U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

REPORT

ON

LAKE MACATAWA

OTTAWA COUNTY

MICHIGAN

EPA REGION V

WORKING PAPER No. 200

PACIFIC NORTHWEST ENVIRONMENTAL RESEARCH LABORATORY

An Associate Laboratory of the

NATIONAL ENVIRONMENTAL RESEARCH CENTER - CORVALLIS, OREGON

and

NATIONAL ENVIRONMENTAL RESEARCH CENTER - LAS VEGAS, NEVADA

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With the cooperation of the

Michigan Department of Natural Resources

and the

Michigan National Guard

May, 1975

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F O R E W O R D

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 Michigan Department of Natural Resources for professional involvement and to the Michigan National Guard for conducting the tributary sampling phase of the Survey.

A. Gene Gazlay, former Director, and David H. Jenkins, Acting Director, Michigan Department of Natural Resources; and Carlos Fetterolf, Chief Environmental Scientist, and Dennis Tierney, Aquatic Biologist, Bureau of Water Management, Department of Natural Resources, provided invaluable lake documentation and counsel during the course of the Survey. John Vogt, Chief of the Bureau of Environmental Health, Michigan Department of Public Health, and his staff were most helpful in identfying point sources and soliciting municipal participation in the Survey.

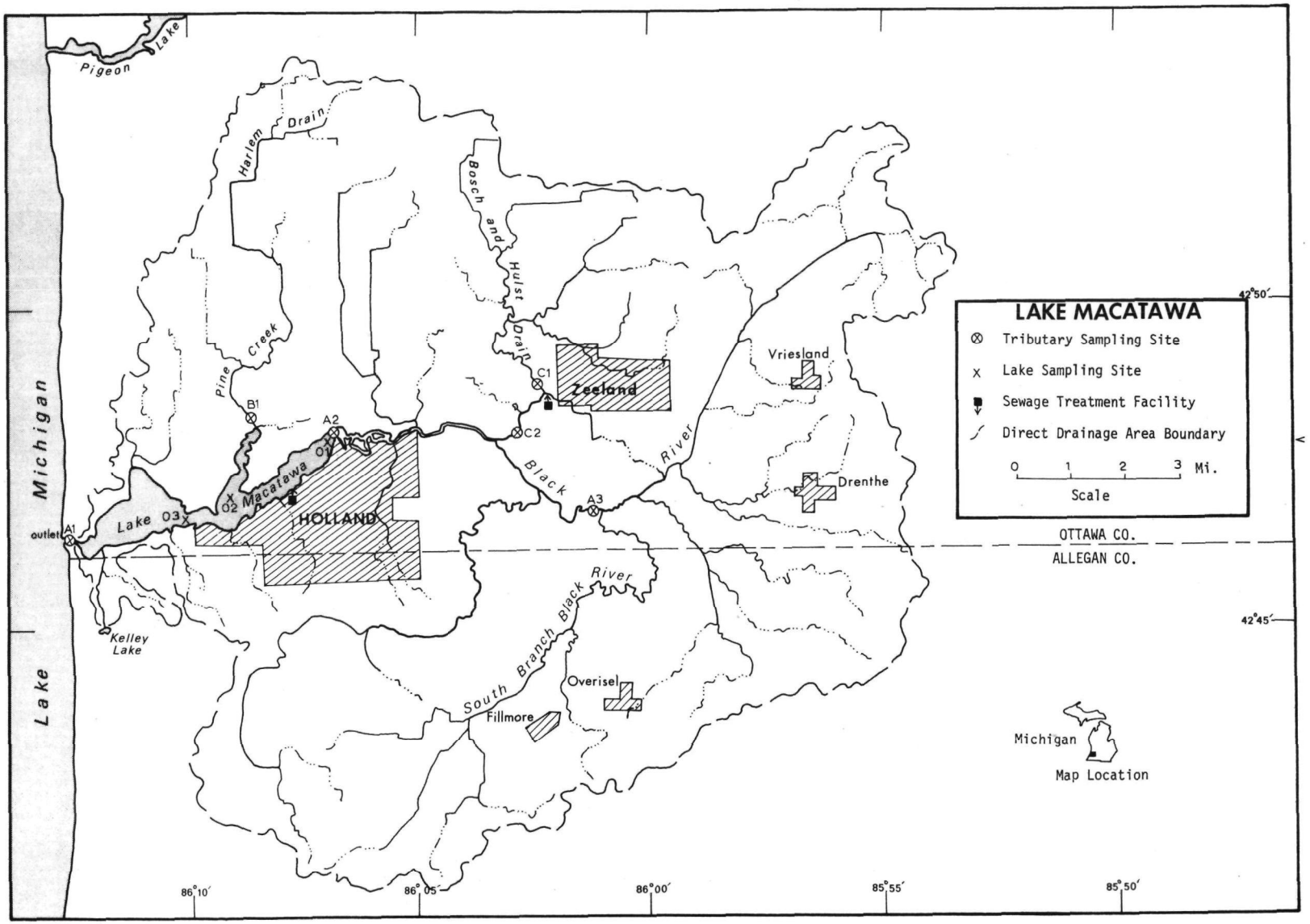
Major General Clarence A. Schnipke (Retired), then the Adjutant General of Michigan, and Project Officer Colonel Albert W. Lesky, who directed the volunteer efforts of the Michigan National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF MICHIGAN

