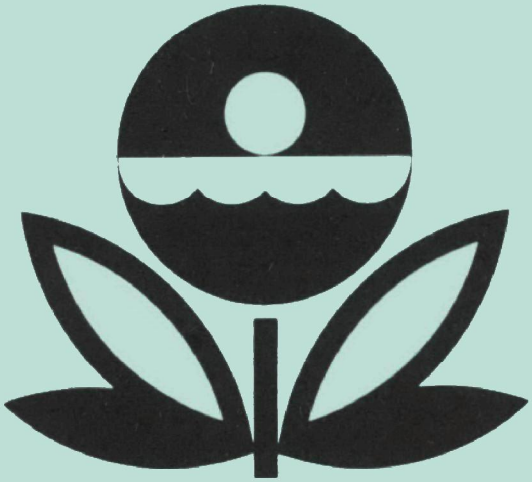
U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES



REPORT

ON

LAKE VANDALIA

FAYETTE COUNTY

ILLINOIS

EPA REGION V

WORKING PAPER No. 319

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

☆G.P.O. 699-440

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WITH THE COOPERATION OF THE

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

AND THE

ILLINOIS NATIONAL GUARD

JUNE, 1975

CONTENTS

	Page
Foreword	ii
List of Illinois Study Lakes	iv
Lake and Drainage Area Map	v
Sections	
I. Conclusions	1
II. Lake and Drainage Basin Characteristics	3
III. Lake Water Quality Summary	4
IV. Nutrient Loadings	9
V. Literature Reviewed	14
VI. Appendices	15

FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water 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 non-point 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 fresh water 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 EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

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

Dr. Richard H. Briceland, Director of the Illinois Environmental Protection Agency; and Ronald M. Barganz, State Survey Coordinator, and John J. Forneris, Manager of Region III, Field Operations Section of the Division of Water Pollution Control, 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.

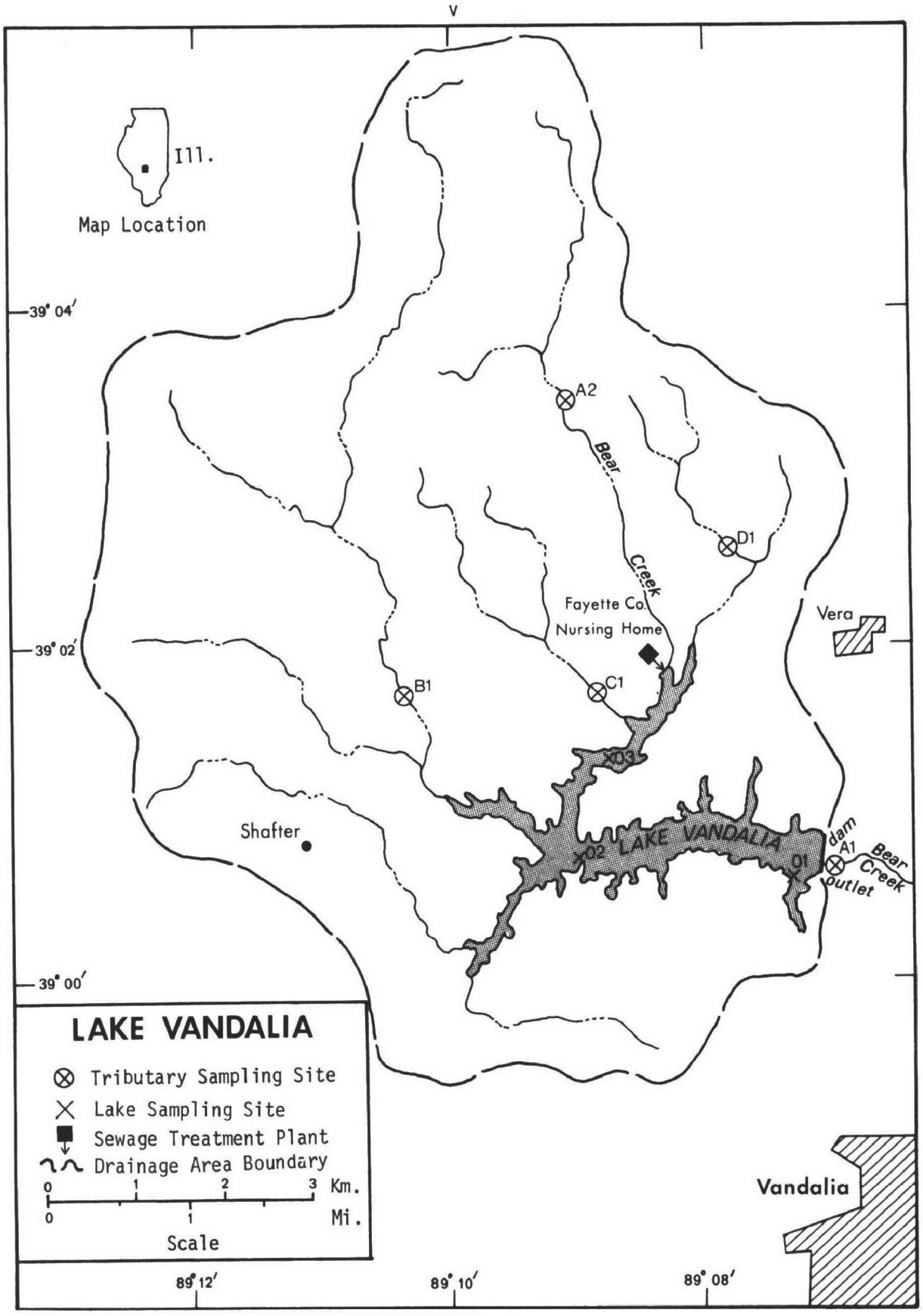
Major General Harold R. Patton, the Adjutant General of Illinois, and Project Officer Colonel Daniel L. Fane, who directed the volunteer efforts of the Illinois National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF ILLINOIS

