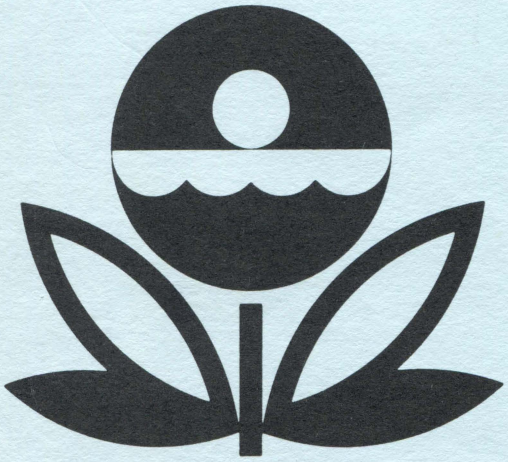
U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES



REPORT

ON

UNION LAKE

CUMBERLAND COUNTY

NEW JERSEY

EPA REGION II

WORKING PAPER No. 375

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

☆G.P.O. 699-440

REPORT
ON
UNION LAKE
CUMBERLAND COUNTY
NEW JERSEY
EPA REGION II
WORKING PAPER NO. 375

WITH THE COOPERATION OF THE

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

AND THE

NEW JERSEY NATIONAL GUARD

MAY 1976

CONTENTS

FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point source discharge reduction and nonpoint source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by the U.S. Environmental Protection Agency and to augment plans implementation by the states.

ACKNOWLEDGMENTS

The staff of the National Eutrophication Survey (Office of Research and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the New Jersey Department of Environmental Protection for professional involvement and to the New Jersey National Guard for conducting the tributary sampling phase of the Survey.

Douglas Clark, Chief of the Bureau of Water Quality Planning and Management, Mr. Frank Takacs, New Jersey National Eutrophication Survey Coordinator, Principal Environmental Specialist, and Robert Kotch, Senior Environmental Engineer, provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

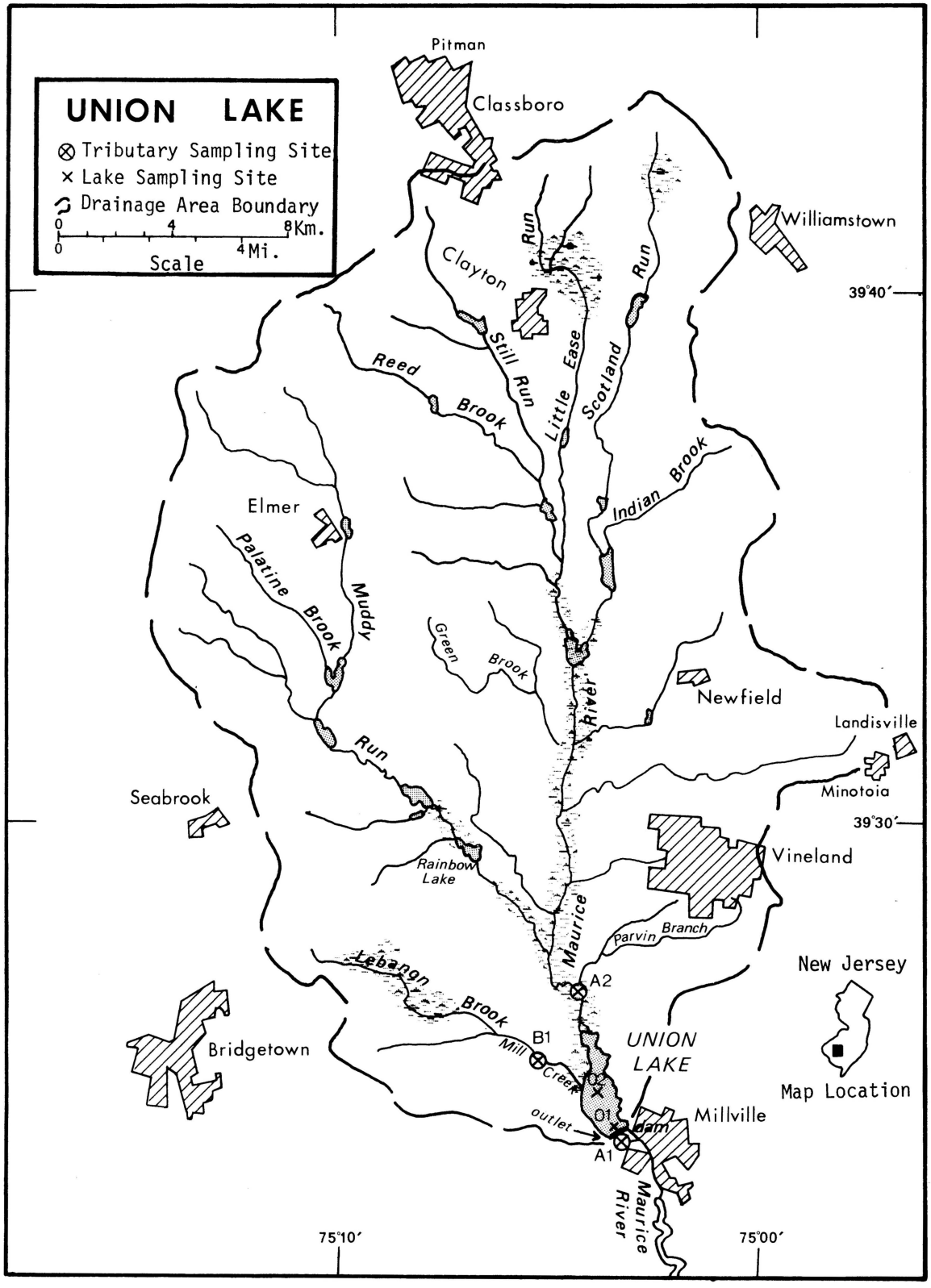
Major General William R. Sharp, Former Chief of Staff, Major General Wilfred G. Menard, Jr., Chief of Staff, and Project Officer Colonel Herbert D. Ruhlin, who directed the volunteer efforts of the New Jersey National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF NEW JERSEY