LAKE NAME	COUNTY
Allegan Res.	Allegan
Barton	Kalamazoo
Belleville	Wayne
Betsie	Benzie
Brighton	Livingston
Caro Res.	Tuscola
Charlevoix	Charlevoix
Chemung	Livingston
Constantine Res.	St. Joseph
Crystal	Montcalm
Deer	Marquette
Ford	Washtenaw
Fremont	Newago
Higgins	Roscommon
Holloway Res.	Genesee, Lapeer
Houghton	Roscommon
Jordon	Ionia, Barry
Kent	Oakland
Long	St. Joseph
Macatawa	Ottawa
Manistee	Manistee
Mona	Muskegon
Muskegon	Muskegon
Pentwater	Oceana
Pere Marquette	Mason
Portage	Houghton
Randall	Branch
Rogers Pond	Mecosta
Ross	Gladwin
St. Louis Res.	Gratiot
Sanford	Midland
Strawberry	Livingston
Thompson	Livingston
Thornapple	Barry
Union	Branch
White	Muskegon


LAKE MACATAWA
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
Direct Drainage Area Boundary
0 1 2 3 Mi.
Scale
Lake Michigan
Pigeon Lake
Harlem Drain
Pine Creek
Bosch and Hulst Drain
Macatawa
Lake
Black River
South Branch Black River
Kelley Lake
outlet
A1
A2
A3
B1
C1
C2
O1
O2
O3
HOLLAND
Zeeland
Vriesland
Drenthe
Overisel
Fillmore
OTTAWA CO.
ALLEGAN CO.
42°50′
42°45′
86°10′
86°05′
86°00′
85°55′
85°50′
Michigan
Map Location

LAKE MACATAWA

STORET NO. 2648

I. CONCLUSIONS

A. Trophic Condition:

Survey data show that Lake Macatawa is eutrophic. Of the 35 Michigan lakes studied, 32 had better overall water quality based on the parameters measured during the Survey, and only two had lower overall quality; none of the 35 had less Secchi disc transparency, only 3 had greater mean inorganic nitrogen, and 7 had more mean total phosphorus*. Survey limnologists noted a heavy algal bloom in September, 1972.

Ketelle and Uttormark (1971) report that this lake has severe and frequent algal blooms.

B. Rate-Limiting Nutrient:

There was a significant loss of phosphorus in the algal assay sample, and the results are not representative of conditions in the lake at the time the sample was collected. The lake data indicate phosphorus limitation at all sampling times.

C. Nutrient Controllability:

1. Point sources--During the sampling year, Lake Macatawa received a total phosphorus load at a rate nearly eight times that proposed by Vollenweider (in press) as "dangerous"; i.e.,

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* See Appendix A.

a eutrophic rate (see page 13). It is calculated that the cities of Holland and Zeeland contributed almost 55% of this load.