LAKE NAME	COUNTY
Baldwin	Randolph
Bloomington	McLean
Carlyle	Bond, Clinton, Fayette
Cedar	Lake
Charleston	Coles
Coffeen	Montgomery
Crab Orchard	Jackson, Williamson
Decatur	Macon
DePue	Bureau
East Loon	Lake
Fox	Lake
Grass	Lake
Highland Silver	Madison
Holiday	LaSalle
Horseshoe	Madison
Long	Lake
Lou Yaeger	Montgomery
Marie	Lake
Old Ben Mine	Franklin
Pistakee	Lake, McHenry
Raccoon	Marion
Rend	Franklin, Jefferson
Sangchris	Christian
Shelbyville	Moultrie, Shelby
Slocum	Lake
Springfield	Sangamon
Storey	Knox
Vandalia	Fayette
Vermilion	Vermilion
Wee Ma Tuk	Fulton
Wonder	McHenry


Ill.
Map Location
39° 04′
39° 02′
39° 00′
89° 12′
89° 10′
89° 08′
A2
Bear Creek
D1
Fayette Co.
Nursing Home
Vera
B1
C1
Shafter
LAKE VANDALIA
dam
A1
Bear Creek
outlet
Vandalia
LAKE VANDALIA
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Plant
Drainage Area Boundary
0 1 2 3 Km.
0 1 Mi.
Scale

LAKE VANDALIA

STORET NO. 1764

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Lake Vandalia is eutrophic. Of the 31 Illinois water bodies sampled in 1973, Lake Vandalia ranked thirteenth in overall trophic quality based on an index of six parameters*. Sixteen of the lakes had less median total phosphorus, 12 had less median dissolved phosphorus, 12 had less median inorganic nitrogen, five had less mean chlorophyll a, and 12 had greater mean Secchi disc transparency. Marked depression of dissolved oxygen with depth occurred at sampling station 1 at all three sampling times and at station 2 in August, 1973.

Survey limnologists did not observe any nuisance conditions during their visits to the lake.

B. Rate-Limiting Nutrient:

The algal assay results indicate Lake Vandalia was phosphorus limited at the time the assay sample was collected (05/11/73). The lake data indicate phosphorus limitation at the other sampling times as well.

C. Nutrient Controllability:

1. Point sources--The Fayette County Nursing Home was the only known point source impacting Lake Vandalia during the sampling year

* See Appendix A.

and is estimated to have contributed 3.5% of the total phosphorus load.

The present phosphorus loading rate of 0.96 $g/m^2/yr$ (see page 13) is more than two times that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic rate. Therefore, all phosphorus inputs should be minimized to the greatest practicable extent.

2. Non-point sources--The gaged tributaries of Lake Vandalia contributed 44.9% of the total phosphorus loading. The minor tributaries and immediate drainage were estimated to have contributed 49.6% of the total load.

The phosphorus export rates of the tributaries (see page 13) are comparable to the rates of other unimpacted streams elsewhere in the Kaskaskia River drainage; e.g., the export rate of Blue Grass Creek (a tributary of nearby Lake Lou Yaeger*) was 39 kg/km^2 during the Survey sampling year.

* Working Paper No. 310.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Lake Morphometry††:

1. Surface area: 2.67 kilometers^2.
2. Mean depth: 16.2 meters.
3. Maximum depth: >16.2 meters.
4. Volume: 43.246 x 10^6 m^3.
5. Mean hydraulic retention time: 3.4 years.

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

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Bear Creek	9.2	0.1
Unnamed Creek (B-1)	13.3	0.1
Unnamed Creek (C-1)	4.4	<0.1
Unnamed Creek (D-1)	3.1	<0.1
Minor tributaries & immediate drainage -	30.2	0.2
Totals	60.2	0.4

2. Outlet -

Bear Creek	62.9**	0.4

C. Precipitation***:

1. Year of sampling: 130.3 centimeters.
2. Mean annual: 93.6 centimeters.

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† Table of metric conversions--Appendix B.
†† Forneris, 1973.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of lake.
*** See Working Paper No. 175.

III. LAKE WATER QUALITY SUMMARY

Lake Vandalia 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 three stations on the lake and from a number of depths at each station (see map, page v). During each visit, a single depth-integrated (4.6 m or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first visit, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 9.8 meters at station 1, 4.0 meters at station 2, and 1.2 meters at station 3.

