITY Cs	9.964
NBOD DECAY Kn ..	.32	VELOCITY (fps)	.47
CBOD FLUX Lrd ..	0	WATER TEMPERATURE (C)..	15
NBOD FLUX Nrd ..	0	STARTING MILE	1.79
RESPIRATION R ..	.085	ENDING MILE	1.55
PHOTOSYNTHESIS P	0		
MIN. DO (75% Cs).....	7.472	INITIAL CBOD (Lo)	4.6832
MIN. DO (90% ASSETS).	7.6907	INITIAL NBOD (No)	1.3659
INITIAL DO MIX.......	9.527124	ENDING CBOD (Le)	3.9372
INITIAL DO DEFICIT...	.4368	ENDING NBOD (Ne)	1.3523

RIVER MILE	DISTANCE (miles)	DEFICIT (mg/l)	DISSOLVED OXYGEN (mg/l)
1.79	0	.4368	9.527124
1.778	.012	.474	9.488
1.766	.024	.514	9.448
1.755	.035	.554	9.409
1.744	.046	.592	9.371
1.733	.057	.63	9.333
1.722	.068	.669	9.295
1.71	.08	.704	9.258
1.698	.092	.742	9.22
1.686	.104	.78	9.184
1.674	.116	.816	9.147
1.663	.127	.851	9.111
1.652	.138	.887	9.076
1.641	.149	.921	9.042
1.63	.16	.955	9.007
1.619	.171	.99	8.973
1.608	.182	1.024	8.939
1.597	.193	1.056	8.906
1.586	.204	1.09	8.873
1.575	.215	1.121	8.842
1.564	.226	1.154	8.809
1.553	.237	1.185	8.777

```
*** RIVER MODEL PROGRAM ** EPA (600/6/82-004a) ***
    PC BASIC,   DESDORM1.BAS - LAST REVISED 3/95

INPUT FILE.. c:\model\sugrw22

RIVER ...... Sugar                    MODELER .. JHerrick
REACH ......  2                       DATE ..... 2/13/96

COMMENTS.... OPTION #2 CLAREMONT WWTF TO THE CONNECTICUT RIVER

UP FLOW (cfs) ..    41.29             DISCHARGE FLOW (cfs) ..     6.1
UP DO (mg/l) ...    8.777             DISCHARGE DO (mg/l) ...     7
UP UCBOD (mg/l).    3.94              DISCHARGE UCBOD (mg/l).     46
UP NBOD (mg/l) .    1.35              UCBOD/CBOD5............     1.6
                                      DISCHARGE NBOD (mg/l) .     42
                                      NBOD/NH3-N.............     4.57

DILUTION X 0.9 ......     6.991967    DISCHARGE CBOD5 (mg/l).     28.75
                                      DISCHARGE NH3-N (mg/l)      9.190372

REAERATION Ka ..    8.4               SOD Sb ................     0
BOD DECAY Kd ...    1.91              SOLUBILITY Cs .........     9.964
NBOD DECAY Kn ..    1.67              VELOCITY (fps) ........     .51
CBOD FLUX Lrd ..    0                 WATER TEMPERATURE (C)..     15
NBOD FLUX Nrd ..    0                 STARTING MILE .........     1.55
RESPIRATION R ..    .05               ENDING MILE ...........     0
PHOTOSYNTHESIS P    0

MIN. DO (75% Cs).....     7.472       INITIAL CBOD (Lo) .....     9.3539
MIN. DO (90% ASSETS).     7.6034      INITIAL NBOD (No) .....     6.5824
INITIAL DO MIX.......     8.548266    ENDING  CBOD (Le) .....     6.5603
INITIAL DO DEFICIT...     1.4157      ENDING  NBOD (Ne) .....     4.827
```

RIVER MILE	DISTANCE (miles)	DEFICIT (mg/l)	DISSOLVED OXYGEN (mg/l)
1.55	0	1.4157	8.548266
1.469	.081	1.572	8.392
1.388	.162	1.71	8.253
1.307	.243	1.835	8.128
1.226	.324	1.946	8.017
1.145	.405	2.042	7.92
1.064	.486	2.127	7.836
.983	.567	2.2	7.762
.902	.648	2.263	7.699
.822	.728	2.32	7.642
.7409999	.809	2.365	7.598
.661	.889	2.404	7.559
.5799999	.97	2.436	7.527
.5	1.05	2.46	7.503
.42	1.13	2.48	7.482
.3399999	1.21	2.494	7.468
.2589999	1.291	2.503	7.46
.1789999	1.371	2.509	7.454
9.799993E-02	1.452	2.509	7.454
1.800001E-02	1.532	2.506	7.456

option #2
winter
Dry weather

*** RIVER MODEL PROGRAM ** EPA (600/6/82-004a) ***
PC BASIC, DESDORM1.BAS - LAST REVISED 3/95

INPUT FILE.. c:\model\sugrw22

RIVER ...... Sugar
REACH 2

MODELER .. JHerrick
DATE 2/13/96

COMMENTS.... OPTION #2 CLAREMONT WWTF TO THE CONNECTICUT RIVER

UP FLOW (cfs) .. 41.29
UP DO (mg/l) ... 8.777
UP UCBOD (mg/l). 3.94
UP NBOD (mg/l) . 1.35

DISCHARGE FLOW (cfs) .. 6.1
DISCHARGE DO (mg/l) ... 7
DISCHARGE UCBOD (mg/l). 40
UCBOD/CBOD5............ 1.6
DISCHARGE NBOD (mg/l) . 39
NBOD/NH3-N............ 4.57

DILUTION X 0.9 ...... 6.991967

DISCHARGE CBOD5 (mg/l). 25
DISCHARGE NH3-N (mg/l). 8.533916

REAERATION Ka .. 8.4
BOD DECAY Kd ... 1.91
NBOD DECAY Kn .. 1.67
CBOD FLUX Lrd .. 0
NBOD FLUX Nrd .. 0
RESPIRATION R .. .05
PHOTOSYNTHESIS P 0

SOD Sb 0
SOLUBILITY Cs 9.964
VELOCITY (fps) .... .51
WATER TEMPERATURE (C).. 15
STARTING MILE 1.55
ENDING MILE 0

MIN. DO (75% Cs)..... 7.472
MIN. DO (90% ASSETS). 7.6034
INITIAL DO MIX....... 8.548266
INITIAL DO DEFICIT... 1.4157

INITIAL CBOD (Lo) 8.5816
INITIAL NBOD (No) 6.1962
ENDING CBOD (Le) 6.0187
ENDING NBOD (Ne) 4.5438

RIVER MILE	DISTANCE (miles)	DEFICIT (mg/l)	DISSOLVED OXYGEN (mg/l)
1.55	0	1.4157	8.548266
1.469	.081	1.552	8.411
1.388	.162	1.672	8.29
1.307	.243	1.781	8.182
1.226	.324	1.878	8.085
1.145	.405	1.963	8
1.064	.486	2.033	7.929
.983	.567	2.098	7.865
.902	.648	2.151	7.811
.822	.728	2.2	7.763
.7409999	.809	2.237	7.725
.661	.889	2.269	7.693
.5799999	.97	2.296	7.667
.5	1.05	2.315	7.648
.42	1.13	2.332	7.631
.3399999	1.21	2.342	7.621
.2589999	1.291	2.348	7.615
.1789999	1.371	2.351	7.612
9.799993E-02	1.452	2.348	7.614
1.800001E-02	1.532	2.345	7.618

APPENDIX F

<u>SAMPLING RESULTS</u>

ID# 225.6

FY 1995
AMBIENT WATER QUALITY MONITORING PROGRAM
FIELD NOTES FORM

DATE: 7/27/ 95 SAMPLE ROUND #: 1 2 3

RIVER NAME(s): Sugar FIELD CREW: Heather + Jason

WEATHER: Hot + Humid CLASS: A B

****

	Station	DO/Temp	Conductivity	pH	Parameters
50	1-Sgr	8.5/25.5 ✓	142	7.4	—
:25	9A-Sgr	6.9/24 ✓	121	6.9	—
0	13T-Sgr 13 D-Sgr	8.0/23.0 ✓	111	6.9	Cu, Pb, Zn, Hard (13T-Sgr) Cu, Pb, Zn (13D-Sgr)
5	14 Sgr	7.8/23 ✓	112	6.8	—
5	15T Sgr 15D Sgr	8.0/24 ✓	102	6.8	Cu, Pb, Zn, Hard (15T Sgr) Cu, Pb, Zn (15 D Sgr)

	Cu	Pb	Zn	Hard
13T	.004	<.005	<.025	17.1
13D	<.0025	<.005	0.036	17.1
15T	<.0025	<.005	<.025	16.1
15D	<.0025	<.005	0.032	16.1

E.Coli X10-18_____

TKN-35_____	Alk- 58_____	Al-40 _____
NH3-36_____	Turb-68_____	✓Cu-46 _____
NO3-37_____	TS- 70_____	✓Pb-48 _____
TP -39_____	TSS- 72_____	✓Zn-57 _____
✓Hard-62_____	BOD5-31_____	

N.H.D.E.S. Laboratory Services
Analytical Results
Authorized Signature: ____________