Primarily for the protection of Lake Michigan, the cities of Holland and Zeeland are required to provide 80% phosphorus removal, but it appears this may not have been completely implemented during the sampling year judging by the phosphorus loads measured (1.2 lbs/capita/year at the Holland STP and 4.8 lbs/capita/year at the Zeeland STP). However, it is calculated that even 100% removal at the STP's would still leave a loading rate of 25.5 lbs/acre/yr (2.86 $g/m^2/yr$) or over three times the eutrophic rate of 0.80 $g/m^2/yr$. While a high degree of phosphorus removal at the municipal point sources could be expected to at least reduce the incidence and severity of nuisance algal blooms, it appears that a marked improvement in the trophic condition of the lake will require control of phosphorus from other sources as well (see below).

2. Non-point sources (see page 12)--During the sampling year, the phosphorus export rate of the Black River was a very high 300 lbs per square mile of drainage as compared to a "regional" mean export rate of 59 $lbs/mi^2/yr$ measured in

unimpacted tributaries to Mona Lake, Muskegon Lake, and Lake Allegan*.

Although the Survey did not involve industries, in a Michigan Department of Natural Resources report, Jackson (1971) noted that there are ten industrial discharges to the Black River and the lake, as well as seven storm drains. Several of these discharges are believed to be significant nutrient sources and probably account for the very high Black River phosphorus export noted above.

If the phosphorus export rate of the Black River can be reduced to the regional mean and at least 80% phosphorus removal is attained at the municipal sources, it is calculated that the phosphorus loading rate could be reduced from the 6.35 g/m^2 measured during the sampling year to about 2.2 $g/m^2/yr$. Considering the relatively short mean hydraulic retention time of the lake (77 days), it is likely that the reduced phosphorus loading would result in a significant improvement in the trophic condition of Lake Macatawa and provide additional protection for Lake Michigan as well.

* Black Creek (65 lbs $P/mi^2/yr$) to Mona Lake; Muskegon River (59 lbs) and Green Creek (55 lbs) to Muskegon Lake; and Dumont Creek (57 lbs) to Lake Allegan.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

A. Lake Morphometry†:

1. Surface area: 1,780 acres.
2. Mean depth: 12 feet.
3. Maximum depth: 40+ feet.
4. Volume: 21,360 acre-feet.
5. Mean hydraulic retention time: 77 days.

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

1. Tributaries -

Name	Drainage area*	Mean flow*
Black River	134.0 mi^2	104.0 cfs
Pine Creek	18.0 mi^2	14.0 cfs
Minor tributaries & immediate drainage -	24.2 mi^2	21.0 cfs
Totals	176.2 mi^2	139.0 cfs

2. Outlet -

Black River**	179.0 mi^2	139.0 cfs

C. Precipitation***:

1. Year of sampling: 36.4 inches.
2. Mean annual: 33.8 inches.

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† MI Dept. Cons. lake inventory map (1942); mean depth by random-dot method.

* Drainage areas are accurate within ±5%; mean daily flows for 74% of the sampling sites are accurate within ±25% and the remaining sites up to ±40%; and mean monthly flows, normalized mean monthly flows, and mean annual flows are slightly more accurate than mean daily flows.

** Includes area of lake; outflow adjusted to equal sum of inflows.

*** See Working Paper No. 1, "Survey Methods, 1972".

III. LAKE WATER QUALITY SUMMARY

Lake Macatawa was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the lake (a third station was sampled once) and from a number of depths at each station (see map, page v). During each visit, a single depth-integrated (15 feet to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the second visit, a single five-gallon 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 analyses. The maximum depths sampled were 21 feet at station 1, 20 feet at station 2, and 21 feet at station 3.

The results obtained are presented in full in Appendix C, and the data for the fall sampling period, when the lake essentially was well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix C.