LAKE NAME	COUNTY
Budd Lake	Morris
Duhernal Lake	Middlesex
Farrington Lake	Middlesex
Greenwood Lake	Passaic, N.J.; Orange, N.Y.
Lake Hopatcong	Morris, Sussex
Lake Musconetcong	Morris, Sussex
Oradell Reservoir	Bergen
Paulinskill Lake	Sussex
Pinecliff Lake	Passaic
Pompton Lakes	Passaic
Spruce Run Reservoir	Hunterdon
Union Lake	Cumberland
Wanaque Reservoir	Passaic


UNION LAKE
⊗ Tributary Sampling Site
× Lake Sampling Site
Drainage Area Boundary
0 4 8 Km.
0 4 Mi.
Scale
Pitman
Classboro
Williamstown
Clayton
Run
Still Run
Little Ease Run
Scotland Run
Reed Brook
Indian Brook
Elmer
Palatine Brook
Muddy Run
Green Brook
Newfield
Landisville
Minotoia
Seabrook
Rainbow Lake
Vineland
Parvin Branch
Maurice River
Lebanon Brook
Mill Creek
Bridgetown
A2
B1
UNION LAKE
dam
outlet
Millville
A1
Maurice River
New Jersey
Map Location
39°40′
39°30′
75°10′
75°00′

UNION LAKE, NEW JERSEY

STORET NO. 3422

I. CONCLUSIONS

A. Trophic Condition:

Union Lake is considered eutrophic based upon field observations and the analysis of Survey data. The lake is characterized by high nutrient concentrations, brown humic colored water and summer algal blooms. Chlorophyll *a* values ranged from a low of 2.5 µg/l in the spring to 61.1 µg/l in the summer, with a mean of 22.1 µg/l. Algal assay results indicated the potential primary productivity in Union Lake was moderately high when sampled.

B. Rate-Limiting Nutrient:

Algal assay results indicate that Union Lake is limited by available phosphorus. Spikes with phosphorus, or phosphorus and nitrogen simultaneously resulted in increased assay yields. The addition of nitrogen alone did not produce a growth response. The mean total inorganic nitrogen to orthophosphorus ratio (N/P) further substantiates these results.

C. Nutrient Controllability:

The only known point source impacting Union Lake is the city of Clayton wastewater treatment plant, which is estimated to contribute 53.2% of the total phosphorus load to the lake. Of the nonpoint contributions, measured tributaries accounted for 43.9% of the total load, and the ungaged drainage areas were estimated to account for 2.3%. Although it is suspected that a portion of the sewage treatment plant effluent from Vineland, released to ground, ultimately will impact Union Lake, no estimates of loading directly attributable to this source are available.