		Sample Id:	L12417-1		L12417-2		L12417-3		L12417-4		L12417-5		L12417-[illegible]
		Collect Date:	27-JUL-95		27-JUL-95		27-JUL-95		27-JUL-95		27-JUL-95		27-JUL-[illegible]
		Sampler	KENDALL, ROSS		KENDALL, ROSS		KENDALL, ROSS		KENDALL, ROSS		HEATHER, JASON		HEATHER, JASON
		Client Id:	IN HOUSE		IN HOUSE		IN HOUSE		IN HOUSE		IN HOUSE		IN HOUSE
		Locator:	15B-WIN		14A-WIN		15A01-WIN		15A-WIN		13T-SGR		13D-SGR
		Site:	WINNIPESAUKEE		WINNIPESAUKEE		WINNIPESAUKEE		WINNIPESAUKEE		SUGAR RIVER		SUGAR RIVER
		Description	WQ-106 GRANT		WQ-106 GRANT		WQ-106 GRANT		WQ-106 GRANT		WQ-106 GRANT		WQ-106 GRANT
		Comments	*		*		*		*		*		*
		EPA - Billable #	05-0022585		05-0022585		05-0022585		05-0022585		05-0022585		05-0022585
arameter	Units	Units	Result	R.D.L.	Result	R.D.L.	Result	R.D.L.	Result	R.D.L.	Result	R.D.L.	Result	R.D.L.
ARSENIC	mg/L	mg/L	*	<.005	*	<.005	*	<.005	*	<.005	*		*	
CADMIUM	mg/L	mg/L	*	<.0005	*	<.0005	*	<.0005	*	<.0005	*		*	
LEAD	mg/L	mg/L	*	<.005	*	<.005	*	<.005	*	<.005	*	<.005	*	<.005
ANTIMONY			*		*		*		*		*		*	
BERYLLIUM			*		*		*		*		*		*	
COPPER	mg/L	mg/L	*		*		*		*		0.00400	<.0025	*	<.0025
SELENIUM	mg/L	mg/L	*	<.010	*	<.010	*	<.010	*	<.010	*		*	
THALLIUM			*		*		*		*		*		*	
BARIUM	mg/L	mg/L	*	<.1	*	<.1	*	<.1	*	<.1	*		*	
CHROMIUM	mg/L	mg/L	*	<.01	*	<.01	*	<.01	*	<.01	*		*	
COPPER			*		*		*		*		*		*	
IRON			*		*		*		*		*		*	
NICKEL			*		*		*		*		*		*	
SILVER			*		*		*		*		*		*	
SODIUM			*		*		*		*		*		*	
ZINC	mg/L	mg/L	*		*		*		*		*	<.025	0.0360	<.025
HARDNESS			*		*		*		*		*		*	
MANGANESE			*		*		*		*		*		*	
HARDNESS, TOTAL	mg/L	mg/L	12.7	<1.35	13.3	<1.35	13.1	<1.35	13.3	<1.35	17.1	<1.35	*	
CALCIUM HARDNESS					*		*		*		*		*	
ALUMINUM			*		*		*		*		*		*	
CALCIUM			*		*		*		*		*		*	
MAGNESIUM			*		*		*		*		*		*	
POTASSIUM			*		*		*		*		*		*	
MOLYBDENUM			*		*		*		*		*		*	
BISMUTH			*		*		*		*		*		*	
COBALT			*		*		*		*		*		*	
STRONTIUM			*		*		*		*		*		*	
VANADIUM			*		*		*		*		*		*	
TITANIUM			*		*		*		*		*		*	
TIN			*		*		*		*		*		*	
BARIUM			*		*		*		*		*		*	
CHROMIUM			*		*		*		*		*		*	
COPPER			*		*		*		*		*		*	
IRON			*		*		*		*		*		*	
NICKEL			*		*		*		*		*		*	
SILVER			*		*		*		*		*		*	
SODIUM			*		*		*		*		*		*	
ZINC			*		*		*		*		*		*	

mg/L = milligrams / liter
< = less than

N.H.D.E.S. Laboratory Services
Analytical Results
Authorized Signature: ____________

	Sample Id:		L12417-1		L12417-2		L12417-3		L12417-4		L12417-5		L12417-6
	Collect Date:		27-JUL-95		27-JUL-95		27-JUL-95		27-JUL-95		27-JUL-95		27-JUL-95
	Sampler		KENDALL, ROSS		KENDALL, ROSS		KENDALL, ROSS		KENDALL, ROSS		HEATHER, JASON		HEATHER, JASON
	Client Id:		IN HOUSE		IN HOUSE		IN HOUSE		IN HOUSE		IN HOUSE		IN HOUSE
	Locator:		15B-WIN		14A-WIN		15A01-WIN		15A-WIN		13T-SGR		13D-SGR
	Site:		WINNIPESAUKEE		WINNIPESAUKEE		WINNIPESAUKEE		WINNIPESAUKEE		SUGAR RIVER		SUGAR RIVER
	Description		WQ-106 GRANT		WQ-106 GRANT		WQ-106 GRANT		WQ-106 GRANT		WQ-106 GRANT		WQ-106 GRANT
	Comments		*		*		*		*		*		*
	EPA - Billable #		05-0022585		05-0022585		05-0022585		05-0022585		05-0022585		05-0022585
arameter	Units	Units	Result	R.D.L.	Result	R.D.L.	Result	R.D.L.	Result	R.D.L.	Result	R.D.L.	Result	R.D.L.
HARDNESS			*		*		*		*		*		*	
MANGANESE			*		*		*		*		*		*	
HARDNESS,TOTAL			*		*		*		*		*		*	
CALCIUM HARDNESS			*		*		*		*		*		*	
ALUMINUM			*		*		*		*		*		*	
CALCIUM			*		*		*		*		*		*	
MAGNESIUM			*		*		*		*		*		*	
POTASSIUM			*		*		*		*		*		*	
MOLYBDENUM			*		*		*		*		*		*	
BISMUTH			*		*		*		*		*		*	
COBALT			*		*		*		*		*		*	
STRONTIUM			*		*		*		*		*		*	
VANADIUM			*		*		*		*		*		*	
TITANIUM			*		*		*		*		*		*	
TIN			*		*		*		*		*		*	

mg/L = milligrams / liter
< = less than

N.H.D.E.S. Laboratory Services
Analytical Results
Authorized Signature: ____________

Sample Id:	L12417-7		L12417-8		
Collect Date:	27-JUL-95		27-JUL-95		
Sampler	HEATHER, JASON		HEATHER, JASON		
Client Id:	IN HOUSE		IN HOUSE		
Locator:	15T-SGR		15D-SGR		
Site:	SUGAR RIVER		SUGAR RIVER		
Description	WQ-106 GRANT		WQ-106 GRANT		
Comments	*		*		
EPA - Billable #	05-0022585		05-0022585		

arameter	Units	Units	Result	R.D.L.	Result	R.D.L.
ARSENIC			*		*	
CADMIUM			*		*	
LEAD	mg/L	mg/L	*	<.005	*	<.005
ANTIMONY			*		*	
BERYLLIUM			*		*	
COPPER	mg/L	mg/L	*	<.0025	*	<.0025
SELENIUM			*		*	
THALLIUM			*		*	
BARIUM			*		*	
CHROMIUM			*		*	
COPPER			*		*	
IRON			*		*	
NICKEL			*		*	
SILVER			*		*	
SODIUM			*		*	
ZINC			*		*	
HARDNESS			*		*	
MANGANESE			*		*	
HARDNESS,TOTAL			*		*	
CALCIUM HARDNESS			*		*	
ALUMINUM			*		*	
CALCIUM			*		*	
MAGNESIUM			*		*	
POTASSIUM			*		*	
MOLYBDENUM			*		*	
BISMUTH			*		*	
COBALT			*		*	
STRONTIUM			*		*	
VANADIUM			*		*	
TITANIUM			*		*	
TIN			*		*	
BARIUM			*		*	
CHROMIUM			*		*	
COPPER			*		*	
IRON			*		*	
NICKEL			*		*	
SILVER			*		*	
SODIUM			*		*	

mg/L = milligrams / liter
< = less than

N.H.D.E.S. Laboratory Services
Analytical Results
Authorized Signature: ________________

		Sample Id:	L12417-7		L12417-8	
		Collect Date:	27-JUL-95		27-JUL-95	
		Sampler	HEATHER, JASON		HEATHER, JASON	
		Client Id:	IN HOUSE		IN HOUSE	
		Locator:	15T-SGR		15D-SGR	
		Site:	SUGAR RIVER		SUGAR RIVER	
		Description	WQ-106 GRANT		WQ-106 GRANT	
		Comments	*		*	
		EPA - Billable #	05-0022585		05-0022585	
arameter	Units	Units	Result	R.D.L.	Result	R.D.L.
ZINC	mg/L	mg/L	*	<.025	0.0320	<.025
HARDNESS			*		*	
MANGANESE			*		*	
HARDNESS,TOTAL	mg/L	mg/L	16.1	<1.35	*	
CALCIUM HARDNESS			*		*	
ALUMINUM			*		*	
CALCIUM			*		*	
MAGNESIUM			*		*	
POTASSIUM			*		*	
MOLYBDENUM			*		*	
BISMUTH			*		*	
COBALT			*		*	
STRONTIUM			*		*	
VANADIUM			*		*	
TITANIUM			*		*	
TIN			*		*	

mg/L = milligrams / liter
< = less than

ID# 225.6

FY 1995
AMBIENT WATER QUALITY MONITORING PROGRAM
FIELD NOTES FORM

DATE: 6/26/ 95 SAMPLE ROUND #: 1 2 3

RIVER NAME (s): Sugar FIELD CREW: Jason, Heather, Ross

WEATHER: Cloudy CLASS: A B

****

	Station	DO/Temp	Conductivity	pH	Parameters
45	11-Sgr	8.71/19.5°	109	7.1	Cu, Pb, Hard metal drum/tank 100' downstream
55	13-Sgr	8.36/21.5°	100	7.1	Cu, Pb, Hard - Cast or ductile iron pipe traversing river [lead calking joints?]
0	14-Sgr	1.39/21.5°	100	6.7	Cu, Pb, Hard Lumber Yard - looks like part of impoundment
5	15Sgr	8.10/21°	93	7.1	Cu, Pb, Hard
30	1-Trq	7.80/20.5°	98	6.9	Cu, Pb, Hard Reddish colored water
0	16Sgr	8.54/21°	91	7.1	Cu, Pb, Hard - Metal debris in river junkyard surrounding river
20	17Sgr	8.08/21°	99	6.7	Cu, Pb, Hard - ~~foot bridge~~ snowmobile bridge
0	18Sgr	8.63/21°	83	7.0	Cu, Pb, Hard - ductile iron pipe downstream side running across water