A. Physical and chemical characteristics:

Parameter	Minimum	Mean	Median	Maximum
		FALL VALUES (11/14/72)		
Temperature (Cent.)	4.8	5.6	5.6	6.4
Dissolved oxygen (mg/l)	9.0	9.1	9.0	9.2
Conductivity (μmhos)	450	520	520	600
pH (units)	7.5	7.5	7.5	7.6
Alkalinity (mg/l)	122	140	139	158
Total P (mg/l)	0.174	0.197	0.205	0.212
Dissolved P (mg/l)	0.113	0.120	0.120	0.125
NO_2 + NO_3 (mg/l)	1.410	1.800	1.945	2.020
Ammonia (mg/l)	0.420	0.558	0.565	0.690
		ALL VALUES		
Secchi disc (inches)	9	22	24	36

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
06/14/72	1. Scenedesmus	1,049
	2. Cryptomonas	850
	3. Asterionella	687
	4. Pediastrum	597
	5. Melosira	488
	Other genera	1,302
	Total	4,973
09/18/72	1. Anabaena	1,683
	2. Stephanodiscus	1,683
	3. Scenedesmus	980
	4. Melosira	553
	5. Microcystis	377
	Other genera	1,885
	Total	7,161
11/14/72	1. Raphidiopsis	1,564
	2. Cyclotella	217
	3. Scenedesmus	172
	4. Melosira	163
	5. Synedra	72
	Other genera	497
	Total	2,685

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll a (μg/l)
06/14/72	01	25.0
	02	10.4
	03	-
09/18/72	01	21.7
	02	31.5
	03	59.6
11/14/72	01	-
	02	5.4
	03	-

C. Limiting Nutrient Study:

There was a loss of about 41% of the total phosphorus in the algal assay sample from the time of collection until the assay was begun. Consequently, the results are not representative of conditions in the lake at the time the sample was taken.

The lake data indicate phosphorus limitation at all sampling times (the N/P ratios were 22/1 in June, 14/1 in September, and 20/1 in November; and phosphorus limitation would be expected).

IV. NUTRIENT LOADINGS
(See Appendix D for data)

For the determination of nutrient loadings, the Michigan 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 April and May, when two samples were collected, and the colder months when one or more samples were omitted because of low flows. Sampling was begun in October, 1972, and was completed in September, 1973.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Michigan 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 loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated by using the nutrient loads, in $lbs/mi^2/year$, in Pine Creek at station B-1 and multiplying by the ZZ area in mi^2.

The apparent high degree of retention of phosphorus (73%) and nitrogen (42%) in Lake Macatawa during the sampling year is attributed to periodic dilution of the outlet samples by better quality Lake

* See Working Paper No. 1.

Michigan waters when on-shore winds occur. This dilution has been noted before (Jackson, 1971) and continues to be a problem in obtaining representative outlet samples (Massey, 1975).

The operators of the Holland and Zeeland wastewater treatment plants provided monthly effluent samples and corresponding flow data.

In the following loading tables, the nutrient loads attributed to the Black River are those measured at station A-2 minus the Zeeland loads.

A. Waste Sources:

1. Known municipal† -

Name	Pop.* Served	Treatment	Mean Flow (mgd)	Receiving Water
Holland	26,337	act. sludge	4.378	Lake Macatawa
Zeeland	4,734	trickling filter	0.537	Black River

2. Industrial - Jackson (op. cit.) listed 12 industries and seven storm drains in the Lake Macatawa drainage; at least two of the industries involved food processing and were possible sources of nutrients. However, because of Survey constraints** these sources were not evaluated.

† Wasbotten, 1973.
* 1970 Census.
** See Working Paper No. 1.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	lbs P/ yr	% of total
a. Tributaries (non-point load) -		
Black River	40,190	39.9
Pine Creek	2,040	2.0
b. Minor tributaries & immediate drainage (non-point load) -	2,740	2.7
c. Known municipal STP's -		
Holland	32,740	32.5
Zeeland	22,600	22.4
d. Septic tanks* -	190	0.2
e. Industrial - Unknown	?	-
f. Direct precipitation** -	280	0.3
Total	100,780	100.0

2. Outputs -

Lake outlet - Black River 27,500

3. Net annual P accumulation - 73,280 pounds

* Estimate based on 300 lakeshore dwellings; see Working Paper No. 1.
** See Working Paper No. 1.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	lbs N/ yr	% of total
a. Tributaries (non-point load) -		
Black River	652,880	64.7
Pine Creek	64,200	6.4
b. Minor tributaries & immediate drainage (non-point load) -	86,320	8.6
c. Known municipal STP's -		
Holland	149,510	14.8
Zeeland	32,220	3.2
d. Septic tanks* -	7,050	0.7
e. Industrial - Unknown	?	-
f. Direct precipitation** -	17,150	1.6
Total	1,009,330	100.0