The results obtained are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR LAKE VANDALIA
STORET CODE 1764

PARAMETER	1ST SAMPLING (5/11/73) 3 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (8/10/73) 3 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (10/18/73) 3 SITES RANGE	MEAN	MEDIAN
TEMP (C)	14.5 - 19.8	17.2	17.0	16.0 - 29.4	25.6	27.5	16.4 - 19.7	18.5	18.6
DISS OXY (MG/L)	2.1 - 9.5	6.8	7.6	0.0 - 7.2	3.7	4.6	0.2 - 9.8	6.5	7.8
CNDCTVY (MCROMO)	180. - 210.	191.	190.	162. - 188.	173.	172.	153. - 252.	170.	156.
PH (STAND UNITS)	7.4 - 7.6	7.6	7.6	6.8 - 8.5	7.6	7.5	7.0 - 8.4	7.7	7.6
TOT ALK (MG/L)	62. - 179.	90.	65.	56. - 94.	64.	60.	60. - 117.	70.	64.
TOT P (MG/L)	0.115 - 0.174	0.137	0.136	0.038 - 0.480	0.142	0.113	0.044 - 1.020	0.175	0.055
ORTHO P (MG/L)	0.022 - 0.039	0.032	0.033	0.005 - 0.064	0.022	0.018	0.017 - 0.075	0.028	0.023
NO2+NO3 (MG/L)	0.780 - 1.340	0.962	0.940	0.060 - 0.170	0.107	0.100	0.050 - 0.170	0.107	0.125
AMMONIA (MG/L)	0.080 - 0.150	0.104	0.100	0.070 - 1.590	0.376	0.110	0.050 - 3.310	0.506	0.095
KJEL N (MG/L)	0.600 - 1.000	0.711	0.700	0.800 - 3.000	1.411	1.200	0.800 - 5.200	1.525	1.050
INORG N (MG/L)	0.900 - 1.490	1.067	1.030	0.150 - 1.730	0.482	0.230	0.110 - 3.360	0.614	0.220
TOTAL N (MG/L)	1.540 - 2.040	1.673	1.620	0.880 - 3.140	1.518	1.270	0.860 - 5.250	1.632	1.165
CHLRPYL A (UG/L)	1.4 - 11.5	5.2	2.8	6.0 - 31.3	15.1	8.1	10.1 - 18.0	13.5	12.3
SECCHI (METERS)	0.3 - 0.4	0.3	0.3	0.3 - 0.9	0.6	0.7	0.6 - 0.9	0.7	0.6

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal units per ml
05/11/73	1. Trachelomonas sp.	133
	2. Cryptomonas sp.	133
	3. Dactylococcopsis sp.	133
	4. Flagellates	89
	5. Cyclotella sp.	44
	Other genera	44
	Total	576
08/10/73	1. Coelosphaerium sp.	712
	2. Blue-green filaments	269
	3. Melosira sp.	192
	4. Cyclotella sp.	135
	5. Merismopedia sp.	116
	Other genera	153
	Total	1,577
10/18/73	1. Microcystis sp.	974
	2. Coelosphaerium sp.	799
	3. Flagellates	174
	4. Schroederia sp.	145
	5. Cryptomonas sp.	131
	Other genera	568
	Total	2,791

2. Chlorophyll *a* -

Sampling Date	Station Number	Chlorophyll *a* (µg/l)
05/11/73	01	2.8
	02	1.4
	03	11.5
08/10/73	01	6.0
	02	8.1
	03	31.3
10/18/73	01	10.1
	02	12.3
	03	18.0

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	0.020	0.760	9.2
0.050 P	0.070	0.760	22.7
0.050 P + 1.0 N	0.070	1.760	37.3
1.0 N	0.020	1.760	9.4

2. Discussion -

The control yield of the assay alga, *Selenastrum capricornutum*, indicates that the potential primary productivity of Lake Vandalia was high at the time the assay sample was collected (05/11/73). The results also indicate that the lake was phosphorus limited at that time. Note the lack of a significant increase in yield with the addition of nitrogen only, but the addition of orthophosphorus alone or in combination with nitrogen resulted in a marked yield increase.

The lake data indicate phosphorus limitation at the other sampling times as well. The inorganic nitrogen to orthophosphorus ratio was 22 to 1 in August and in October, and phosphorus limitation would be expected.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Illinois 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 June, 1973, and was completed in May, 1974.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Illinois District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loads shown are those measured minus point-source loads, if any.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the means of the nutrient loads, in $kg/km^2/year$, at stations A-2, B-1, and C-1 and multiplying the means by the ZZ area in km^2.

The Fayette County Nursing Home did not participate in the Survey, and nutrient loads were estimated at 1.134 kg P and 3.401 kg N/capita/year.

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* See Working Paper No. 175.

