U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

REPORT

ON

PAULINSKILL LAKE

SUSSEX COUNTY

NEW JERSEY

EPA REGION II

WORKING PAPER No. 371

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

☆G.P.O. 699-440

REPORT

ON

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WORKING PAPER No. 371

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.

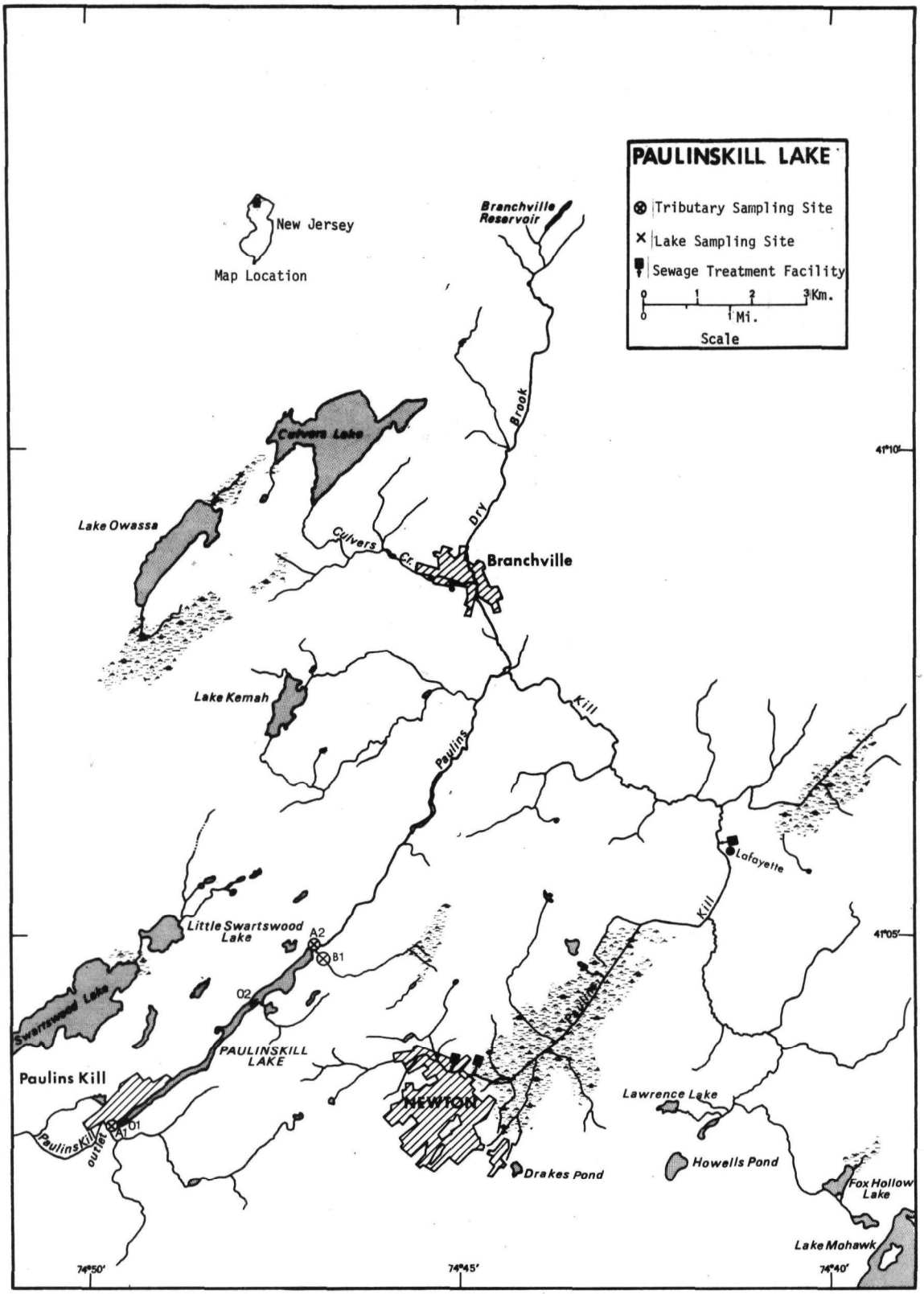
Major General William R. Sharp, Former Chief of Staff, Major General Wilfred G. Menard, Jr., Chief of Staff, and Project Officer Colonel Herbert D. Ruhlin, who directed the volunteer efforts of the New Jersey National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