2. Outputs -

Lake outlet - Black River 582,070

3. Net annual N accumulation - 427,260 pounds

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

Tributary	lbs P/mi^2/yr	lbs N/mi^2/yr	N/P Ratio
Black River	300	4,872	16/1
Pine Creek	113	3,567	32/1

* Estimate based on 300 lakeshore dwellings; see Working Paper No. 1.
** See Working Paper No. 1.

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (in press). Essentially, his "dangerous" rate is the rate at which the receiving waters 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 very short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
Units	Total	Accumulated*	Total	Accumulated*
lbs/acre/yr	56.6	41.2	567.0	240.0
grams/m^2/yr	6.35	4.61	63.6	26.9

Vollenweider loading rates for phosphorus ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Lake Macatawa:

"Dangerous" (eutrophic rate)	0.80
"Permissible" (oligotrophic rate)	0.40

* The apparent high degree of accumulation (retention) of phosphorus (73%) and nitrogen (42%) during the sampling year is attributed to periodic dilution of outlet samples by Lake Michigan waters (see pages 9 and 10).

V. LITERATURE REVIEWED

Jackson, George, 1971. A biological survey of the Black River and Lake Macatawa, vicinity of Holland, Michigan. MI Dept. Nat. Resources, Lansing.

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Massey, Albert, 1975. Personal communication (dilution of Lake Macatawa outlet samples by Lake Michigan waters). MI Dept. Nat. Resources, Lansing.

Vollenweider, Richard A. (in press). Input-output models. Schweiz. Z. Hydrol.

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VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	FALL VALUES MEAN TOTAL P	FALL VALUES MEAN DISS P	FALL VALUES MEAN INORG N	ALL VALUES 500-MEAN SEC	ALL VALUES MEAN CHLORA	ALL VALUES 15-MIN DO
26A0	HOLLOWAY RESERVOIR	0.062	0.043	1.461	439.375	10.678	9.200
26A1	CARO RESERVOIR	0.117	0.022	3.835	473.000	11.967	9.500
26A2	BOARDMAN HYDRO POND	0.006	0.005	0.358	363.500	1.267	6.600
2603	ALLEGAN LAKE	0.123	0.057	1.168	470.222	20.311	12.600
2606	BARTON LAKE	0.121	0.086	1.489	456.167	27.800	14.850
2609	BELLEVILLE LAKE	0.118	0.048	1.420	465.250	28.262	8.200
2610	BETSIE LAKE	0.025	0.008	0.273	461.667	4.567	7.400
2613	BRIGHTON LAKE	0.109	0.073	1.015	456.000	44.233	7.500
2617	LAKE CHARLEVOIX	0.007	0.006	0.230	351.250	3.008	9.240
2618	LAKE CHEMUNG	0.044	0.014	0.132	404.333	13.483	14.800
2621	CONSTANTINE RESERVOIR	0.027	0.008	0.910	456.167	39.317	7.500
2629	FORD LAKE	0.105	0.058	1.536	456.167	14.733	14.000
2631	FREMONT LAKE	0.372	0.342	1.406	441.667	28.500	14.800
2640	JORDAN LAKE	0.180	0.144	1.998	427.667	20.517	14.900
2643	KENT LAKE	0.040	0.015	0.417	455.000	33.944	13.000
2648	LAKE MACATAWA	0.197	0.120	2.358	477.600	25.600	12.200
2649	MANISTEE LAKE	0.018	0.010	0.304	451.333	6.317	11.380
2659	MUSKEGON LAKE	0.087	0.043	0.469	436.444	9.511	14.800
2665	PENTWATER LAKE	0.027	0.017	0.496	430.667	16.083	14.800
2671	RANDALL LAKE	0.246	0.183	0.818	457.333	27.217	8.020
2672	ROGERS POND	0.026	0.015	0.183	435.500	8.133	9.600
2673	ROSS RESERVOIR	0.034	0.021	0.460	465.333	10.383	8.200
2674	SANFORD LAKE	0.016	0.008	0.307	458.750	13.791	8.300
2683	THORNAPPLE LAKE	0.042	0.032	1.737	442.833	14.650	10.800
2685	UNION LAKE	0.083	0.064	1.252	455.500	15.667	8.200
2688	WHITE LAKE	0.027	0.019	0.367	417.778	9.211	13.400
2691	MONA LAKE	0.307	0.241	0.963	451.667	27.783	14.100
2692	LONG LAKE	0.163	0.148	0.749	418.400	10.067	13.600