Loading calculations based upon available nutrient concentrations and flow data yield a net export of phosphorus from Union Lake, suggesting that sampling was not adequate to depict actual loading and export rates. This export could be due to undetected discharges reaching the lake from unknown industrial or municipal sources. Additional sampling and an evaluation of current land use and lakeshore construction are required before a nutrient budget for the lake can be determined.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

Lake and drainage basin characteristics are itemized below. The lake surface area and mean depth were provided by the State of New Jersey. Tributary flow data were provided by the New Jersey District Office of the U.S. Geological Survey (USGS). Outlet drainage area includes the lake surface area. Mean hydraulic retention time was obtained by dividing the lake volume by the mean flow of the outlet. Precipitation values were estimated by methods as outlined in National Eutrophication Survey (NES) Working Paper No. 175. A table of metric/English conversions is included as Appendix A.

A. Lake Morphometry:

1. Surface area: 3.60 km^2.
2. Mean depth: 2.7 meters.
3. Maximum depth: 8.2 meters.
4. Volume: 9.72×10^6 m^3.
5. Mean hydraulic retention time: 12 days.

B. Tributary and Outlet (see Appendix B for flow data):

1. Tributaries -

Name	Drainage area(km^2)	Mean flow (m^3/sec)
A(2) Maurice River	499.9	7.95
B(1) Mill Creek	39.1	0.48
Minor tributaries and immediate drainage -	21.8	0.31
Totals	560.8	8.74
2. Outlet - A(1) Maurice River	564.6	8.98

C. Precipitation:

1. Year of sampling: 104.7 cm.

2. Mean annual: 105.3 cm.

III. LAKE WATER QUALITY SUMMARY

Union Lake was sampled three times during the open-water season of 1973 by means of a pontoon-equipped Huey helicopter. During spring, summer, and fall visits at Station 1 and spring and summer visits at Station 2, samples for physical and chemical parameters were collected from the stations on the lake and from one or more depths at each station (see map, page v). During each visit, depth-integrated samples were collected from each station for chlorophyll a analysis and phytoplankton identification and enumeration. During the first visit, 18.9-liter depth-integrated samples were composited for algal assays. Maximum depths sampled were 4.6 meters at Station 1 and 3.0 meters at Station 2. For a more detailed explanation of NES methods, see NES Working Paper No. 175.

The results obtained are presented in full in Appendix C and are summarized in III A for waters at the surface and at the maximum depth for each site. Results of the phytoplankton counts and chlorophyll a determinations are included in III B. Results of the limiting nutrient study are presented in III C.