11 am 7.004

L10285-1
06/26 1[illegible]
L10285-2
06/26 10:55
L10285-3
06/26 11:1[illegible]
L10285-4
06/26 11:25
L10285-5
06/26 11:[illegible]
L10285-6
06/26 11:40
L10285-7
06/26 11:50
L10285-8
06/26 12:00

E.Coli X10-18_____

TKN-35_____	Alk- 58_____	Al-40 _____
NH3-36_____	Turb-68_____	✓Cu-46 _____
NO3-37_____	TS- 70_____	✓Pb-48 _____
TP -39_____	TSS- 72_____	Zn-57 _____

✓Hard-62_____ BOD5-31_____

State of New Hampshire
Department of Environmental Services
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(603) 271-3445/3446

Results of Laboratory Analysis

Matrix : Aqueous
Sample #: L10285-1
Category: IN HOUSE
Collection Date: 06/26/95 10:45
Log in Date : 06/27/95
Completion Date: 07/18/95

Site :
Locator : 11-SGR
Descript: Non-Point Source
Acnt nbr: 05-04-04
Proj nbr: 05-0022560

Analyte	Results	Units	RDL	EPA Method
COPPER	.0044	mg/L	.0025	200.9
LEAD	.006	mg/L	.005	200.9
HARDNESS	18	mg/L	1.35	200.7

Client's Comments: SUGAR RIVER

Authorized Signature: Garry Haworth

mg/L = Milligrams per Liter
> = Greater Than
BDL = Below Detection Limit
pCi/L = pico Curies per Liter
RDL = Reporting Detection Limit

ug/L = Micrograms per Liter
< = Less Than
ug/Kg = micrograms per Kilogram
mg/Kg = Milligrams per Kilogram

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Department of Environmental Services
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NHDES

Results of Laboratory Analysis

trix : Aqueous
mple #: L10285-2
ategory: IN HOUSE
llection Date: 06/26/95 10:55
g in Date : 06/27/95
ompletion Date: 07/21/95

Site :
Locator : 13-SGR
Descript: Non-Point Source
Acnt nbr: 05-04-04
Proj nbr: 05-0022560

Analyte	Results	Units	RDL	EPA Method
PPER	.0025	mg/L	.0025	200.9
AD	<.005	mg/L	.005	200.9
RDNESS	14.3	mg/L	1.35	200.7

lient's Comments: SUGAR RIVER

Authorized Signature: Garry Haworth

/L = Milligrams per Liter
= Greater Than
DL = Below Detection Limit
Ci/L = pico Curies per Liter
L = Reporting Detection Limit

ug/L = Micrograms per Liter
< = Less Than
ug/Kg = micrograms per Kilogram
mg/Kg = Milligrams per Kilogram

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Department of Environmental Services
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Results of Laboratory Analysis

Matrix : Aqueous
Sample #: L10285-3
Category: IN HOUSE
Collection Date: 06/26/95 11:10
Log in Date : 06/27/95
Completion Date: 07/21/95

Site :
Locator : 14-SGR
Descript: Non-Point Source
Acnt nbr: 05-04-04
Proj nbr: 05-0022560

Analyte	Results	Units	RDL	EPA Method
COPPER	<.0025	mg/L	.0025	200.9
LEAD	<.005	mg/L	.005	200.9
HARDNESS	14.1	mg/L	1.35	200.7

Client's Comments: SUGAR RIVER

Authorized Signature: Garry Haworth

mg/L = Milligrams per Liter
> = Greater Than
BDL = Below Detection Limit
pCi/L = pico Curies per Liter
RDL = Reporting Detection Limit
ug/L = Micrograms per Liter
< = Less Than
ug/Kg = micrograms per Kilogram
mg/Kg = Milligrams per Kilogram

State of New Hampshire
Department of Environmental Services
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NHDES

Results of Laboratory Analysis

:rix : Aqueous
ample #: L10285-4
ategory: IN HOUSE
.lection Date: 06/26/95 11:25
j in Date : 06/27/95
ompletion Date: 07/21/95

Site :
Locator : 15-SGR
Descript: Non-Point Source
Acnt nbr: 05-04-04
Proj nbr: 05-0022560

Analyte	Results	Units	RDL	EPA Method
?PER	<.0025	mg/L	.0025	200.9
AD	<.005	mg/L	.005	200.9
ARDNESS	12.8	mg/L	1.35	200.7

Iient's Comments: SUGAR RIVER

Authorized Signature: Garry Haworth

/L = Milligrams per Liter
= Greater Than
DL = Below Detection Limit
Ci/L = pico Curies per Liter
L = Reporting Detection Limit

ug/L = Micrograms per Liter
< = Less Than
ug/Kg = micrograms per Kilogram
mg/Kg = Milligrams per Kilogram

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Department of Environmental Services
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Results of Laboratory Analysis

atrix : Aqueous
Sample #: L10285-5
Category: IN HOUSE
ollection Date: 06/26/95 11:30
Log in Date : 06/27/95
Completion Date: 07/21/95

Site :
Locator : 1-TRA
Descript: Non-Point Source
Acnt nbr: 05-04-04
Proj nbr: 05-0022560

Analyte	Results	Units	RDL	EPA Method
OPPER	<.0025	mg/L	.0025	200.9
EAD	<.005	mg/L	.005	200.9
HARDNESS	20.7	mg/L	1.35	200.7

Client's Comments: SUGAR RIVER

Authorized Signature: Garry Haworth

ıg/L = Milligrams per Liter
\> = Greater Than
BDL = Below Detection Limit
pCi/L = pico Curies per Liter
RDL = Reporting Detection Limit

ug/L = Micrograms per Liter
< = Less Than
ug/Kg = micrograms per Kilogram
mg/Kg = Milligrams per Kilogram

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Department of Environmental Services
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Results of Laboratory Analysis

atrix : Aqueous
sample #: L10285-6
Category: IN HOUSE
ollection Date: 06/26/95 11:40
og in Date : 06/27/95
Completion Date: 07/21/95

Site :
Locator : 16-SGR
Descript: Non-Point Source
Acnt nbr: 05-04-04
Proj nbr: 05-0022560

Analyte	Results	Units	RDL	EPA Method
OPPER	<.0025	mg/L	.0025	200.9
EAD	<.005	mg/L	.005	200.9
HARDNESS	12.1	mg/L	1.35	200.7

Client's Comments: SUGAR RIVER

Authorized Signature: Garry Haworth

ng/L = Milligrams per Liter
> = Greater Than
BDL = Below Detection Limit
pCi/L = pico Curies per Liter
RDL = Reporting Detection Limit

ug/L = Micrograms per Liter
< = Less Than
ug/Kg = micrograms per Kilogram
mg/Kg = Milligrams per Kilogram

State of New Hampshire
Department of Environmental Services
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Results of Laboratory Analysis

:trix : Aqueous
ample #: L10285-7
ategory: IN HOUSE
llection Date: 06/26/95 11:50
g in Date : 06/27/95
ompletion Date: 07/21/95

Site :
Locator : 17-SGR
Descript: Non-Point Source
Acnt nbr: 05-04-04
Proj nbr: 05-0022560

Analyte	Results	Units	RDL	EPA Method
PPER	.0042	mg/L	.0025	200.9
AD	<.005	mg/L	.005	200.9
ARDNESS	12.3	mg/L	1.35	200.7

lient's Comments: SUGAR RIVER

Authorized Signature: Garry Haworth

/L = Milligrams per Liter
= Greater Than
3DL = Below Detection Limit
Ci/L = pico Curies per Liter
DL = Reporting Detection Limit

ug/L = Micrograms per Liter
< = Less Than
ug/Kg = micrograms per Kilogram
mg/Kg = Milligrams per Kilogram

State of New Hampshire
Department of Environmental Services
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(603) 271-3445/3446

NHDES

Results of Laboratory Analysis

atrix : Aqueous
ample #: L10285-8
Category: IN HOUSE
Collection Date: 06/26/95 12:00
og in Date : 06/27/95
ompletion Date: 07/21/95

Site :
Locator : 18-SGR
Descript: Non-Point Source
Acnt nbr: 05-04-04
Proj nbr: 05-0022560

Analyte	Results	Units	RDL	EPA Method
COPPER	<.0025	mg/L	.0025	200.9
EAD	<.005	mg/L	.005	200.9
ARDNESS	10.6	mg/L	1.35	200.7

lient's Comments: SUGAR RIVER

Authorized Signature:

g/L = Milligrams per Liter
 = Greater Than
DL = Below Detection Limit
pCi/L = pico Curies per Liter
DL = Reporting Detection Limit

ug/L = Micrograms per Liter
< = Less Than
ug/Kg = micrograms per Kilogram
mg/Kg = Milligrams per Kilogram

APPENDIX G

REFERENCES

REFERENCES

1. The Clean Water Act of 1987, section 303 (d).

2. Total Maximum Daily Load Guidelines, State of New Hampshire Department of Environmental Services, Water Supply and Pollution Control Division, August 9, 1994.