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


PAULINSKILL LAKE
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
0 1 2 3 Km.
0 1 Mi.
Scale
New Jersey
Map Location
Branchville Reservoir
Culvers Lake
Lake Owassa
Culvers Cr.
Dry Brook
Branchville
Lake Kemah
Paulins Kill
Lafayette
Little Swartswood Lake
A2
B1
O2
Swartswood Lake
PAULINSKILL LAKE
Paulins Kill
Paulinskill outlet
O1
NEWTON
Drakes Pond
Lawrence Lake
Howells Pond
Fox Hollow Lake
Lake Mohawk
41°10'
41°05'
74°50'
74°45'
74°40'

PAULINSKILL LAKE, NEW JERSEY

STORET NO. 3419

I. CONCLUSIONS

A. Trophic Condition:

Paulinskill Lake is classified as eutrophic on the basis of Survey data. Survey limnologists observed mats of floating aquatic vegetation, but no visible algal blooms in the grey-green lake. Potential for primary productivity as measured by algal assay control yield and phosphorus levels were high, while Secchi disc visibility was moderately low. Chlorophyll a values ranged from 3.1 µg/l in the spring to a high of 21.6 µg/l in the fall.

Kettelle and Uttormark (1971) reported dense algal growths and aquatic weeds in Paulinskill Lake. The lake was drained in 1944, and weed growth was successfully curtailed.

B. Rate-Limiting Nutrient:

Algal assay results indicate that Paulinskill Lake was limited by available nitrogen. Spikes with nitrogen or nitrogen and phosphorus simultaneously resulted in increased assay yields. Additions of phosphorus alone did not stimulate a growth response.

The mean total inorganic nitrogen to mean orthophosphorus ratios (N/P) substantiate these results.

C. Nutrient Controllability:

1. Point Sources -

Point sources contributed 47.3% of the total phosphorus loading to Paulinskill Lake. The city of Newton wastewater treatment plant contributed 45.2% of the total load. The loading of 18.17 $g/m^2/yr$ is 7.3 times higher than the "dangerous" level proposed by Vollenweider (Vollenweider and Dillon, 1974). However, Vollenweider's model may not be applicable to lakes with short retention times. Paulinskill Lake is nitrogen limited as a result of a super-abundance of available phosphorus, rather than a nitrogen deficit. Removal of phosphorus from all known point sources should result in a persistent state of phosphorus limitation and slow the rate of eutrophication.

2. Non-point Sources -

The total phosphorus load from non-point sources accounted for 52.7% of the load reaching Paulinskill Lake. Major tributaries contributed 50.4%, while minor tributaries contributed 2.1% of the load.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

Lake and drainage basin characteristics are itemized below. 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. Tributary 3419B(1) is included in drainage area and discharge figures for Station 3419A(2). Available chemistry for B(1) was used, however, in calculating loading for the minor tributaries ("ZZ"), since tributary A(2) was impacted by point sources upstream of the B(1) sampling site. Precipitation values are estimated by methods as outlined in National Eutrophication Survey (NES) Working Paper No. 174. A table of metric/English conversions is included as Appendix A.

A. Lake Morphometry:

1. Surface area: 0.64 km^2.
2. Mean depth: 1.8 meters.
3. Maximum depth: 4.3 meters.
4. Volume: 1.152×10^6 m^3.
5. Mean hydraulic retention time: 4 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) Paulinskill River	179.0	2.87
Minor tributaries and immediate drainage -	9.2	0.16
Totals	188.2	3.03
2. Outlet - A(1) Paulinskill R.	188.8	3.03

C. Precipitation:

1. Year of sampling: 139.8 cm.

2. Mean annual: 106.9 cm.

III. LAKE WATER QUALITY SUMMARY

Paulinskill Lake was sampled three times during the open-water season of 1973 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the lake and from a number of depths at each station (see map, page v). During each visit, samples were collected from one or more depths at 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 2.1 meters at Station 1 and 0.9 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.