UNION LAKE
STORET CODE 3422

PHYSICAL AND CHEMICAL CHARACTERISTICS

PARAMETER	(4/16/73) S*** = 2 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)	(7/20/73) S*** = 2 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)	(9/28/73) S*** = 1 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)
TEMPERATURE (DEG CENT)												
0.-1.5 M DEPTH	4	11.3- 12.1	11.6	0.0- 1.2	4	24.7- 26.8	26.4	0.0- 1.5	1	21.0- 21.0	21.0	0.0- 0.0
MAX DEPTH**	2	11.2- 12.0	11.6	3.0- 4.0	2	22.1- 26.7	24.4	3.0- 4.0	1	19.9- 19.9	19.9	4.6- 4.6
DISSOLVED OXYGEN (MG/L)												
0.-1.5 M DEPTH	2	9.9- 9.9	9.9	1.2- 1.2	2	6.6- 9.2	7.9	1.5- 1.5	1	10.0- 10.0	10.0	0.0- 0.0
MAX DEPTH**	2	10.2- 10.2	10.2	3.0- 4.0	2	2.2- 5.2	3.7	3.0- 4.0	1	8.0- 8.0	8.0	4.6- 4.6
CONDUCTIVITY (UMHOS)												
0.-1.5 M DEPTH	4	78.- 80.	79.	0.0- 1.2	4	84.- 86.	85.	0.0- 1.5	1	100.- 100.	100.	0.0- 0.0
MAX DEPTH**	2	78.- 78.	78.	3.0- 4.0	2	80.- 86.	83.	3.0- 4.0	1	100.- 100.	100.	4.6- 4.6
PH (STANDARD UNITS)												
0.-1.5 M DEPTH	4	6.7- 6.9	6.8	0.0- 1.2	4	6.7- 8.3	7.2	0.0- 1.5	1	8.2- 8.2	8.2	0.0- 0.0
MAX DEPTH**	2	6.7- 6.8	6.7	3.0- 4.0	2	6.1- 6.3	6.2	3.0- 4.0	1	7.4- 7.4	7.4	4.6- 4.6
TOTAL ALKALINITY (MG/L)												
0.-1.5 M DEPTH	4	10.- 10.	10.	0.0- 1.2	4	10.- 10.	10.	0.0- 1.5	1	13.- 13.	13.	0.0- 0.0
MAX DEPTH**	2	10.- 10.	10.	3.0- 4.0	2	10.- 10.	10.	3.0- 4.0	1	11.- 11.	11.	4.6- 4.6
TOTAL P (MG/L)												
0.-1.5 M DEPTH	4	0.026-0.035	0.030	0.0- 1.2	4	0.058-0.064	0.063	0.0- 1.5	1	0.075-0.075	0.075	0.0- 0.0
MAX DEPTH**	2	0.026-0.029	0.027	3.0- 4.0	2	0.075-0.083	0.079	3.0- 4.0	1	0.069-0.069	0.069	4.6- 4.6
DISSOLVED ORTHO P (MG/L)												
0.-1.5 M DEPTH	4	0.013-0.026	0.015	0.0- 1.2	4	0.016-0.023	0.019	0.0- 1.5	1	0.029-0.029	0.029	0.0- 0.0
MAX DEPTH**	2	0.014-0.015	0.014	3.0- 4.0	2	0.018-0.019	0.018	3.0- 4.0	1	0.020-0.020	0.020	4.6- 4.6
NO2+NO3 (MG/L)												
0.-1.5 M DEPTH	4	1.200-1.300	1.300	0.0- 1.2	4	0.790-0.940	0.895	0.0- 1.5	1	0.900-0.900	0.900	0.0- 0.0
MAX DEPTH**	2	1.300-1.300	1.300	3.0- 4.0	2	0.780-1.200	0.990	3.0- 4.0	1	0.850-0.850	0.850	4.6- 4.6
AMMONIA (MG/L)												
0.-1.5 M DEPTH	4	0.130-0.130	0.130	0.0- 1.2	4	0.080-0.210	0.140	0.0- 1.5	1	0.090-0.090	0.090	0.0- 0.0
MAX DEPTH**	2	0.130-0.130	0.130	3.0- 4.0	2	0.220-0.340	0.280	3.0- 4.0	1	0.090-0.090	0.090	4.6- 4.6
KJELDAHL N (MG/L)												
0.-1.5 M DEPTH	4	0.400-0.400	0.400	0.0- 1.2	4	0.600-1.200	0.950	0.0- 1.5	1	1.400-1.400	1.400	0.0- 0.0
MAX DEPTH**	2	0.400-0.400	0.400	3.0- 4.0	2	0.800-0.800	0.800	3.0- 4.0	1	0.700-0.700	0.700	4.6- 4.6
SECCHI DISC (METERS)	2	0.9- 1.0	1.0		2	0.8- 0.9	0.9		1	1.0- 1.0	1.0	

* N = NO. OF SAMPLES
** MAXIMUM DEPTH SAMPLED AT EACH SITE
*** S = NO. OF SITES SAMPLED ON THIS DATE

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera		Algal Units per ml
04/16/73	1.	Flagellates	576
	2.	Fragilaria	107
	3.	Melosira	74
	4.	Centric diatom	33
	5.	Pennate diatom	33
		Other genera	74
		Total	897
07/20/73	1.	Melosira	6,732
	2.	Fragilaria	931
	3.	Chroococcus	421
	4.	Tabellaria	300
	5.	Stipitococcus	180
		Other genera	480
		Total	9,044
09/28/73	1.	Aphanothece	2,077
	2.	Flagellates	1,547
	3.	Fragilaria	1,458
	4.	Melosira	1,149
	5.	Aphanizomemon	795
		Other genera	2,299
		Total	9,325

2. Chlorophyll *a* -

Sampling Date	Station Number	Chlorophyll *a* (μg/liter)
04/16/73	1	2.5
	2	3.0
07/20/73	1	17.3
	2	61.1
09/28/73	1	26.5