3. Hydrologic Data for Gaged Watersheds of New Hampshire and Vermont, S. L. Dingman and G. K. Capsis, October 1981.

5. Characterization of Stormwater Runoff from Concord, New Hampshire, New Hampshire Department of Environmental Services, August 1979.

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8. U.S. EPA. 1985. U.S. Environmental Protection Agency. Rates, Constants, and Kinetics Formulation in Surface Water Quality Modeling, Second Edition, EPA/600/3-85/040, pages 90 - 205.

9. NHWSPCC. March 1993. Sugar River WLA Study. Staff Report.

10. Thomann, Robert V. And Mueller, John A., Principles of Surface Water Quality Modeling and Control, Harper and Row, New York, pg. 283-293.

11. USEPA. 1982. Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants - Part I. EPA-600/6-82-004a.

APPENDIX H

PERTINENT INFORMATION FROM THE SUGAR RIVER WLA STUDY SUNAPEE TO CLAREMONT, NH NHDES, 1993.

The velocities and depths during the sampling periods are given in Table 3. The calculated velocities and depths at 7Q10 also are presented in Table 3.

TABLE 3

HYDRAULIC RELATIONSHIPS

June 23-24, 1992

Reach	Flows (cfs)	Velocity (fps)	Depth (ft)
I	33.95	0.62	1.38
II	36.95	0.63	1.44
III	56.05	0.91	1.15
IV	56.95	0.91	1.17
V	120.0	1.11	1.74
VI	121.0	0.91	2.32
VII	123.9	0.92	2.33

August 11-12, 1992

Reach	Flows (cfs)	Velocity (fps)	Depth (ft)
I	33.3	0.61	1.37
II	36.0	0.62	1.42
III	47.6	0.87	1.06
IV	48.4	0.87	1.07
V	78.0	0.99	1.38
VI	78.7	0.70	2.05
VII	80.2	0.71	2.06

7Q10 CONDITIONS

Reach	Flows (cfs)	Velocity (fps)	Depth (ft)
I	17.1	0.53	0.98
II	20.6	0.55	1.07
III	25.9	0.74	0.76
IV	27.9	0.76	0.79
V	39.9	0.83	0.96
VI	41.1	0.47	1.71
VII	47.2	0.51	1.77

TABLE 4

REAERATION RATES

June 23-24, 1992

Reach	Vel (fps)	Depth (ft)	O-D	C	O	Ave K_a
I	0.62	1.38	6.3	4.3	8.7	6.4
II	0.63	1.44	6.0	4.0	8.1	6.0
III	0.91	1.15	10.1	8.4	15.7	11.4
IV	0.91	1.17	9.8	8.1	15.2	11.0
V	1.11	1.74	6.0	5.1	8.4	6.5
VI	0.91	2.32	3.5	2.6	4.3	3.5
VII	0.92	2.33	3.5	2.6	4.3	3.5

August 11-12, 1992

Reach	Vel (fps)	Depth (ft)	O-D	C	O	Ave K_a
I	0.61	1.37	6.3	4.2	8.7	6.4
II	0.62	1.42	6.0	4.1	8.2	6.1
III	0.87	1.06	11.1	9.2	17.7	12.7
IV	0.87	1.07	11.1	9.1	17.4	12.5
V	0.99	1.38	8.0	6.7	11.9	8.9
VI	0.70	2.05	3.7	2.5	4.5	3.6
VII	0.71	2.06	3.7	2.5	4.5	3.6

7Q10 Conditions

Reach	Vel (fps)	Depth (ft)	O-D	C	O	Ave K_a
I	0.53	0.98	13.3	8.7	14.7	12.2
II	0.55	1.07	8.7	5.8	12.8	9.1
III	0.74	0.76	16.9	13.7	26.7	19.1
IV	0.76	0.79	16.1	13.2	27.9	19.1
V	0.83	0.96	12.6	10.4	20.7	14.6
VI	0.47	1.71	4.0	2.3	4.8	3.7
VII	0.51	1.77	3.9	2.3	4.8	3.7

O-D = O'Connor-Dobbins equation, Appendix F.
C = Churchill, et.al. equation, Appendix F.
O = Owens, et.al. equation, Appendix F.

TABLE 12

INPUT SOURCE DATA

June 23-24, 1992

Source	Flow (cfs)	D.O. (mg/l @25oC)	UCBOD (mg/l)	NBOD (mg/l)
Sunapee WWTF	0.45	2.1	63	85
Trask Bk	1.20	6.74	1.68	0.73
Dorr WWTF	0.85	3.05	31	7.5
Long Pond Bk	2.15	6.98	1.91	0.61
So Branch	19.1	7.1	1.1	0.6
Newport WWTF	0.90	5.93	59	72
No Branch	72.0	7.30	2.3	0.56
Coy Paper TF	1.0	7.8	38	0.80
Claremont WWTF	2.9	6.18	13	32

August 11-12, 1992

Source	Flow (cfs)	D.O. (mg/l @25oC)	UCBOD (mg/l)	NBOD (mg/l)
Sunapee WWTF	0.6	1.4	63	84
Trask Bk	0.7	6.90	1.9	0.7
Dorr WWTF	-	-	-	-
Long Pond Bk	2.7	6.6	1.8	0.65
So Branch	11.6	6.4	1.1	0.6
Newport WWTF	0.8	3.8	78	82
No Branch	20.1	6.9	2.3	0.6
Coy Paper TF	0.7	7.6	4.9	0.1
Claremont WWTF	2.0	6.0	31	52

DISSOLVED OXYGEN CONCENTRATIONS

It is important to note that the individual DO readings have been adjusted to negate the effects of temperature. That is, since the concentration of DO is dependent on the water temperature at the time of sampling, it is necessary to adjust the dissolved oxygen concentrations to a common temperature, in this case 25°C. The dissolved oxygen concentrations for each station were corrected to 25°C and are summarized in Table 13.

TABLE 13

DO CONCENTRATIONS (mg/l at 25°)

Station	June 23-24, 1992 % Sat 0800	June 23-24, 1992 DO 0800	August 11-12, 1992 % Sat 0800	August 11-12, 1992 DO 0800
17A-Sgr	89	7.14	92	7.38
Sunapee WWTF	27	2.17	17	1.36
17-Sgr	82	6.58	84	6.74
16-Sgr	89	7.14	92	7.38
Trask Bk	84	6.74	86	6.90
15-Sgr	86	6.90	90	7.22
Dorr WWTF	38	3.05	-	-
Long Pond Bk	87	6.98	81	6.50
14-Sgr	77	6.18	81	6.50
13-Sgr	91	7.30	91	7.30
So Branch	88	7.06	79	6.34
11-Sgr	93	7.46	90	7.22
Newport WWTF	74	5.93	48	3.85
9A-Sgr	85	6.82	76	6.10
No Branch	91	7.30	84	6.74
9-Sgr	96	7.70	84	6.74
7-Sgr	96	7.70	94	7.54
6-Sgr	89	7.14	71	5.70
2-Sgr	91	7.30	91	7.30
Coy Paper TF	97	7.78	93	7.46
1A-Sgr	82	6.58	86	6.90
Claremont WWTF	77	6.18	74	5.93
1-Sgr	89	7.14	89	7.14

A plot of the preceding DO data versus distance is shown in Appendix J. This DO curve is the standard against which the model DO concentration values will be compared.

MODEL PARAMETER SUMMARY

For the reader's convenience, Table 14 is a summary of all the parameters that were obtained during the June 23-24, 1992 stream survey.