A. Waste Sources:

1. Known domestic* -

Name	Pop. Served	Treatment	Mean Flow (m^3/d)	Receiving Water
Fayette Co. Nursing Home	80	ponds	30.3**	Bear Creek

2. Known industrial - None

* Barganz, 1975.
** 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 (non-point load) -		
Bear Creek	310	12.1
Unnamed Creek (B-1)	485	18.9
Unnamed Creek (C-1)	180	7.0
Unnamed Creek (D-1)	180	7.0
b. Minor tributaries & immediate drainage (non-point load) -	1,275	49.6
c. Known domestic STP's -		
Fayette Co. Nursing Home	90	3.5
d. Septic tanks* -	5	0.2
e. Known industrial - None	-	-
f. Direct precipitation** -	45	1.7
Total	2,570	100.0

2. Outputs -

Lake outlet - Bear Creek 2,260

3. Net annual P accumulation - 310 kg.

* Estimate based on 25 lakeshore dwellings; see Working Paper No. 175.
** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/ yr	% of total
a. Tributaries (non-point load) -		
Bear Creek	3,960	13.4
Unnamed Creek (B-1)	5,500	18.6
Unnamed Creek (C-1)	1,720	5.8
Unnamed Creek (D-1)	1,620	5.5
b. Minor tributaries & immediate drainage (non-point load) -	13,275	45.0
c. Known domestic STP's -		
Fayette Co. Nursing Home	270	0.9
d. Septic tanks* -	265	0.9
e. Known industrial - None	-	-
f. Direct precipitation** -	2,885	9.9
Total	29,495	100.0

2. Outputs -

Lake outlet - Bear Creek 27,555

3. Net annual N accumulation - 1,940 kg.

* Estimate based on 25 lakeshore dwellings; see Working Paper No. 175.
** See Working Paper No. 175.

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

Tributary	kg P/km²/yr	kg N/km²/yr
Bear Creek	34	430
Unnamed Creek (B-1)	36	414
Unnamed Creek (C-1)	41	391
Unnamed Creek (D-1)	58	523

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" rate is the rate at which the receiving water would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate 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 Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m²/yr	0.96	0.12	11.0	0.7

Vollenweider loading rates for phosphorus (g/m²/yr) based on mean depth and mean hydraulic retention time of Lake Vandalia:

"Dangerous" (eutrophic rate)	0.42
"Permissible" (oligotrophic rate)	0.21

V. LITERATURE REVIEWED

Barganz, Ronald M., 1975. Personal communication (point source impacting Lake Vandalia). IL Env. Prot. Agency, Springfield.

Forneris, John J., 1973. Personal communication (lake morphometry). IL Env. Prot. Agency, Springfield.

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

LAKE RANKINGS

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
1703	LAKE BLOOMINGTON	0.050	5.730	464.667	26.200	14.800	0.020
1706	LAKE CARLYLE	0.084	1.270	477.889	17.367	11.000	0.032
1708	LAKE CHARLESTON	0.160	4.680	490.667	12.000	8.400	0.065
1711	COFFEEN LAKE	0.032	0.260	456.222	7.700	14.900	0.012
1712	CRAB ORCHARD LAKE	0.082	0.200	482.222	59.867	13.800	0.013
1714	LAKE DECATUR	0.129	3.750	479.571	43.000	14.500	0.062
1725	LONG LAKE	0.704	1.190	482.667	49.333	8.800	0.398
1726	LAKE LOU YAEGER	0.186	1.600	489.583	10.662	11.400	0.076
1727	LAKE MARIE	0.098	0.370	467.667	39.533	14.700	0.057
1733	PISTAKEE LAKE	0.203	0.370	485.667	75.867	7.000	0.062
1735	REND LAKE	0.071	0.210	471.500	23.533	12.700	0.012
1739	LAKE SHELBYVILLE	0.062	3.290	461.333	17.161	14.800	0.019
1740	SILVER LAKE (HIGHLAND)	0.226	0.970	489.500	5.822	14.800	0.057
1742	LAKE SPRINGFIELD	0.108	3.265	483.385	13.013	10.800	0.059
1748	VERMILION LAKE	0.109	4.695	481.500	31.150	14.200	0.050
1750	WONDER LAKE	0.426	0.890	486.000	98.533	7.800	0.132
1751	LAKE STORY	0.072	2.510	459.333	17.250	14.800	0.021
1752	DEPUE LAKE	0.438	4.050	490.000	58.833	7.600	0.276
1753	LAKE SANGCHRIS	0.050	1.970	475.417	19.292	14.500	0.009
1754	LAKE HOLIDAY	0.167	3.135	485.167	51.217	7.200	0.046
1755	FOX LAKE	0.219	0.375	486.167	63.850	8.800	0.083
1756	GRASS LAKE	0.301	0.820	481.000	83.500	5.900	0.093
1757	EAST LOON LAKE	0.076	0.120	450.000	22.300	14.900	0.018
1758	SLOCUM LAKE	0.865	0.200	487.333	221.100	5.800	0.362
1759	CEDAR LAKE	0.029	0.170	400.333	5.767	12.800	0.013
1761	LAKE WEMATUK	0.069	1.770	466.333	7.967	14.500	0.031
1762	RACCOON LAKE	0.106	0.310	484.333	19.217	13.800	0.020
1763	BALDWIN LAKE	0.044	0.140	461.167	11.333	13.200	0.007

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
1764	LAKE VANDALIA	0.116	0.480	478.111	11.278	14.800	0.023
1765	OLD BEN MINE RESERVOIR	0.930	0.205	478.333	31.433	11.200	0.575
1766	HORSESHOE LAKE	0.127	0.705	482.833	182.250	6.800	0.018