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc.(mg/l)	Inorganic N Conc.(mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.015	1.340	1.3
0.05 P	0.065	1.340	18.6
0.05 P + 1.0 N	0.065	2.340	20.1
1.00 N	0.015	2.340	0.7

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential for primary productivity in Union Lake was high at the time of sampling. The lake was phosphorus limited at that time as indicated by the increased yield of the test alga in response to an addition of orthophosphorus. Spikes with phosphorus and nitrogen simultaneously resulted in a maximum yield. Additions of nitrogen alone did not produce any response beyond the control yield. The N/P ratio of 83/1 in the spring lake data further indicates phosphorus limitation. At all other sampling times, the N/P ratio was 39/1 or greater and phosphorus limitation also would be expected.

IV. NUTRIENT LOADINGS
(See Appendix D for data)

For the determination of nutrient loadings, the New Jersey National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff months of February and March when two samples were collected. Sampling was begun in July 1973, and was completed in June 1974.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the New Jersey District Office of the USGS for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of the USGS computer program for calculating stream loadings. Nutrient loads indicated for tributaries are those measured minus known point source loads, if any.

Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of USGS) were estimated by using the mean annual concentrations in Mill Creek at Station B(1) and mean annual ZZ flow. Nutrient loads for the city of Clayton wastewater treatment plant were estimated at 1.134 kg P and 3.401 kg N/capita/yr.

A. Waste Sources:

1. Known municipal* -

Name	Population Served**	Treatment	Mean Flow ($m^3/d \times 10^3$)***	Receiving Water
Clayton	5,193	Primary clarification	1.966	Still Run to Maurice River
Vineland	47,399	Secondary, application to land	17.940	---

2. Known industrial - None

*U.S. EPA, 1971.
**1970 Census.
***Flow based on 0.3785 m^3/capita/day.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/yr	% of total
a. Tributaries (nonpoint load) -		
A(2) Maurice River	4,455	40.3
B(1) Mill Creek	395	3.6
b. Minor tributaries and immediate drainage (nonpoint load) -	255	2.3
c. Known municipal STP's -		
Clayton	5,890	53.2
d. Septic tanks* -	5	<0.1
e. Known industrial - None		
f. Direct precipitation** -	65	0.6
Total	11,065	100.0
2. Output - A(1) Maurice River	12,430	
3. Net annual P export*** -	1,365	

*Estimate based on 13 lakeside residences.
**Estimated (see NES Working Paper No. 175).
***Export probably due to unknown sources and/or sampling error.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (nonpoint load) -		
A(2) Maurice River	616,865	90.0
B(1) Mill Creek	28,375	4.1
b. Minor tributaries and immediate drainage (nonpoint load) -	18,665	2.7
c. Known municipal STP's -		
Clayton	17,660	2.6
d. Septic tanks* -	140	<0.1
e. Known industrial - None		
f. Direct precipitation** -	3,885	0.6
Total	685,590	100.0

2. Output - A(1) Maurice River 593,375

3. Net annual N accumulation - 92,215

*Estimate based on 13 lakeside residences.
**Estimated (see NES Working Paper No. 175).

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
A(2) Maurice River	9	1,234
B(1) Mill Creek	10	726

E. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Yearly Phosphorus Loading (g/m^2/yr)
Estimated loading for Union Lake	3.07
Vollenweider's "dangerous" or eutrophic loading	1.70
Vollenweider's "permissible" or oligotrophic loading	0.85

V. LITERATURE REVIEWED

U.S. Environmental Protection Agency. 1971. Inventory of Wastewater Treatment Facilities. Office of Media Programs, Office of Water Programs, Washington, D.C.

_____. 1975. National Eutrophication Survey Methods 1973-1976. Working Paper No. 175. Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, and Corvallis Environmental Research Laboratory, Corvallis, Oregon.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

VI. APPENDICES

APPENDIX A

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX B

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR NEW JERSEY 06/04/76

LAKE CODE 3422 UNION LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 564.6

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
3422A1	564.6	10.25	11.19	13.05	12.26	10.17	7.59	6.29	7.08	7.42	6.12	7.84	8.72	8.98
3422A2	499.9	9.06	9.88	11.55	10.85	9.00	6.74	5.58	6.26	6.57	5.41	6.94	7.70	7.95
3422B1	39.1	0.51	0.57	0.74	0.57	0.62	0.57	0.34	0.40	0.34	0.37	0.40	0.37	0.48
3422ZZ	25.4	0.31	0.37	0.48	0.37	0.40	0.34	0.23	0.25	0.22	0.24	0.26	0.24	0.31