TABLE 14

MODEL PARAMETER SUMMARY - June 23-24, 1992

PARAMETER	REACH						
	I	II	III	IV	V	VI	VII
STREAM							
Flow (cfs)	33.5	33.95	36.95	56.05	56.95	120.0	121.0
DO (mg/l)	7.5	6.95	7.0	7.4	7.3	7.3	7.0
UCBOD (mg/l)	2.3	2.0	2.4	1.6	2.8	3.0	2.9
NBOD (mg/l)	0.9	1.5	1.1	1.0	1.9	0.5	0.5
DISCHARGE	Sun	Dorr/LP	SB	Newport	NB	Coy	Claremont
Flow (cfs)	0.45	3.0	19.1	0.9	72.0	1.0	2.9
DO (mg/l)	2.1	3.1	7.1	5.93	7.3	7.8	6.18
UCBOD (mg/l)	63	31.0	1.1	59	2.3	38.0	13
NBOD (mg/l)	85	8.0	0.6	72	0.56	0.8	32
K_a (1/day)	6.4	6.0	11.4	11.0	6.5	3.5	3.5
K_d (1/day)	-5.88	-0.87	-2.11	-5.02	-0.13	-20.0	-2.37
K_N (1/day)	-3.51	-6.24	-16.24	-2.63	-2.63	-2.63	-6.98
R (mg/l)	0.04	0.09	0.05	0.116	0.102	0.085	0.05
P (mg/l)	0	0	0	0	0	0	0
Velocity (fps)	0.62	0.63	0.91	0.91	1.11	0.91	0.92
T (^oC)	25	25	25	25	25	25	25
C_S (mg/l)	8.16	8.16	8.16	8.16	8.16	8.16	8.16
S_B ($g/m^2/d$)	0	0	0	0	0	0	0
Starting Mile	25.72	23.28	20.26	18.68	17.25	1.79	1.55
Ending Mile	23.28	20.26	18.68	17.25	6.92	1.55	0

MODEL CALIBRATION

A computer run was made using the data in Table 14, and the output is provided in Appendix K. After adjustments were made to some rate values in order to calibrate the model to field data, a comparison of the computed DO values with the June 23-24, 1992 (0800) stream DO concentrations indicates that the computed DO values are within 10 percent of the field values (Appendix L). Table 15 shows the changes made in order to calibrate the model. Computer output of the calibrated model can be found in Appendix M.

TABLE 15

CALCULATED vs CALIBRATED RATES

		I	II	III	IV	V	VI	VII
Calculated	Ka	6.4	6.0	11.4	11.0	6.5	3.5	3.5
	Kd	-5.88	-0.87	-2.11	-5.02	-0.13	-20.0	-2.37
	Kn	-3.51	-6.24	-16.24	-2.63	-2.63	-2.63	-6.98
Calibrated	Ka	8.0	7.5	9.0	7.0	4.0	2.0	10
	Kd	-5.88	-2.0	-2.11	-2.0	-0.13	-7.0	-2.4
	Kn	-2.0	-2.0	-2.0	-1.0	-1.5	-0.5	-2.1

MODEL VERIFICATION

In order to verify the Sugar River model, a second set of data at a different flow (Table 16) was input into the model to see if the field data results could, again, be predicted. The predicted results (Appendix M) are all within 10 percent of field values. The data in Table 16 includes the calibrated rates from Table 15. A plot of the field measurements and predicted values is given in Appendix L. Since the Sugar River model adequately predicts field DO concentrations with the second independent set of data, it is considered to be verified.

SENSITIVITY ANALYSIS

A sensitivity analysis is a process whereby parameters are changed from their original value and the effect of the change upon the model is evaluated. The purpose of a sensitivity analysis is to determine the effect parameter adjustments have on the model predictions. A sensitivity analysis is a recognition that there is some degree of uncertainty in determining model parameters.

The sensitivity of the calibrated model is examined relative to base

TABLE 16

MODEL PARAMETER SUMMARY - August 11-12, 1992

PARAMETER	REACH I	II	III	IV	V	VI	VII
STREAM							
Flow (cfs)	32.7	33.3	36.0	47.6	48.4	78.0	78.7
DO (mg/l)	7.7	7.0	7.4	7.3	7.0	7.4	7.0
UCBOD (mg/l)	1.9	2.0	2.4	1.6	2.8	3.0	2.6
NBOD (mg/l)	0.7	1.5	1.1	1.0	1.9	0.5	0.5
DISCHARGE	Sun	LPBk	SB	Newport	NB	Coy	Claremont
Flow (cfs)	0.6	2.7	11.6	0.8	20.1	0.7	2.0
DO (mg/l)	1.4	6.6	6.4	3.8	6.9	7.6	6.0
UCBOD (mg/l)	63	1.8	1.1	78	2.3	4.9	31
NBOD (mg/l)	84	0.65	0.6	82	0.6	0.1	52
K_a (1/day)	8.0	7.5	9.0	7.0	4.0	2.0	10.0
K_d (1/day)	-5.88	-2.0	-2.11	-2.0	-0.13	-7.0	-2.4
K_N (1/day)	-2.0	-2.0	-2.0	-1.0	-1.5	-0.5	-2.1
R (mg/l)	0.04	0.09	0.05	0.116	0.102	0.085	0.05
P (mg/l)	0	0	0	0	0	0	0
Velocity (fps)	0.61	0.62	0.87	0.87	0.99	0.70	0.71
T (^oC)	25	25	25	25	25	25	25
C_S (mg/l)	8.16	8.16	8.16	8.16	8.16	8.16	8.16
S_B ($g/m^2/d$)	0	0	0	0	0	0	0
Starting Mile	25.72	23.28	20.26	18.68	17.25	1.79	1.55
Ending Mile	23.28	20.26	18.68	17.25	6.92	1.55	0

data which, in this case, is the June 23-24, 1992 survey condition. The various parameters were adjusted around these data values. The variation for the reaction rates (K_a, K_d, K_n), loadings (UCBOD, NBOD), background dissolved oxygen, discharge dissolved oxygen, and the respiration rate were adjusted to +/-50% of their base values. Hydraulic parameters (flow, velocity) were varied +/-20%. The magnitude of the change was standardized within each group of parameters in order to facilitate the comparison of the sensitivity of similar parameters. The magnitude of the variation used in each group of parameters represents the relative confidence in the estimation of each parameter.

Sensitivity analyses were conducted on the June 1992 data for the Sugar River. Results show that the parameters most sensitive through the study area are; reaeration rate (K_a), the upstream UCBOD concentration, background DO concentration, UCBOD decay rate (K_d), and stream velocity.

Specifically, Table 17 lists the parameters which change the dissolved oxygen prediction by 0.5 mg DO/l or greater.

TABLE 17

SENSITIVITY ANALYSIS

Reach	Sensitive Parameters
I	Reaeration rate
II	Reaeration rate
VI	Upstream DO

MODEL APPLICATION

In order to determine whether Class B standards would be met throughout the study area at 7Q10 river conditions, the following discharge condition summary was compiled for the Sugar River dischargers.

TABLE 18

INPUT SOURCE DATA

Source	Flow cfs	D.O. mg/l	BOD5 mg/l	BOD5 lbs/d	NH3 mg/l	NBOD mg/l
Sunapee WWTF	1.0	1.4	30		21.8	99
Dorr WWTF	1.5	3.1	40	335	2.0	9
Newport WWTF	2.0	3.8	30		16.5	75
Coy Paper TF	1.4	6.0	40	300	0.1	0.5
Claremont WWTF	6.1	6.0	30		13.9	63

TABLE 19

MODEL PARAMETER SUMMARY - 7Q10

PARAMETER	REACH I	II	III	IV	V	VI	VII
STREAM							
Flow (cfs)	16.1	19.05	20.6	25.9	27.9	39.9	41.29
DO (mg/l)	7.5	7.1	6.7	7.4	6.4	7.9	~~7.5~~ 7.0
UCBOD (mg/l)	2.1	1.2	5.0	3.2	9.2	3.0	~~3.0~~ 3.4
NBOD (mg/l)	0.8	2.1	2.0	1.3	4.7	1.1	~~1.0~~ 1.3
DISCHARGE	Sunapee	Dorr	SB	Newport	NB	Coy	Claremont
Flow (cfs)	1.0	1.55	5.3	2.0	12.0	1.39	6.1
DO (mg/l)	1.4	3.1	6.3	3.85	6.8	6.0	6.0
UCBOD (mg/l)	73	117	1.1	120	2.3	40	48
NBOD (mg/l)	51	26	0.6	57.5	0.6	9	45.7
K_a (1/day)	15.3	11.4	15.1	12.2	9.0	2.1	10.6
K_d (1/day)	-5.88	-2.0	-2.11	-2.0	-0.13	-7.0	-2.4
K_N (1/day)	-2.0	-2.0	-2.0	-1.0	-1.5	-0.5	-2.1
R (mg/l)	0.04	0.09	0.05	0.116	0.102	0.085	0.05
P (mg/l)	0	0	0	0	0	0	0
Velocity (fps)	0.53	0.55	0.74	0.76	0.83	0.47	0.51
T (^oC)	25	25	25	25	25	25	25
C_S (mg/l)	8.16	8.16	8.16	8.16	8.16	8.16	8.16
S_B ($g/m^2/d$)	0	0	0	0	0	0	0
Starting Mile	25.72	23.28	20.26	18.68	17.25	1.79	1.55
Ending Mile	23.28	20.26	18.68	17.25	6.92	1.55	0

TIME OF TRAVEL

The time required for a slug of water to travel from one point in a stream to another point downstream is known as the "time of travel" (TOT) and is calculated by the following formula:

TOT (days) = Length of segment (mi)/(16.36 X Velocity (fps))

The TOT for each reach at the time of the field survey in June 1992, during the August 1992 survey, and at 7Q10 are given below.