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 NU
1703	LAKE BLOOMINGTON	88 (26)	0 (0)	80 (24)	47 (14)	13 (2)	68 (20)	296
1706	LAKE CARLYLE	63 (19)	40 (12)	63 (19)	63 (19)	63 (19)	53 (16)	345
1708	LAKE CHARLESTON	37 (11)	7 (2)	0 (0)	77 (23)	77 (23)	27 (8)	225
1711	COFFEEN LAKE	97 (29)	77 (23)	93 (28)	93 (28)	2 (0)	92 (27)	454
1712	CRAB ORCHARD LAKE	67 (20)	90 (27)	43 (13)	20 (6)	42 (12)	85 (25)	347
1714	LAKE DECATUR	40 (12)	13 (4)	53 (16)	33 (10)	30 (8)	32 (9)	201
1725	LONG LAKE	7 (2)	43 (13)	40 (12)	30 (9)	72 (21)	3 (1)	195
1726	LAKE LOU YAEGER	30 (9)	37 (11)	7 (2)	87 (26)	57 (17)	23 (7)	241
1727	LAKE MARIE	60 (18)	68 (20)	73 (22)	37 (11)	23 (7)	42 (12)	303
1733	PISTAKEE LAKE	27 (8)	68 (20)	23 (7)	13 (4)	90 (27)	32 (9)	253
1735	RENO LAKE	77 (23)	80 (24)	70 (21)	50 (15)	53 (16)	92 (27)	422
1739	LAKE SHELBYVILLE	83 (25)	17 (5)	83 (25)	70 (21)	13 (2)	73 (22)	339
1740	SILVER LAKE (HIGHLAND)	20 (6)	47 (14)	10 (3)	97 (29)	13 (2)	42 (12)	229
1742	LAKE SPRINGFIELD	53 (16)	20 (6)	33 (10)	73 (22)	67 (20)	37 (11)	283
1748	VERMILION LAKE	50 (15)	3 (1)	47 (14)	43 (13)	37 (11)	47 (14)	227
1750	WONDER LAKE	13 (4)	50 (15)	20 (6)	7 (2)	80 (24)	13 (4)	183
1751	LAKE STORY	73 (22)	27 (8)	90 (27)	67 (20)	13 (2)	63 (19)	333
1752	DEPUE LAKE	10 (3)	10 (3)	3 (1)	23 (7)	83 (25)	10 (3)	139
1753	LAKE SANGCHRIS	88 (26)	30 (9)	67 (20)	57 (17)	30 (8)	97 (29)	369
1754	LAKE HOLIDAY	33 (10)	23 (7)	27 (8)	27 (8)	87 (26)	50 (15)	247
1755	FOX LAKE	23 (7)	63 (19)	17 (5)	17 (5)	72 (21)	20 (6)	212
1756	GRASS LAKE	17 (5)	53 (16)	50 (15)	10 (3)	97 (29)	17 (5)	244
1757	EAST LOON LAKE	70 (21)	100 (30)	97 (29)	53 (16)	2 (0)	77 (23)	399
1758	SLOCUM LAKE	3 (1)	87 (26)	13 (4)	0 (0)	100 (30)	7 (2)	210
1759	CEDAR LAKE	100 (30)	93 (28)	100 (30)	100 (30)	50 (15)	85 (25)	528
1761	LAKE WEMATUK	80 (24)	33 (10)	77 (23)	90 (27)	30 (8)	57 (17)	367
1762	RACCOON LAKE	57 (17)	73 (22)	30 (9)	60 (18)	42 (12)	68 (20)	330
1763	BALDWIN LAKE	93 (28)	97 (29)	87 (26)	80 (24)	47 (14)	100 (30)	504

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
1764	LAKE VANDALIA	47 (14)	60 (18)	60 (18)	83 (25)	13 (2)	60 (18)	323
1765	OLD BEN MINE RESERVOIR	0 (0)	83 (25)	57 (17)	40 (12)	60 (18)	0 (0)	240
1766	HORSESHOE LAKE	43 (13)	57 (17)	37 (11)	3 (1)	93 (28)	80 (24)	313

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	1759	CEDAR LAKE	528
2	1763	BALDWIN LAKE	504
3	1711	COFFEEN LAKE	454
4	1735	REND LAKE	422
5	1757	EAST LOON LAKE	399
6	1753	LAKE SANGCHRIS	369
7	1761	LAKE WEMATUK	367
8	1712	CRAB ORCHARD LAKE	347
9	1706	LAKE CARLYLE	345
10	1739	LAKE SHELBYVILLE	339
11	1751	LAKE STORY	333
12	1762	RACCOON LAKE	330
13	1764	LAKE VANDALIA	323
14	1766	HORSESHOE LAKE	313
15	1727	LAKE MARIE	303
16	1703	LAKE BLOOMINGTON	296
17	1742	LAKE SPRINGFIELD	283
18	1733	PISTAKEE LAKE	253
19	1754	LAKE HOLIDAY	247
20	1756	GRASS LAKE	244
21	1726	LAKE LOU YAEGER	241
22	1765	OLD BEN MINE RESERVOIR	240
23	1740	SILVER LAKE (HIGHLAND)	229
24	1748	VERMILION LAKE	227
25	1708	LAKE CHARLESTON	225
26	1755	FOX LAKE	212
27	1758	SLOCUM LAKE	210
28	1714	LAKE DECATUR	201

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
29	1725	LONG LAKE	195
30	1750	WONDER LAKE	183
31	1752	DEPUE LAKE	139