PAULINS KILL LAKE
STORET CODE 3419

PHYSICAL AND CHEMICAL CHARACTERISTICS

PARAMETER	(4/17/73) S*** = 2 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)	(7/22/73) S*** = 2 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)	(10/ 2/73) S*** = 2 N*	RANGE	MEDIAN	MAX DEPTH RANGE (METERS)
TEMPERATURE (DEG CENT)												
0.-1.5 M DEPTH	2	13.5- 13.8	13.6	0.0- 0.0	3	21.5- 22.5	21.5	0.0- 0.9	2	16.0- 18.6	17.3	0.0- 0.0
MAX DEPTH**	2	12.8- 13.5	13.1	0.0- 1.8	2	21.2- 21.5	21.3	0.9- 2.1	2	16.0- 18.3	17.1	0.0- 1.8
DISSOLVED OXYGEN (MG/L)												
0.-1.5 M DEPTH	1	10.7- 10.7	10.7	0.0- 0.0	1	8.0- 8.0	8.0	0.0- 0.0	1	8.2- 8.2	8.2	0.0- 0.0
MAX DEPTH**	2	9.6- 10.7	10.1	0.0- 1.8	1	6.0- 6.0	6.0	2.1- 2.1	2	8.2- 13.4	10.8	0.0- 1.8
CONDUCTIVITY (UMHOS)												
0.-1.5 M DEPTH	2	370.- 375.	373.	0.0- 0.0	3	243.- 301.	243.	0.0- 0.9	2	725.- 775.	750.	0.0- 0.0
MAX DEPTH**	2	360.- 370.	365.	0.0- 1.8	2	243.- 294.	269.	0.9- 2.1	2	750.- 775.	763.	0.0- 1.8
PH (STANDARD UNITS)												
0.-1.5 M DEPTH	2	7.8- 8.0	7.9	0.0- 0.0	2	7.4- 7.4	7.4	0.0- 0.0	2	7.9- 9.0	8.4	0.0- 0.0
MAX DEPTH**	2	7.8- 7.8	7.8	0.0- 1.8	1	7.3- 7.3	7.3	2.1- 2.1	2	7.9- 8.5	8.2	0.0- 1.8
TOTAL ALKALINITY (MG/L)												
0.-1.5 M DEPTH	2	93.- 96.	95.	0.0- 0.0	2	78.- 109.	94.	0.0- 0.0	2	114.- 119.	117.	0.0- 0.0
MAX DEPTH**	2	94.- 96.	95.	0.0- 1.8	1	103.- 103.	103.	2.1- 2.1	2	113.- 119.	116.	0.0- 1.8
TOTAL P (MG/L)												
0.-1.5 M DEPTH	2	0.100-0.141	0.120	0.0- 0.0	2	0.120-0.137	0.128	0.0- 0.0	2	0.187-0.325	0.256	0.0- 0.0
MAX DEPTH**	2	0.089-0.141	0.115	0.0- 1.8	1	0.133-0.133	0.133	2.1- 2.1	2	0.112-0.187	0.149	0.0- 1.8
DISSOLVED ORTHO P (MG/L)												
0.-1.5 M DEPTH	2	0.057-0.099	0.078	0.0- 0.0	2	0.065-0.082	0.073	0.0- 0.0	2	0.029-0.135	0.082	0.0- 0.0
MAX DEPTH**	2	0.055-0.099	0.077	0.0- 1.8	1	0.071-0.071	0.071	2.1- 2.1	2	0.026-0.135	0.080	0.0- 1.8
NO2+NO3 (MG/L)												
0.-1.5 M DEPTH	2	0.920-1.000	0.960	0.0- 0.0	2	0.500-0.860	0.680	0.0- 0.0	2	0.170-0.820	0.495	0.0- 0.0
MAX DEPTH**	2	0.870-1.000	0.935	0.0- 1.8	1	0.880-0.880	0.880	2.1- 2.1	2	0.220-0.820	0.520	0.0- 1.8
AMMONIA (MG/L)												
0.-1.5 M DEPTH	2	0.080-0.100	0.090	0.0- 0.0	2	0.110-0.150	0.130	0.0- 0.0	2	0.040-0.090	0.065	0.0- 0.0
MAX DEPTH**	2	0.080-0.100	0.090	0.0- 1.8	1	0.160-0.160	0.160	2.1- 2.1	2	0.050-0.090	0.070	0.0- 1.8
KJELDAHL N (MG/L)												
0.-1.5 M DEPTH	2	0.300-0.400	0.350	0.0- 0.0	2	0.800-1.000	0.900	0.0- 0.0	2	0.400-2.200	1.300	0.0- 0.0
MAX DEPTH**	2	0.200-0.300	0.250	0.0- 1.8	1	0.700-0.700	0.700	2.1- 2.1	2	0.400-0.600	0.500	0.0- 1.8
SECCHI DISC (METERS)												
	2	0.9- 1.0	1.0		2	0.6- 0.8	0.7		2	1.0- 1.8	1.4	