JUNE TIME OF TRAVEL

Reach	Distance (Miles)	Velocity (fps)	TOT (Days)
I	2.44	0.62	0.241
II	3.02	0.63	0.293
III	1.58	0.91	0.106
IV	1.43	0.91	0.096
V	10.33	1.11	0.569
VI	0.24	0.91	0.016
VII	1.55	0.92	0.103

AUGUST TIME OF TRAVEL

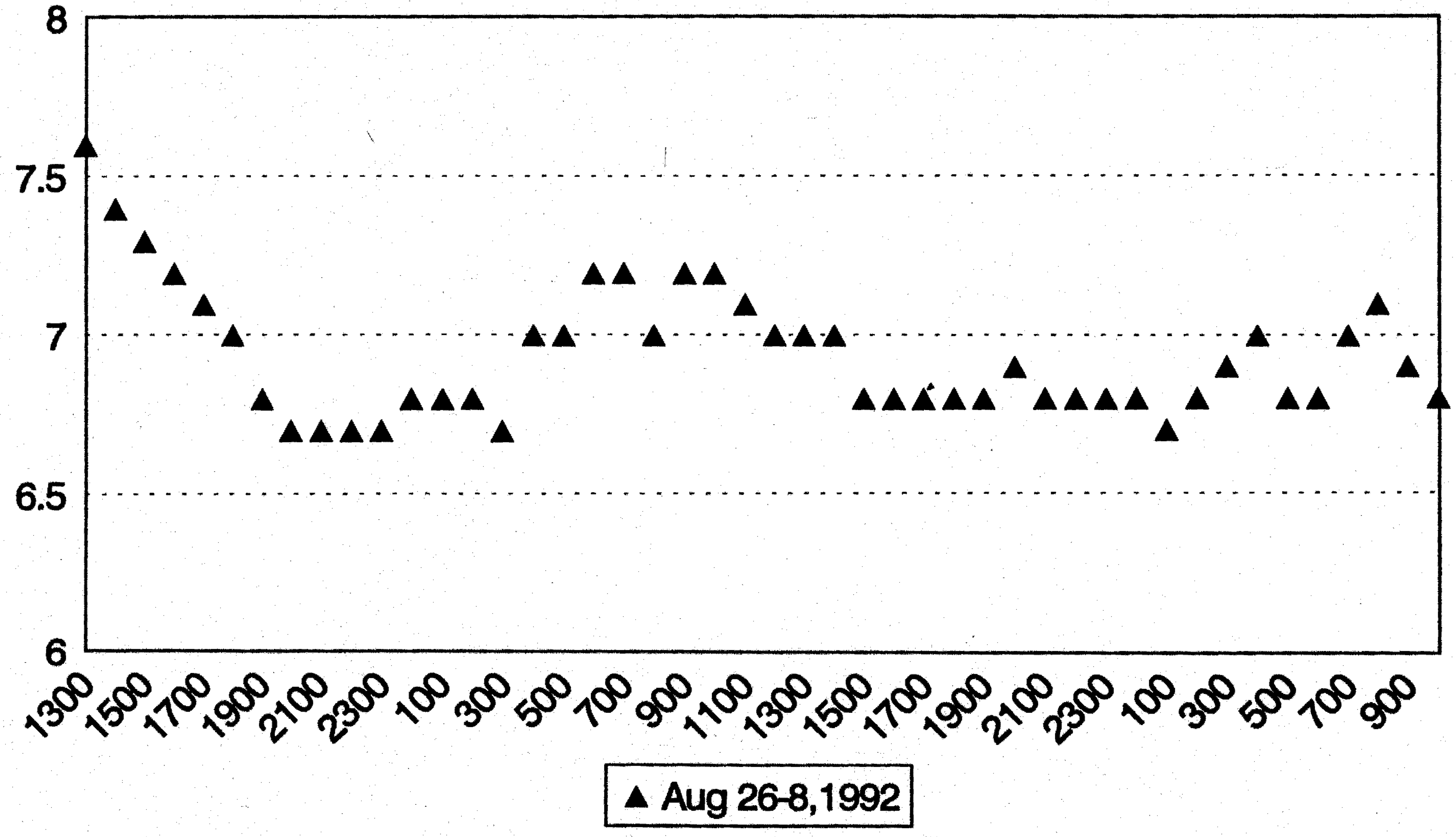
Reach	Distance (Miles)	Velocity (fps)	TOT (Days)
I	2.44	0.61	0.244
II	3.02	0.62	0.298
III	1.58	0.87	0.111
IV	1.43	0.87	0.100
V	10.33	0.99	0.638
VI	0.24	0.70	0.021
VII	1.55	0.71	0.133

7Q10 TIME OF TRAVEL

Reach	Distance (Miles)	Velocity (fps)	TOT (Days)
I	2.44	0.53	0.281
II	3.02	0.55	0.336
III	1.58	0.74	0.131
IV	1.43	0.76	0.115
V	10.33	0.83	0.761
VI	0.24	0.47	0.031
VII	1.55	0.51	0.186