APPENDIX B

CONVERSIONS 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 C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR ILLINOIS 10/23/75

LAKE CODE 1764 VANDALIA LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 62.9

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1764A1	62.9	0.40	0.61	0.75	0.77	0.61	0.52	0.31	0.16	0.11	0.12	0.18	0.21	0.39
1764A2	9.2	0.05	0.09	0.11	0.11	0.08	0.07	0.04	0.02	0.01	0.01	0.02	0.03	0.05
1764B1	13.3	0.08	0.13	0.15	0.16	0.12	0.11	0.06	0.03	0.02	0.02	0.03	0.04	0.08
1764C1	4.4	0.03	0.04	0.05	0.05	0.04	0.04	0.02	0.01	0.01	0.01	0.01	0.01	0.03
1764D1	3.1	0.02	0.03	0.03	0.04	0.03	0.02	0.01	0.01	0.00	0.00	0.01	0.01	0.02
1764ZZ	33.2	0.22	0.32	0.40	0.42	0.33	0.27	0.17	0.09	0.06	0.07	0.10	0.12	0.21

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 62.9
SUM OF SUB-DRAINAGE AREAS = 63.1
TOTAL FLOW IN = 4.73
TOTAL FLOW OUT = 4.73

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
1764A1	6	73	1.13	2	0.08				
	7	73	0.11	7	0.05				
	8	73	0.0	4	0.0				
	9	73	0.0	17	0.0				
	10	73	0.0	13	0.0				
	11	73	0.06	3	0.0				
	12	73	1.47	1	0.05				
	1	74	2.07	5	0.28				
	2	74	1.22	2	0.28	15	0.14		
	3	74	1.44	2	0.71	16	0.45		
	4	74	1.81	6	0.68				
	5	74	1.13	4	0.16				
1764A2	6	73	0.21	2	0.01				
	7	73	0.02	7	0.01				
	8	73	0.01	4	0.0				
	9	73	0.0	17	0.0				
	10	73	0.0	13	0.0				
	11	73	0.02	3	0.0				
	12	73	0.20	1	0.01				
	1	74	0.28	5	0.04				
	2	74	0.18	2	0.04	15	0.02		
	3	74	0.20	2	0.10	16	0.07		
	4	74	0.25	6	0.10				
	5	74	0.16	4	0.02				

TRIBUTARY FLOW INFORMATION FOR ILLINOIS 10/23/75

LAKE CODE 1764 VANDALIA LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
1764B1	6	73	0.31	2	0.02				
	7	73	0.03	7	0.01				
	8	73	0.01	4	0.00				
	9	73	0.0	17	0.0				
	10	73	0.0	13	0.0				
	11	73	0.02	3	0.0				
	12	73	0.28	1	0.01				
	1	74	0.42	5	0.06				
	2	74	0.26	2	0.06	15	0.03		
	3	74	0.28	2	0.15	16	0.10		
	4	74	0.37	6	0.14				
	5	74	0.23	4	0.03				
1764C1	6	73	0.10	2	0.01				
	7	73	0.01	7	0.00				
	8	73	0.00	4	0.0				
	9	73	0.0	17	0.0				
	10	73	0.0	13	0.0				
	11	73	0.01	3	0.0				
	12	73	0.09	1	0.00				
	1	74	0.13	5	0.02				
	2	74	0.09	2	0.02	15	0.01		
	3	74	0.10	2	0.05	16	0.03		
	4	74	0.12	6	0.05				
	5	74	0.07	4	0.01				
1764D1	6	73	0.07	2	0.00				
	7	73	0.01	7	0.00				
	8	73	0.00	4	0.0				
	9	73	0.0	17	0.0				
	10	73	0.0	13	0.0				
	11	73	0.01	3	0.0				
	12	73	0.06	1	0.00				
	1	74	0.09	5	0.01				
	2	74	0.06	2	0.01	15	0.01		
	3	74	0.07	2	0.03	16	0.02		
	4	74	0.08	6	0.03				
	5	74	0.05	4	0.01				
1764ZZ	6	73	0.76	2	0.04				
	7	73	0.08	7	0.03				
	8	73	0.03	4	0.01				
	9	73	0.0	17	0.0				
	10	73	0.00	13	0.0				
	11	73	0.07	3	0.0				
	12	73	0.0	1	0.03				
	1	74	1.13	5	0.16				
	2	74	0.62	2	0.15	15	0.07		
	3	74	0.79	2	0.37	16	0.24		
	4	74	0.99	6	0.37				
	5	74	0.62	4	0.08				