* 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
04/18/73	1.	Navicula	610
	2.	Flagellates	557
	3.	Stephanodiscus	478
	4.	Cyclotella	133
	5.	Melosira	107
		Other genera	742
		Total	2,627
07/22/73	1.	Flagellates	1,013
	2.	Cyclotella	220
	3.	Stephanodiscus	176
	4.	Synedra	154
	5.	Nitzschia	154
		Other genera	639
		Total	2,356
10/02/73	1.	Flagellates	5,840
	2.	Stephanodiscus	531
	3.	Cyclotella	190
	4.	Fragilaria	190
	5.	Scenedesmus	190
		Other genera	454
		Total	7,395

2. Chlorophyll *a* -

Sampling Date	Station Number	Chlorophyll *a* (µg/liter)
04/17/73	1	4.8
	2	3.1
07/22/73	1	4.8
	2	4.0
10/02/73	1	21.6
	2	3.8

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	0.065	0.676	16.0
0.05 P	0.115	0.676	16.9
0.05 P + 1.0 N	0.115	1.676	33.3
1.00 N	0.065	1.676	21.2

2. Discussion -

The control yield of the assay alga, *Selenastrum capricornutum*, indicates that the potential for primary productivity was very high in Paulinskill Lake at the time of sampling. The lake was nitrogen limited at that time as indicated by the increased yield of the assay alga in response to an addition of nitrogen. Spikes with phosphorus and nitrogen simultaneously resulted in a maximum yield.

The mean total N/P ratios of 13/1 in the spring lake samples, 12/1 in the summer, and 7/1 in the fall further suggest nitrogen limitation in Paulinskill Lake.

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 month of February 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 USGS for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a 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 Unnamed Stream at Station B(1) and mean annual ZZ flow.

The operators of the Schering Laboratory (Lafayette), and Newton wastewater treatment plants provided monthly effluent samples and corresponding flow data. Nutrient loads for the Big N Shopping Center (Sparta) 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
Schering Laboratory (Lafayette)	58	1.	0.060	Paulinskill River
The Big N Shopping Center (Sparta)	150	2.	0.057**	Paulinskill River
Newton	8,000	3.	3.888	Morris Brook/ Paulinskill River

Key: 1. Stabilization pond
2. Secondary
3. Trickling filter

*Treatment plant questionnaires.
**Estimated at 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) Paulinskill River	5,865	50.4
b.	Minor tributaries and immediate drainage (nonpoint load) -	250	2.1
c.	Known municipal STP's -		
	Schering Lab (Lafayette)	70	0.6
	The Big N Shopping Center (Sparta)	170	1.5
	Newton	5,255	45.2
d.	Septic tanks* -	10	0.1
e.	Known industrial - None		
f.	Direct precipitation -	10	0.1
	Total	11,630	100.0

2. Outputs - A(1) Paulinskill River 9,750

3. Net annual P accumulation 1,880

*Estimate based on 39 lakeside residences.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source		kg N/yr	% of total
a.	Tributaries (nonpoint load)		
	A(2) Paulinskill River	183,825	84.8
b.	Minor tributaries and immediate drainage (nonpoint load) -	8,015	3.7
c.	Known municipal STP's -		
	Schering Lab (Lafayette)	760	0.4
	The Big N Shopping Center (Sparta)	510	0.2
	Newton	22,600	10.4
d.	Septic tanks* -	415	0.2
e.	Known industrial - None		
f.	Direct precipitation -	690	0.3
	Total	216,815	100.0

2. Outputs - A(1) Paulinskill River 190,695

3. Net annual N accumulation 26,120

*Estimate based on 39 lakeside residences.