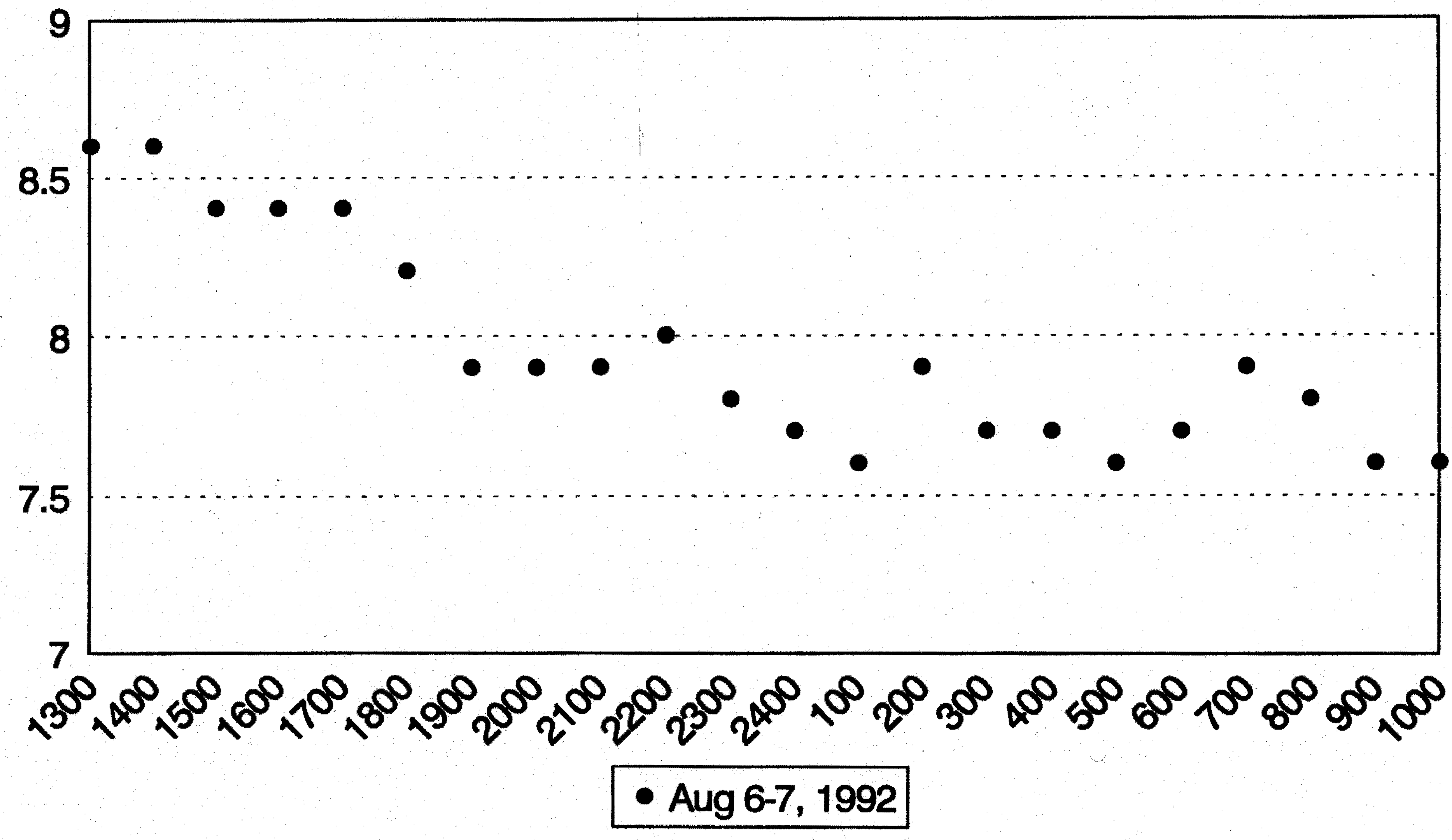
24 hr DO PLOT

Station 17-Sgr

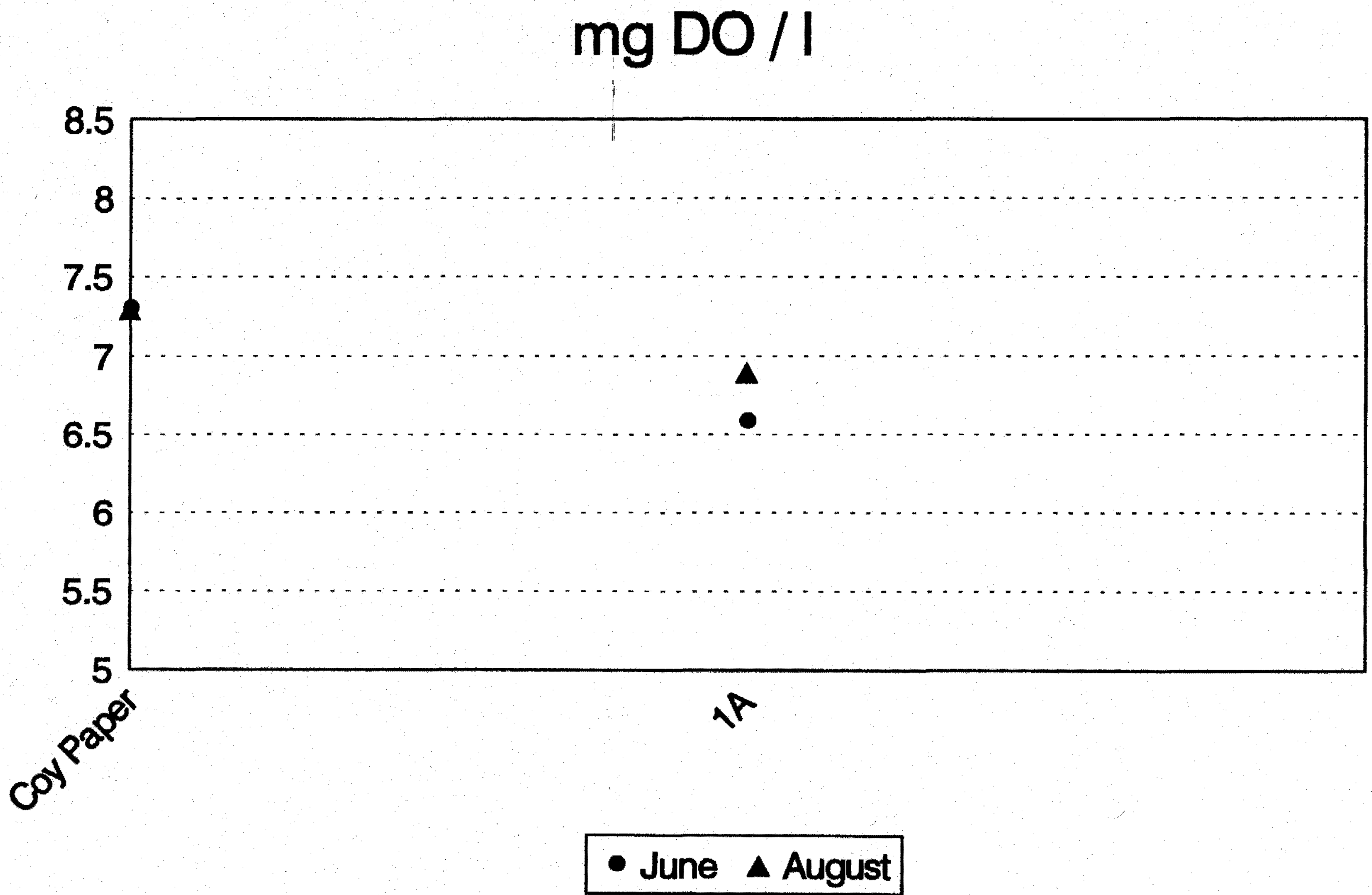


24 hr DO

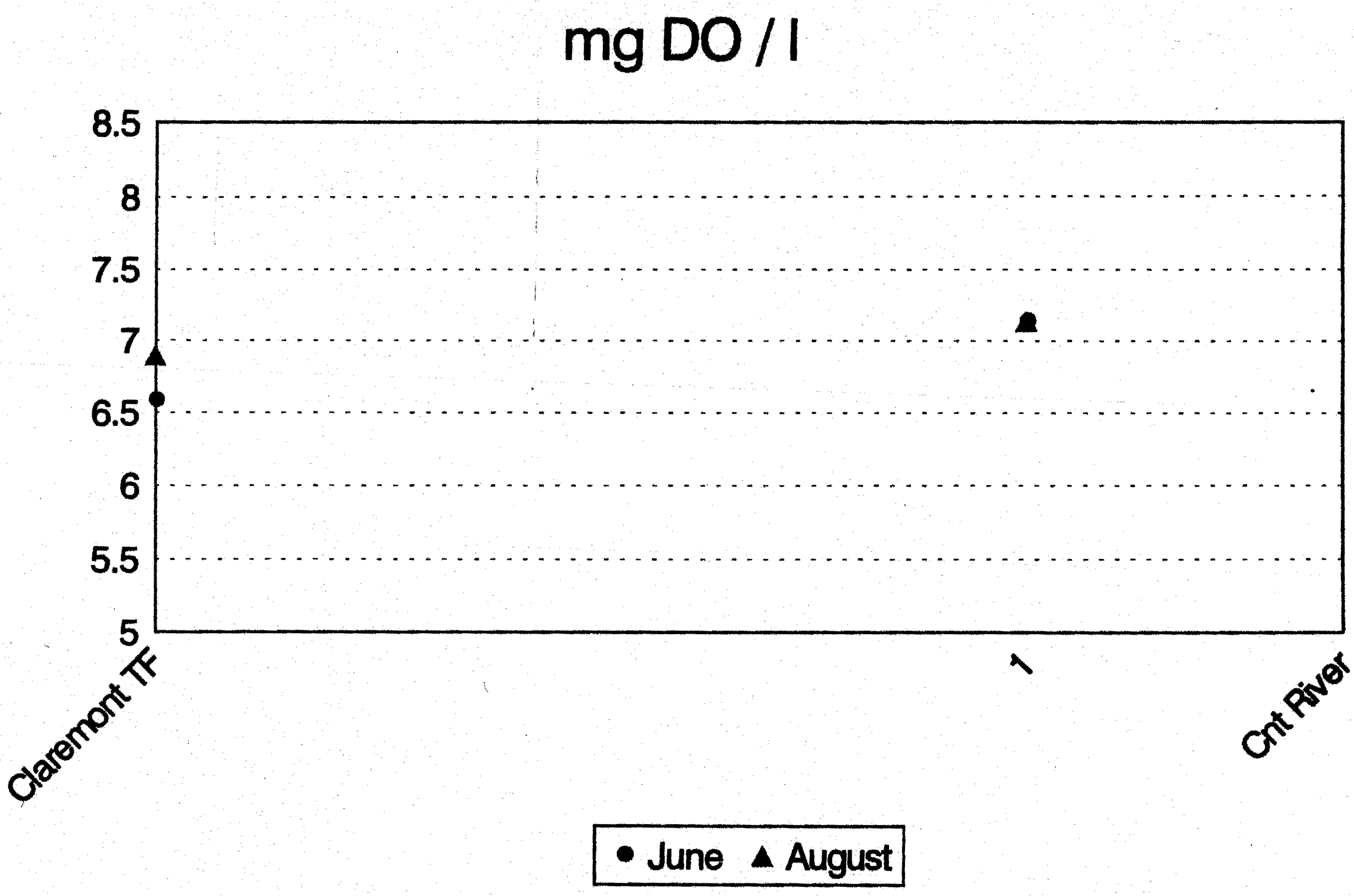
Station 14-Sgr

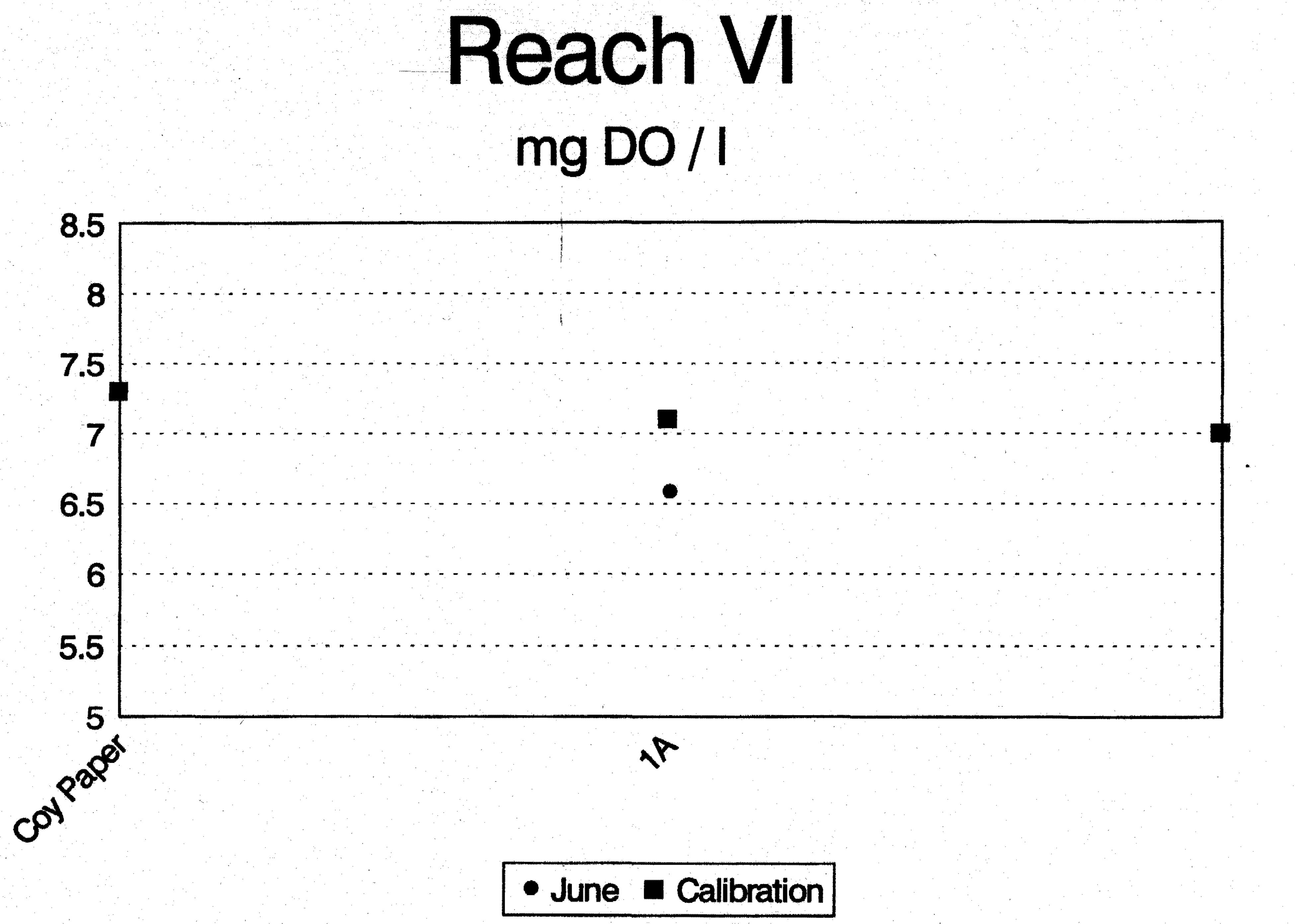


Reach VI