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 564.6
SUM OF SUB-DRAINAGE AREAS = 564.4
TOTAL FLOW IN = 105.01
TOTAL FLOW OUT = 107.97

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
3422A1	7	73	9.231	21	7.362				
	8	73	5.097	12	4.701				
	9	73	5.069	16	7.532				
	10	73	4.332	18	3.653				
	11	73	5.040	10	5.465				
	12	73	10.052	8	4.304				
	1	74	11.638	12	14.045				
	2	74	8.750	10	8.467	26	8.467		
	3	74	10.052	10	8.750	22	14.215		
	4	74	13.281	21	11.044				
	5	74	8.891	13	10.392				
	6	74	6.230	22	5.465				
3422A2	7	73	8.184	21	6.541				
	8	73	4.531	12	4.163				
	9	73	4.502	16	6.683				
	10	73	3.851	18	3.228				
	11	73	4.446	10	4.842				
	12	73	8.891	8	3.823				
	1	74	10.307	12	12.431				
	2	74	7.730	10	7.504	26	7.504		
	3	74	8.891	10	7.730	22	12.573		
	4	74	11.751	21	9.769				
	5	74	7.872	13	9.203				
	6	74	5.522	22	4.842				

TRIBUTARY FLOW INFORMATION FOR NEW JERSEY 06/04/76

LAKE CODE 3422 UNION LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
3422B1	7	73	0.510	21	0.340				
	8	73	0.278	12	0.278				
	9	73	0.229	16	0.340				
	10	73	0.263	18	0.181				
	11	73	0.255	10	0.263				
	12	73	0.425	8	0.249				
	1	74	0.595	12	1.133				
	2	74	0.453	10	0.425	26	0.396		
	3	74	0.566	10	0.396	22	1.104		
	4	74	0.623	21	0.368				
	5	74	0.538	13	0.566				
	6	74	0.453	22	0.283				
3422ZZ	7	73	0.340	21	0.227				
	8	73	0.181	12	0.181				
	9	73	0.150	16	0.227				
	10	73	0.170	18	0.116				
	11	73	0.164	10	0.173				
	12	73	0.272	8	0.161				
	1	74	0.368	12	0.736				
	2	74	0.283	10	0.272	26	0.252		
	3	74	0.368	10	0.252	22	0.708		
	4	74	0.396	21	0.244				
	5	74	0.340	13	0.368				
	6	74	0.283	22	0.190				

APPENDIX C

PHYSICAL AND CHEMICAL DATA

STORET RETRIEVAL DATE 76/06/04

342201
39 24 17.0 075 03 23.0 3
UNION LAKE
34011 NEW JERSEY
020891

11EPALES 2111202
0016 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/04/16	10 35	0000	11.3		37	80	6.90	10K	0.130	0.400	1.200	0.026
	10 35	0004	11.3	9.9		80	6.80	10K	0.130	0.400	1.300	0.015
	10 35	0013	11.2	10.2		78	6.80	10K	0.130	0.400	1.300	0.015
73/07/20	10 30	0000	26.1		35	84	7.20	10K	0.160	1.000	0.930	0.023
	10 30	0005	24.7	6.6		84	6.70	10K	0.210	0.600	0.940	0.020
	10 30	0013	22.1	2.2		80	6.10	10K	0.340	0.800	0.780	0.019
73/09/28	17 15	0000	21.0	10.0	40	100K	8.20	13	0.090	1.400	0.900	0.029
	17 15	0010	20.2	9.0		100K	7.90	11	0.060	0.800	0.870	0.024
	17 15	0015	19.9	8.0		100K	7.40	11	0.090	0.700	0.850	0.020

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/04/16	10 35	0000	0.035	2.5
	10 35	0004	0.027	
	10 35	0013	0.026	
73/07/20	10 30	0000	0.064	17.3
	10 30	0005	0.058	
	10 30	0013	0.075	
73/09/28	17 15	0000	0.075	26.5
	17 15	0010	0.067	
	17 15	0015	0.069	