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	FALL VALUES MEAN TOTAL P	FALL VALUES MEAN DISS P	FALL VALUES MEAN INORG N	ALL VALUES 500- MEAN SEC	ALL VALUES MEAN CHLORA	ALL VALUES 15- MIN DO
2693	ST LOUIS RESERVOIR	0.134	0.093	1.227	462.667	5.583	8.420
2694	CRYSTAL LAKE	0.009	0.006	0.164	380.000	2.986	13.000
2695	HIGGINS LAKE	0.007	0.005	0.058	268.500	1.043	9.400
2696	HOUGHTON LAKE	0.018	0.008	0.136	420.833	9.217	8.200
2697	THOMPSON LAKE	0.043	0.029	0.436	407.889	11.967	14.800
2698	PERE MARQUETTE LAKE	0.032	0.024	0.346	448.667	11.833	8.600
2699	STRAWBERRY LAKE	0.069	0.050	0.567	419.800	11.117	13.600

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

LAKE CODE	LAKE NAME	FALL VALUES: MEAN TOTAL P	FALL VALUES: MEAN DISS P	FALL VALUES: MEAN INORG N	ALL VALUES: 500-MEAN SEC	ALL VALUES: MEAN CHLORA	ALL VALUES: 15-MIN DO	INDEX NO
26A0	HOLLOWAY RESERVOIR	46 (16)	43 (15)	17 (6)	57 (20)	60 (21)	63 (22)	286
26A1	CARO RESERVOIR	29 (10)	54 (19)	0 (0)	3 (1)	49 (17)	54 (19)	189
26A2	BOARDMAN HYDRO POND	97 (34)	97 (34)	69 (24)	91 (32)	94 (33)	97 (34)	545
2603	ALLEGAN LAKE	20 (7)	31 (11)	31 (11)	6 (2)	29 (10)	40 (14)	157
2606	BARTON LAKE	23 (8)	20 (7)	14 (5)	29 (9)	14 (5)	3 (1)	103
2609	BELLEVILLE LAKE	26 (9)	37 (13)	20 (7)	11 (4)	11 (4)	79 (26)	184
2610	BETSIE LAKE	77 (27)	77 (27)	80 (28)	17 (6)	86 (30)	94 (33)	431
2613	BRIGHTON LAKE	31 (11)	23 (8)	34 (12)	34 (12)	0 (0)	90 (31)	212
2617	LAKE CHARLEVOIX	91 (32)	91 (32)	83 (29)	94 (33)	89 (31)	60 (21)	508
2618	LAKE CHEMUNG	49 (17)	71 (25)	94 (33)	86 (30)	46 (16)	11 (2)	357
2621	CONSTANTINE RESERVOIR	71 (25)	83 (29)	40 (14)	29 (9)	3 (1)	90 (31)	316
2629	FORD LAKE	34 (12)	29 (10)	11 (4)	29 (9)	37 (13)	23 (8)	163
2631	FREMONT LAKE	0 (0)	0 (0)	23 (8)	54 (19)	9 (3)	11 (2)	97
2640	JORDAN LAKE	11 (4)	11 (4)	6 (2)	69 (24)	26 (9)	0 (0)	123
2643	KENT LAKE	57 (20)	69 (24)	63 (22)	40 (14)	6 (2)	36 (12)	271
2648	LAKE MACATAWA	9 (3)	14 (5)	3 (1)	0 (0)	23 (8)	43 (15)	92
2649	MANISTEE LAKE	80 (28)	74 (26)	77 (27)	46 (16)	80 (28)	46 (16)	403
2659	MUSKEGON LAKE	37 (13)	40 (14)	54 (19)	60 (21)	69 (24)	11 (2)	271
2665	PENTWATER LAKE	69 (24)	63 (22)	51 (18)	66 (23)	31 (11)	11 (2)	291
2671	RANDALL LAKE	6 (2)	6 (2)	43 (15)	23 (8)	20 (7)	86 (30)	184
2672	ROGERS POND	74 (26)	66 (23)	86 (30)	63 (22)	77 (27)	51 (18)	417
2673	ROSS RESERVOIR	60 (21)	57 (20)	57 (20)	9 (3)	63 (22)	79 (26)	325
2674	SANFORD LAKE	86 (30)	80 (28)	74 (26)	20 (7)	43 (15)	71 (25)	374
2683	THORNAPPLE LAKE	54 (19)	46 (16)	9 (3)	51 (18)	40 (14)	49 (17)	249
2685	UNION LAKE	40 (14)	26 (9)	26 (9)	37 (13)	34 (12)	79 (26)	242
2688	WHITE LAKE	66 (23)	60 (21)	66 (23)	80 (28)	74 (26)	31 (11)	377
2691	MONA LAKE	3 (1)	3 (1)	37 (13)	43 (15)	17 (6)	20 (7)	123
2692	LONG LAKE	14 (5)	9 (3)	46 (16)	77 (27)	66 (23)	27 (9)	239