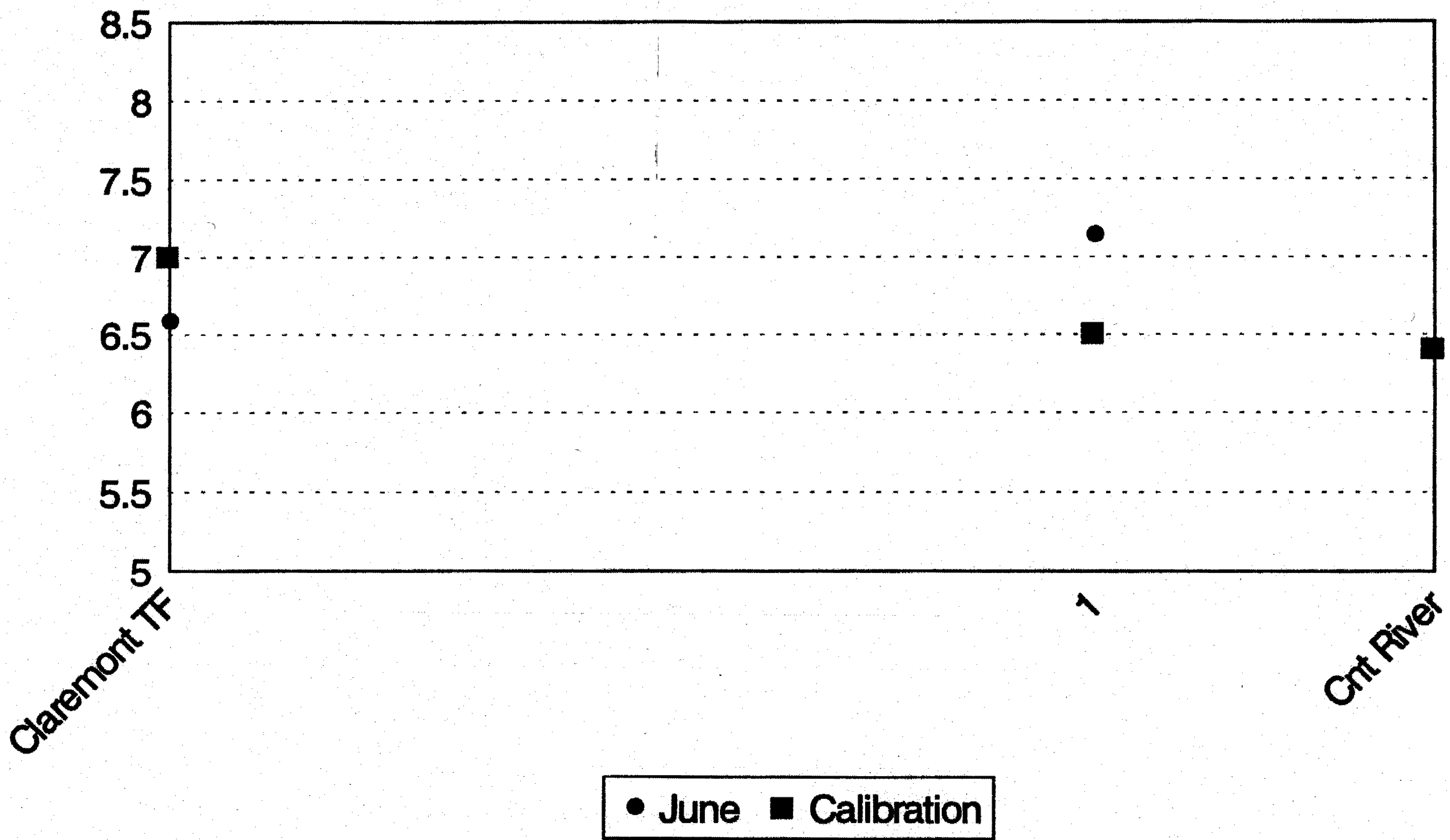
Reach VII




Reach VI
mg DO / l
8.5
8
7.5
7
6.5
6
5.5
5
Coy Paper
1A
June
Calibration

Reach VII

mg DO / l



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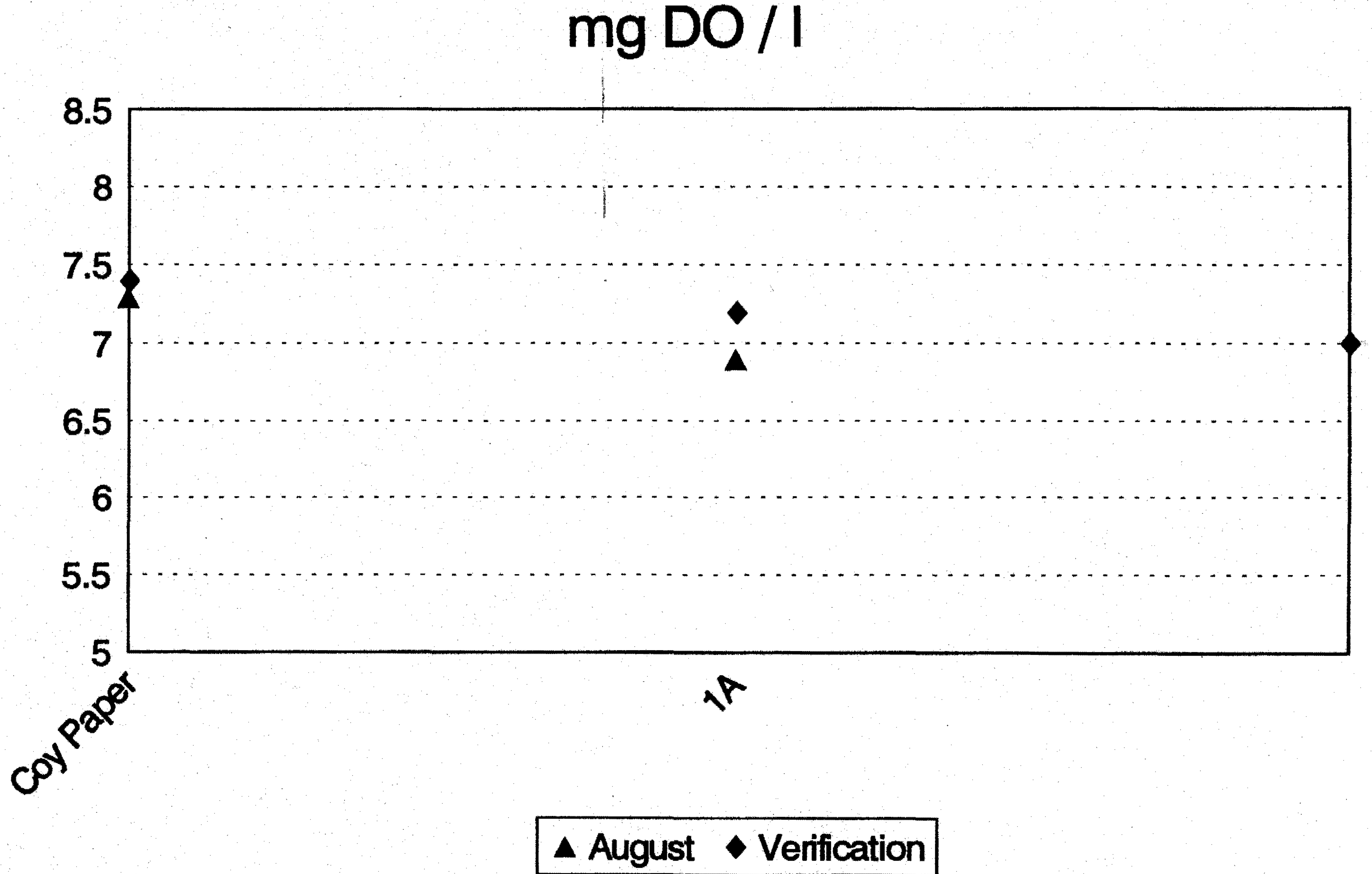

Reach VII

mg DO / l