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

Tributary	kg P/km^2/yr	kg N/km^2/yr
A(2) Paulinskill River	33	1,027

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 Paulinskill Lake	18.17
Vollenweider's "dangerous" or eutrophic loading	2.54
Vollenweider's "permissible" or oligotrophic loading	1.27

V. LITERATURE REVIEWED

Ketelle, M. J. and P. D. Uttormark. 1971. Problem Lakes in the United States. U.S. Environmental Protection Agency Project #16010 EHR. University of Wisconsin, Madison, Wisconsin.

U.S. Environmental Protection Agency. 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 3419 PAULINS KILL LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 188.8

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
3419A1	188.8	3.34	3.85	6.12	5.27	3.23	2.18	1.81	1.81	1.76	1.53	2.55	2.94	3.03
3419A2	179.0	3.14	3.65	5.78	4.98	3.06	2.07	1.73	1.73	1.67	1.44	2.41	2.80	2.87
3419B1	4.6	0.045	0.051	0.082	0.071	0.042	0.028	0.024	0.025	0.024	0.021	0.034	0.040	0.041
3419ZZ	9.8	0.176	0.201	0.311	0.278	0.170	0.113	0.093	0.096	0.093	0.079	0.133	0.156	0.158

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 188.8
SUM OF SUB-DRAINAGE AREAS = 193.4
TOTAL FLOW IN = 36.85
TOTAL FLOW OUT = 36.39

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
3419A1	7	73	4.191	21	6.626				
	8	73	2.039	19	1.699				
	9	73	1.161	23	1.529				
	10	73	1.161	14	0.765				
	11	73	1.529	11	1.218				
	12	73	9.628	8	3.851				
	1	74	5.947	6	5.154				
	2	74	4.587	3	5.918	17	2.803		
	3	74	5.663	29	4.870				
	4	74	8.608	27	4.191				
	5	74	3.993						
	6	74	1.784						
3419A2	7	73	3.964	21	6.286				
	8	73	1.926	19	1.614				
	9	73	1.104	23	1.472				
	10	73	1.104	14	0.736				
	11	73	1.444	11	1.161				
	12	73	9.118	8	3.653				
	1	74	5.635	6	4.899				
	2	74	4.332	3	5.607	17	2.662		
	3	74	5.352	29	4.616				
	4	74	8.155	27	3.964				
	5	74	3.794						
	6	74	1.699						

TRIBUTARY FLOW INFORMATION FOR NEW JERSEY 06/04/76

LAKE CODE 3419 PAULINS KILL LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
3419B1	7	73	0.057	21	0.091				
	8	73	0.027	19	0.023				
	9	73	0.016	23	0.021				
	10	73	0.016	14	0.010				
	11	73	0.021	11	0.016				
	12	73	0.130	8	0.051				
	1	74	0.079	6	0.071				
	2	74	0.062	3	0.079	17	0.037		
	3	74	0.076	29	0.065				
	4	74	0.116	27	0.057				
	5	74	0.054						
	6	74	0.024						
3419ZZ	7	73	0.221	21	0.340				
	8	73	0.108	19	0.091				
	9	73	0.059	23	0.079				
	10	73	0.062	14	0.040				
	11	73	0.079	11	0.062				
	12	73	0.510	8	0.201				
	1	74	0.311	6	0.272				
	2	74	0.241	3	0.311	17	0.147		
	3	74	0.283	29	0.255				
	4	74	0.453	27	0.218				
	5	74	0.210						
	6	74	0.093						

APPENDIX C

PHYSICAL AND CHEMICAL DATA

STORET RETRIEVAL DATE 76/06/04

341901
41 03 12.0 074 49 28.0 3
PAULINS KILL LAKE
34037 NEW JERSEY
020391

11EPALES 2111202
0010 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
73/04/17	15 30	0000	13.8		40	375	8.00	93	0.080	0.400	0.920	0.057
	15 30	0006	12.8	9.6		360	7.80	94	0.080	0.200	0.870	0.055
73/07/22	15 45	0000	22.5		30	301	7.40	109	0.150	0.800	0.860	0.082
	15 45	0007	21.2	6.0		294	7.30	103	0.160	0.700	0.880	0.071
73/10/02	15 50	0000	18.6		38	725	9.00	114	0.040	2.200	0.170	0.029
	15 50	0006	18.3	13.4		750	8.50	113	0.050	0.600	0.220	0.026