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 75/10/23

176401
39 00 35.0 089 07 15.0
LAKE VANDALIA
17051 ILLINOIS

11EPALES 2111202
3 0036 FEET DEPTH

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
73/05/11	15 00	0000	19.8		15	190	7.60	65	0.100	0.700	0.950	0.038
	15 00	0006	18.2	8.2		195	7.60	64	0.080	0.600	0.940	0.039
	15 00	0015	16.5	7.6		180	7.60	64	0.080	0.600	0.940	0.034
	15 00	0022	16.2	6.7		185	7.60	64	0.090	0.600	0.950	0.033
	15 00	0032	14.5	2.1		200	7.50	66	0.120	0.800	0.960	0.022
73/08/10	16 30	0000	29.4		36	175	8.50	58	0.080	1.100	0.070	0.005
	16 30	0005	27.5	6.8		172	7.70	56	0.070	0.800	0.080	0.012
	16 30	0015	21.9	0.0		162	6.90	64	0.490	1.500	0.060	0.022
	16 30	0027	16.0	0.2		188	7.00	94	1.590	3.000	0.140	0.064
73/10/18	15 09	0000	19.7		36	160	7.70	65	0.190	1.000	0.170	0.025
	15 09	0015	19.2	6.2		158	7.50	62	0.180	1.100	0.140	0.023
	15 09	0026	16.4	0.2		252	7.00	117	3.310	5.200	0.050	0.075

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/05/11	15 00	0000	0.118	2.8
	15 00	0006	0.115	
	15 00	0015	0.120	
	15 00	0022	0.121	
	15 00	0032	0.168	
73/08/10	16 30	0000	0.038	6.0
	16 30	0005	0.049	
	16 30	0015	0.165	
	16 30	0027	0.480	
73/10/18	15 09	0000	0.044	10.1
	15 09	0015	0.054	
	15 09	0026	1.020	

STORET RETRIEVAL DATE 75/10/23

176402
39 00 45.0 089 08 58.0
LAKE VANDALIA
17051 ILLINOIS

11EPALES 2111202
3 0017 FEET DEPTH

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
73/05/11	15 25	0000	18.3		12	190	7.60	62	0.090	0.700	0.880	0.028
	15 25	0006	17.0	9.5		185	7.60	179	0.110	0.700	0.920	0.030
	15 25	0013	16.7	5.5		185	7.60	178	0.150	0.700	1.340	0.033
73/08/10	16 50	0000	28.5		28	174	8.40	60	0.110	1.100	0.100	0.010
	16 50	0005	27.0	6.6		170	7.50	58	0.110	0.900	0.120	0.016
	16 50	0013	25.0	0.7		172	6.80	65	0.610	1.800	0.150	0.027
73/10/18	15 25	0000	18.9		24	156	7.60	64	0.100	1.300	0.120	0.021
	15 25	0005	18.9	8.4		156	7.60	65	0.080	0.900	0.130	0.019
	15 25	0012	17.9	7.8			7.50	64	0.090	0.800	0.130	0.017

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/05/11	15 25	0000	0.136	1.4
	15 25	0006	0.145	
	15 25	0013	0.138	
73/08/10	16 50	0000	0.050	8.1
	16 50	0005	0.064	
	16 50	0013	0.185	
73/10/18	15 25	0000	0.055	12.3
	15 25	0005	0.055	
	15 25	0012	0.055	

STORET RETRIEVAL DATE 75/10/23

176403
39 01 10.0 089 03 45.0
LAKE VANDALIA
17051 ILLINOIS

11EPALES 2111202
3 0004 FEET DEPTH

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
73/05/11	15 40	0000	18.0	7.9	10	210	7.40	68	0.120	1.000	0.780	0.027
73/08/10	17 05	0000	27.6	7.2	12	172	8.30	60	0.080	1.200	0.070	0.018
	17 05	0003	27.6	4.6		173	7.30	59	0.240	1.300	0.170	0.022
73/10/18	15 38	0000	18.4		24	153	8.40	62	0.050	1.100	0.060	0.023
	15 38	0004	18.3	9.8		153	8.30	60	0.050	0.800	0.060	0.024

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L
73/05/11	15 40	0000	0.174	11.5
73/08/10	17 05	0000	0.113	31.3
	17 05	0003	0.134	
73/10/18	15 38	0000	0.056	18.0
	15 38	0004	0.059	

APPENDIX E

TRIBUTARY DATA

STORET RETRIEVAL DATE 75/10/23

1764A1
39 00 40.0 089 07 00.0
BEAR CREEK
17157 FAYETTE CO MAP
O/VANDALIA LAKE
BRDG 2 MI N OF VANDALIA CITY LIMITS
11EPALES 2111204
4 0000 FEET DEPTH

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
73/06/02	14 05		0.720	1.980	0.115	0.052	0.150
73/07/07	09 50		0.380	3.360	0.105	0.016	0.080
73/08/04	10 00		0.110	1.540	0.028	0.025	0.025
73/09/17	13 15		0.210	0.870	0.075	0.020	0.080
73/10/13	16 00		0.180	1.100	0.022	0.022	0.125
73/11/03	11 00		0.176	1.500	0.105		0.200
73/12/01	10 45		0.350	0.800	0.088	0.020	0.230
74/01/05	11 05		0.580	2.100	0.076	0.036	0.075
74/02/02	11 30		0.924	0.600	0.065	0.115	0.170
74/02/15	11 00		0.924	1.200	0.105	0.085	0.160
74/03/02	11 05		0.950	1.600	0.085	0.085	0.210
74/03/16	10 30		1.065	1.000	0.075	0.075	0.195
74/04/06	10 00		1.120	1.200	0.030	0.065	0.170
74/05/04	14 00		0.975	2.700	0.200	0.065	0.180