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/06/04

342202
39 24 54.0 075 03 47.0 3
UNION LAKE
34011 NEW JERSEY
020891

11EPALES 2111202
0012 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/04/16	11 15	0000	12.1		40	78	6.80	10K	0.130	0.400	1.300	0.013
	11 15	0004	12.0	9.9		78	6.70	10K	0.130	0.400	1.300	0.016
	11 15	0010	12.0	10.2		78	6.70	10K	0.130	0.400	1.300	0.014
73/07/20	10 55	0000	26.8		32	86	8.30	10K	0.080	1.200	0.790	0.016
	10 55	0005	26.7	9.2		86	7.20	10K	0.120	0.900	0.860	0.018
	10 55	0010	26.7	5.2		86	6.30	10K	0.220	0.800	1.200	0.018

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/04/16	11 15	0000	0.034	3.0
	11 15	0004	0.026	
	11 15	0010	0.029	
73/07/20	10 55	0000	0.064	61.1
	10 55	0005	0.063	
	10 55	0010	0.083	

K VALUE KNOWN TO BE
LESS THAN INDICATED

APPENDIX D

TRIBUTARY DATA

STORET RETRIEVAL DATE 76/06/04

3422A1
39 24 00.0 075 03 15.0 4
MAURICE RIVE
34 7.5 MILLVILLE
O/UNION LAKE 020891
HARP ST BRDG BELO DAM
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/07/21	09	10	0.830	1.050	0.056	0.017	0.055
73/08/12	10	00	0.010K	1.470	0.035	0.022	0.140
73/09/16	11	25	0.800	1.400	0.790	0.011	0.055
73/10/18	10	45	0.960	1.050	0.067	0.015	0.050
73/11/10	14	30	1.640	0.500	0.066	0.011	0.020
73/12/08	10	30	2.000	1.100	0.405	0.016	0.045
74/01/12	13	00	1.200	0.600	0.132	0.008	0.025
74/02/10	13	30	2.000	0.700	0.175	0.010	0.020
74/03/10	11	00	2.100	0.700	0.105	0.010	0.025
74/03/22	11	30	1.800	0.600	0.110	0.010	0.025
74/04/21	14	15	0.900	0.800	0.095	0.032	0.045
74/05/13	14	00	1.100	0.600	0.050	0.015	0.045
74/06/22	10	35	1.180	0.700	0.145	0.005	0.030

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/06/04

3422A2
39 26 55.0 075 04 20.0 4
MAURICE RIVE
34 7.5 MILLVILLE
I/UNION LAKE 020891
ST HWY 552 BRDG 0.4 MI W OF ST HWY 55JCT
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/07/21	08	20	1.700	1.320	0.357	0.033	0.085
73/08/12	08	35	1.740	1.000	0.480	0.022	0.025
73/09/16	11	00	0.990	1.400	0.590	0.018	0.077
73/10/18	09	00	1.780	0.900	0.350	0.015	0.030
73/11/10	13	45	1.600	1.100	0.340	0.016	0.030
73/12/08	11	25	1.300	0.400	0.100	0.016	0.040
74/01/12	12	30	1.600	0.800	0.208	0.012	0.030
74/02/10	12	30	2.300	1.100	0.550	0.020	0.025
74/02/26	10	30	2.300	1.100	0.430	0.020	0.040
74/03/10	10	30	2.100	0.600	0.125	0.010	0.025
74/03/22	10	45	1.440	0.600	0.090	0.010	0.045
74/04/21	13	30	1.520	1.100	0.490	0.015	0.040
74/05/13	13	30	1.200	0.900	0.158	0.015	0.045
74/06/22	10	10	1.430	0.800	0.280	0.015	0.050

STORET RETRIEVAL DATE 76/06/04

3422B1
39 25 32.0 075 05 11.0 4
MILL CREEK
34 7.5 MILLVILLE
T/UNION LAKE 020891
DIRT RD XING 0.8 MI N OF UKRANIAN CHURCH
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
73/07/21	08 45		1.320	0.560	0.075	0.019	0.030
73/08/12	09 15		1.560	0.520	0.052	0.026	0.050
73/09/16	11 15		0.920	1.260	0.200	0.019	0.045
73/10/18	09 25		1.600	0.550	0.023	0.011	0.015
73/11/10	14 00		1.060	0.350	0.066	0.009	0.035
73/12/08	11 00		1.400	0.600	0.040	0.008	0.020
74/01/12	10 15		0.890	0.600	0.032	0.008	0.020
74/02/10	13 00		0.276	0.700	0.045	0.005	0.005
74/02/26	10 45		1.500	1.400	0.115		0.010
74/03/10	10 45		1.440	1.200	0.070	0.005K	0.020
74/03/22	11 15		0.860	0.700	0.050	0.010	0.025
74/04/21	13 45		1.180	0.500	0.030	0.010	0.025
74/05/13	15 45		1.180	0.700	0.055	0.015	0.030
74/06/22	10 25		1.400	0.500	0.050	0.010	0.040