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/04/17	15 30	0000	0.100	4.8
	15 30	0006	0.089	
73/07/22	15 45	0000	0.137	4.8
	15 45	0007	0.133	
73/10/02	15 50	0000	0.325	21.6
	15 50	0006	0.112	

STORET RETRIEVAL DATE 76/06/04

341902
41 04 26.0 074 47 44.0 3
PAULINS KILL LAKE
34037 NEW JERSEY
020391

11EPALES 2111202
0006 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 N02&N03 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
73/04/17	15 50	0000	13.5	10.7	36	370	7.80	96	0.100	0.300	1.000	0.099
73/07/22	15 30	0000	21.5	8.0	24	243	7.40	78	0.110	1.000	0.500	0.065
	15 30	0003	21.5			243						
73/10/02	15 40	0000	16.0	8.2	69	775	7.90	119	0.090	0.400	0.820	0.135

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/04/17	15 50	0000	0.141	3.1
73/07/22	15 30	0000	0.120	4.0
73/10/02	15 40	0000	0.187	3.8

APPENDIX D

TRIBUTARY AND WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 76/06/04

3419A1
41 03 10.0 074 49 40.0 4
PAULINS KILL
34 SUSSEX CO HWY MA
0/PAULINS KILL LAKE 020391
CO HWY 43 BRDG JUST BELO OUTLET
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	20	0.470	2.000	0.750	0.017	0.080
73/08/19	12	10	0.560	2.200	0.096	0.087	0.145
73/09/23	10	15	0.360	1.320	0.086	0.054	0.145
73/10/14	10	40	0.500	1.550	0.140	0.077	0.140
73/11/11	09	10	1.260	1.200	0.189	0.085	0.155
73/12/08	09	50	0.990	1.100	0.088	0.088	0.145
74/01/06	08	50	1.200	0.500	0.072	0.032	0.045
74/02/03	09	10	0.216	0.800	0.070	0.025	0.040
74/02/17	12	20	1.500	0.600	0.082	0.052	0.075
74/04/27	08	50	0.710	0.800	0.015	0.030	0.045

STORET RETRIEVAL DATE 76/06/04

3419A2
41 05 00.0 074 46 50.0 4
PAULINS KILL
34 SUSSEX CO HWY MA
I/PAULINS KILL LAKE 020391
2NDRY RD BRDG NE TIP OF LAKE
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 50		1.100	2.300	0.725	0.102	0.170
73/08/19	12 25		1.600	1.320	0.126	0.147	0.185
73/09/23	10 20		1.120	1.380	0.430	0.110	0.145
73/10/14	09 40		0.850	0.950	0.160	0.140	0.160
73/11/11	08 40		1.430	0.700	0.115	0.132	0.190
73/12/08	10 10		1.260	0.800	0.084	0.072	0.100
74/01/06	08 40		1.300	0.500	0.092	0.032	0.050
74/02/03	09 00		1.230	0.400	0.075	0.035	0.050
74/02/17	12 10		1.600	0.600	0.105	0.050	0.075
74/03/29	08 40		0.710	1.800	0.080	0.055	0.130

STORET RETRIEVAL DATE 76/06/04

341981
41 04 45.0 074 46 40.0 4
UNNAMED STREAM
34 SUSSEX CO HWY MA
T/PAULINS KILL LAKE 020391
2NDRY RD BRDG NEAR NE TIP OF LAKE
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 45		0.230	2.600	0.810	0.023	0.080
73/08/19	12 20		0.430	2.300	0.590	0.036	0.075
73/09/23	09 40		0.378	1.470	0.231	0.019	0.055
73/10/14	09 50		0.270	2.300	0.565	0.014	0.045
73/11/11	08 50		0.300	0.750	0.072	0.012	0.075
73/12/08	10 00		0.224	1.000	0.040	0.008	0.065
74/01/06	08 45		0.352	0.200	0.024	0.008	0.010
74/02/03	09 30		0.340	0.400	0.035	0.020	0.025
74/02/17	12 00		0.460	0.700	0.025	0.010	0.035
74/04/27	08 50		0.276	0.900	0.015	0.005	0.035