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

LAKE CODE	LAKE NAME	FALL VALUES: MEAN TOTAL P	FALL VALUES: MEAN DISS P	FALL VALUES: MEAN INORG N	ALL VALUES: 500-MEAN SEC	ALL VALUES: MEAN CHLORA	ALL VALUES: 15-MIN DO	INDEX NO
2693	ST LOUIS RESERVOIR	17 (6)	17 (6)	29 (10)	14 (5)	83 (29)	69 (24)	229
2694	CRYSTAL LAKE	89 (31)	89 (31)	89 (31)	89 (31)	91 (32)	36 (12)	483
2695	HIGGINS LAKE	94 (33)	94 (33)	97 (34)	97 (34)	97 (34)	57 (20)	536
2696	HOUGHTON LAKE	83 (29)	86 (30)	91 (32)	71 (25)	71 (25)	79 (26)	481
2697	THOMPSON LAKE	51 (18)	49 (17)	60 (21)	83 (29)	51 (18)	11 (2)	305
2698	PERE MARQUETTE LAKE	63 (22)	51 (18)	71 (25)	49 (17)	54 (19)	66 (23)	354
2699	STRAWBERRY LAKE	43 (15)	34 (12)	49 (17)	74 (26)	57 (20)	27 (9)	284

APPENDIX B

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR MICHIGAN 2/3/75

LAKE CODE 2648 MACATAWA LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ MI) 179.00

TRIBUTARY	SUB-DRAINAGE AREA(SQ MI)	NORMALIZED FLOWS(CFS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
2648A1	179.00	128.00	283.00	441.00	307.00	98.70	57.90	7.64	9.74	27.00	40.00	120.00	159.00	138.87
2648A2	134.00	95.90	212.00	330.00	230.00	73.90	43.40	5.72	7.29	20.20	29.90	89.60	119.00	103.96
2648B1	18.00	12.90	28.50	44.30	30.90	9.93	5.83	0.77	0.98	2.71	4.02	12.00	15.90	13.96
2648ZZ	27.00	19.30	42.70	66.50	46.40	14.90	8.74	1.15	1.47	4.07	6.03	18.10	23.90	20.95

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 179.00
SUM OF SUB-DRAINAGE AREAS = 179.00