K VALUE KNOWN TO BE
LESS THAN INDICATED

APPENDIX E

PARAMETRIC RANKINGS OF LAKES SAMPLED BY NES IN 1973

STATE OF NEW JERSEY

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
3402	BUDD LAKE	0.082	0.205	474.000	48.500	7.400	0.012
3403	GREENWOOD LAKE	0.021	0.100	414.250	11.920	14.800	0.007
3406	ORADELL RESERVOIR	0.055	0.990	462.500	22.267	13.600	0.008
3409	PINECLIFF LAKE	0.070	0.175	465.500	38.960	11.000	0.011
3410	POMPTON LAKES	0.071	0.795	463.167	23.033	11.800	0.029
3412	DUHERNAL LAKE	0.082	1.420	466.667	6.800	8.600	0.010
3413	FARRINGTON LAKE	0.055	0.770	462.000	8.283	14.400	0.012
3415	LAKE HOPATCONG	0.022	0.120	416.333	13.627	14.900	0.007
3417	LAKE MUSCONETCONG	0.036	0.140	436.000	11.067	6.000	0.010
3419	PAULINS KILL LAKE	0.133	0.950	460.500	7.017	9.000	0.065
3420	SPRUCE RUN RESERVOIR	0.020	0.470	428.667	15.333	15.000	0.007
3422	UNION LAKE	0.063	1.150	463.200	22.080	12.800	0.018
3423	WANAQUE RESERVOIR	0.014	0.120	355.333	7.111	14.800	0.005

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NO
3402	BUDD LAKE	12 (1)	58 (7)	0 (0)	0 (0)	92 (11)	29 (3)	191
3403	GREENWOOD LAKE	83 (10)	100 (12)	92 (11)	58 (7)	21 (2)	83 (9)	437
3406	ORADELL RESERVOIR	54 (6)	17 (2)	42 (5)	25 (3)	42 (5)	67 (8)	247
3409	PINECLIFF LAKE	33 (4)	67 (8)	17 (2)	8 (1)	67 (8)	42 (5)	234
3410	POMPTON LAKES	25 (3)	33 (4)	33 (4)	17 (2)	58 (7)	8 (1)	174
3412	DUHERNAL LAKE	12 (1)	0 (0)	8 (1)	100 (12)	83 (10)	58 (7)	261
3413	FARRINGTON LAKE	54 (6)	42 (5)	50 (6)	75 (9)	33 (4)	29 (3)	283
3415	LAKE HOPATCONG	75 (9)	87 (10)	83 (10)	50 (6)	8 (1)	83 (9)	386
3417	LAKE MUSCONETCONG	67 (8)	75 (9)	67 (8)	67 (8)	100 (12)	50 (6)	426
3419	PAULINS KILL LAKE	0 (0)	25 (3)	58 (7)	92 (11)	75 (9)	0 (0)	250
3420	SPRUCE RUN RESERVOIR	92 (11)	50 (6)	75 (9)	42 (5)	0 (0)	83 (9)	342
3422	UNION LAKE	42 (5)	8 (1)	25 (3)	33 (4)	50 (6)	17 (2)	175
3423	WANAQUE RESERVOIR	100 (12)	87 (10)	100 (12)	83 (10)	21 (2)	100 (12)	491

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	3423	WANAQUE RESERVOIR	491
2	3403	GREENWOOD LAKE	437
3	3417	LAKE MUSCONETCONG	426
4	3415	LAKE HOPATCONG	386
5	3420	SPRUCE RUN RESERVOIR	342
6	3413	FARRINGTON LAKE	283
7	3412	DUHERNAL LAKE	261
8	3419	PAULINS KILL LAKE	250
9	3406	ORADELL RESERVOIR	247
10	3409	PINECLIFF LAKE	234
11	3402	BUDD LAKE	191
12	3422	UNION LAKE	175
13	3410	POMPTON LAKES	174