STORET RETRIEVAL DATE 76/06/04

3419AA P03419AA P000058*
41 05 55.0 074 41 45.0 4
SCHERING LAB (LAFAYETTE)
34 7.5 NEWTON EAST
T/PAULINSKILL LAKE 020392
PAULINSKILL RIVER
11EPALES 2141204
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	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/07/23	11	00							
CP(T)-			36.000	3.990	0.340	1.900	2.100	0.017	0.015
73/07/23	16	00							
73/07/31	16	00	15.200	0.580	0.480	1.205	1.242	0.015	0.016
73/09/04	11	00							
CP(T)-			14.000	1.990	0.180	2.440		0.017	0.017
73/09/04	15	30							
73/10/02	08	00	11.800	52.000	0.270	2.800	10.800	0.019	0.016
73/11/06	09	30							
CP(T)-			18.000	17.000	0.120	1.700	2.000	0.021	0.017
73/11/06	15	30							
73/12/11	10	00							
CP(T)-			25.200	9.300	1.600	2.310	2.700	0.017	0.017
73/12/11	14	00							
74/01/09	09	00							
CP(T)-			14.000	24.000	1.300	4.000	4.100	0.018	0.016
74/01/09	14	00							
74/02/04	09	00							
CP(T)-			22.700	7.800	0.096	5.300	5.375	0.017	0.017
74/02/04	15	00							
74/03/07	08	30							
CP(T)-			29.000	24.000	8.200	1.700	1.750	0.017	0.016
74/03/07	14	30							
74/04/17	08	30							
CP(T)-			11.200	18.000	0.320	1.610	1.700	0.022	0.018
74/04/17	14	30							
74/05/07	08	30							
CP(T)-			14.300	5.100	0.083	0.840	0.960	0.008	0.010
74/05/07	15	30							
74/07/09	08	30							
CP(T)-			20.130	3.000	0.091	1.570	1.737	0.014	0.014
74/07/09	15	15							
74/08/23	09	00							
CP(T)-			18.400	23.000	17.000	1.500	1.650	0.015	0.017
74/08/23	15	00							

STORET RETRIEVAL DATE 76/06/04

3419AC TF3419AC P008000
41 44 47.0 074 03 34.0 4
NEWTON
34 7.5 NEWTON EAST
T/PAULINSKILL LAKE 013291
PAULINSKILL RIVER
11EPALES 2141204
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	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/09/10	11	00							
CP(T)-			13.000	16.750	8.950	5.800	8.100	0.800	0.800
73/09/10	16	00							
73/10/31	11	00							
CP(T)-			10.000	7.300	3.100	2.730	3.700	1.000	0.700
73/10/31	16	00							
73/11/30	11	00							
CP(T)-			9.900	10.000	4.400	3.300	4.100	0.814	0.750
73/11/30	16	00							
73/12/28	08	00							
CP(T)-			4.600	8.900	1.390	1.700	4.650	1.900	1.300
73/12/28	16	00							
74/01/31	11	00							
CP(T)-			4.100	4.900	1.600	1.280	3.200	1.400	1.100
74/01/31	16	00							
74/02/28	08	00							
CP(T)-			3.680	5.700	0.660	1.400	2.000	0.956	0.993
74/02/28	16	00							
74/03/31	15	00	3.520	3.000	0.230	1.200	1.450	1.810	1.700
74/04/30	08	00							
CP(T)-			10.400	8.000	3.300	3.750	4.600	0.901	1.310
74/04/30	11	00							
74/05/31	10	30	11.800	15.000	6.100	3.400	3.800	0.791	0.900
74/06/29	15	00	14.400	14.000	6.500	6.100	8.400	0.728	0.813
74/07/31	10	30	14.400	26.000		5.600	7.300	0.845	0.807
74/08/31	16	00	5.900	4.600	0.930	0.780	1.200	1.500	0.950
74/09/30	11	00	6.130	2.700	0.395	1.280	1.800	1.500	1.230

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