STORET RETRIEVAL DATE 75/10/23

1764A2
39 02 30.0 089 08 35.0
BEAR CREEK
17 FAYETTE CO MAP
I/VANDALIA LAKE
SEC RD BRDG 2 MI N OF LAKE
11EPALES 2111204
4 0000 FEET DEPTH

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
73/06/02	14 35		0.150	1.380	0.063	0.035	0.080
73/07/07	10 20		0.160	3.200	0.110	0.026	0.060
73/08/04	12 30		0.198	4.300	0.280	0.100	0.200
73/09/17	13 40		0.050	1.400	0.378	0.095	0.210
73/10/13	18 00		0.050	0.920		0.048	0.125
73/12/01	11 30		0.760	0.800	0.032	0.224	0.440
74/01/05	11 35		2.100	2.100	0.720	0.280	0.330
74/02/02	12 00		1.260	0.300	0.035	0.070	0.075
74/02/15	13 30		0.780	0.900	0.050	0.055	
74/03/02	11 55		1.180	1.100	0.045	0.060	0.115
74/03/16	11 05		0.680	1.500	0.080	0.105	0.220
74/04/06	11 50		0.900	1.400	0.230	0.045	0.065
74/05/04	14 20		0.114	1.700	0.300	0.020	0.045

STORET RETRIEVAL DATE 75/10/23

176481
39 01 40.0 089 10 20.0
UNNAMED STREAM
17 FAYETTE CO MAP
T/VANDALIA LAKE
2NDRY RD BRDG 1 MI NW OF LAKE
11EPALES 2111204
4 0000 FEET DEPTH

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
73/06/02	15 10		0.650	1.600	0.044	0.031	0.080
73/07/07	10 40		0.450	5.700	0.147	0.044	0.085
73/08/04	12 00		0.880	2.800	0.069	0.056	0.075
73/09/17	14 00			0.600	0.019	0.015	0.060
73/10/13	16 30		0.220	5.600	2.300	0.034	0.280
73/11/03	12 30		0.250	1.000	0.048		0.215
73/12/01	12 30		0.590	1.600	0.048	0.264	0.590
74/01/05	12 05		1.260	1.200	0.088	0.072	0.095
74/02/02	13 00		0.740	0.900	0.035	0.085	0.105
74/02/15	11 00		0.390	1.400	0.075	0.030	0.105
74/03/02	12 20		0.630	1.400	0.055	0.050	0.180
74/03/16	12 20		0.490	1.500	0.052	0.130	0.310
74/04/06	13 00		0.500	0.700	0.035	0.060	0.115
74/05/04	14 45		0.200	0.500	0.035	0.025	0.065

STORET RETRIEVAL DATE 75/10/23

1764C1
39 01 40.0 089 08 50.0
UNNAMED STREAM
17 FAYETTE CO MAP
T/VANDALIA LAKE
2NDRY RD BRDG 0.2 MI UPSTREAM OF LAKE
11EPALES 2111204
4 0000 FEET DEPTH

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
73/06/02	14 50		0.115	2.310	0.046	0.026	0.220
73/07/07	10 30		0.310	3.800	0.079	0.038	0.260
73/08/04	12 15		0.420	2.970	0.066	0.048	0.165
73/09/17	13 50		0.190	1.200	0.072	0.058	0.175
73/10/13	17 15		0.240	1.300	0.091	0.015	0.105
73/11/03	12 00			1.150	0.052		0.230
73/12/01	12 00		0.460	1.100	0.052	0.145	0.250
74/01/05	13 15		1.120	1.000	0.072	0.132	0.200
74/02/02	12 30		0.320	0.600	0.050	0.050	0.125
74/02/15	11 45		1.680	1.400	0.230	0.185	0.290
74/03/02	12 45		0.840	0.800	0.030	0.070	0.130
74/04/06	12 00		0.224	1.400	0.050	0.040	0.175
74/05/04	14 30		0.102	1.400	0.040	0.017	0.155

STORET RETRIEVAL DATE 75/10/23

176401
39 02 30.0 089 07 40.0
UNNAMED STREAM
17 FAYETTE CO MAP
T/VANDALIA LAKE
2NDRY RD BRDG 1 MI NW OF VERA
11EPALES 2111204
4 0000 FEET DEPTH

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
73/06/02	14 25		1.000	3.000	0.105	0.036	0.095
73/07/07	10 00		1.500	3.300	0.370	0.180	0.480
73/08/04	14 00		0.240	1.200	0.198	0.061	0.130
73/09/17	13 30		0.012	3.400	1.160	0.035	0.560
73/10/13	16 45		0.450	2.730	0.770	0.088	0.270
73/11/03	11 50		0.500	5.100	2.100		0.570
73/12/01	11 15		1.340	1.400	0.156	0.370	0.570
74/01/05	12 30		1.340	1.700	0.092	0.060	0.075
74/02/02	11 15		2.000	1.300	0.460	0.310	0.360
74/02/15	12 30		0.960	1.000	0.170	0.040	0.045
74/03/02	11 30		1.800	1.500	0.075	0.175	0.280
74/03/16	10 30		1.260	1.700	0.090	0.240	0.400
74/04/06	10 50		1.920	0.100K	0.090	0.117	0.200
74/05/04	14 15		0.040	0.800	0.020	0.012	0.345

K VALUE KNOWN TO BE
LESS THAN INDICATED