TOTAL FLOW IN = 1678.91
TOTAL FLOW OUT = 1678.98

MEAN MONTHLY FLOWS AND DAILY FLOWS(CFS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
2648A1	10	72	302.00	28	180.00				
	11	72	296.00	20	218.00				
	12	72	647.00	22	993.00				
	1	73	460.00						
	2	73	115.00	5	193.00				
	3	73	392.00	5	484.00				
	4	73	318.00	11	305.00	23	1550.00		
	5	73	373.00	16	54.00	31	128.00		
	6	73	80.00	14	26.00	29	54.00		
	7	73	32.00	24	16.00				
	8	73	17.00	24	17.00				
	9	73	19.00	28	63.00				
2648A2	10	72	226.00	28	135.00				
	11	72	222.00	20	163.00				
	12	72	486.00	22	745.00				
	1	73	345.00						
	2	73	86.00	5	145.00				
	3	73	294.00	5	363.00				
	4	73	239.00	11	228.00	23	1160.00		
	5	73	279.00	16	41.00	31	96.00		
	6	73	60.00	14	20.00	29	41.00		
	7	73	24.00	24	12.00				
	8	73	13.00	23	14.00				
	9	73	14.00	28	47.00				

TRIBUTARY FLOW INFORMATION FOR MICHIGAN 2/3/75

LAKE CODE 2648 MACATAWA LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS(CFS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
264881	10	72	30.00	28	18.00				
	11	72	30.00	20	22.00				
	12	72	65.00	22	100.00				
	1	73	46.00						
	2	73	12.00	5	20.00				
	3	73	40.00	5	49.00				
	4	73	32.00	11	31.00	23	156.00		
	5	73	38.00	16	5.50	31	13.00		
	6	73	8.00	14	2.60	29	5.50		
	7	73	3.30	24	1.60				
	8	73	1.70	23	1.90				
	9	73	1.90	28	6.30				
2648ZZ	10	72	46.00						
	11	72	45.00						
	12	72	98.00						
	1	73	69.00						
	2	73	17.00						
	3	73	59.00						
	4	73	48.00						
	5	73	56.00						
	6	73	12.00						
	7	73	4.90						
	8	73	2.60						
	9	73	2.90						

APPENDIX C

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 75/02/04

264801
42 48 00.0 086 07 00.0
LAKE MACATAWA
26 MICHIGAN

11EPALES 2111202
5 0021 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	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/14	14 55	0000	23.1	4.8	9	530	7.50	158	0.410	1.500	0.140	0.065
	14 55	0015	22.5	4.2		640	7.40	163	0.400	1.400	0.162	0.066
	14 55	0021	21.9	2.8		650	7.45	165	0.400	1.500	0.253	0.065
72/09/18	10 00	0000						132	0.980	0.250	0.177	0.071
	10 00	0004						131	1.020	0.240	0.159	0.068
	10 00	0010						132	1.040	0.240	0.177	0.068
	10 00	0015						133	1.060	0.250	0.219	0.084
72/11/14	14 50	0000			19	600	7.50	154	2.020	0.460	0.206	0.125
	14 50	0004	4.9	9.0		580	7.50	158	1.970	0.430	0.212	0.124
	14 50	0015	4.8	9.2		580	7.50	158	2.000	0.420	0.204	0.124

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/14	14 55	0000	25.0J
72/09/18	10 00	0000	21.7J

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 75/02/04

264802
42 47 00.0 086 09 00.0
LAKE MACATAWA
26 MICHIGAN

11EPALES 2111202
5 0020 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	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/14	15 21	0000	22.0	7.5	24	470	7.80	136	0.380	0.680	0.124	0.076
	15 21	0015	18.9	4.9		495	7.55	139	0.380	0.940	0.136	0.078
	15 21	0020	18.5	4.0		490	7.50	139	0.350	0.920	0.143	0.074
72/09/18	10 30	0000						117	0.230	0.150	0.142	0.042
	10 30	0004						122	0.230	0.160	0.137	0.042
	10 30	0015						121	0.240	0.190	0.117	0.038
72/11/14	14 30	0000			24	460	7.60	124	1.480	0.670	0.174	0.115
	14 30	0004	6.4	9.0		450	7.60	122	1.920	0.690	0.208	0.113
	14 30	0015	6.4	9.1		450	7.60	122	1.410	0.680	0.181	0.117

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/14	15 21	0000	10.4J
72/09/18	10 30	0000	31.5J
72/11/14	14 30	0000	5.4J

J VALUE KNOWN TO BE IN ERROR

STORET RETRIEVAL DATE 75/02/04

264803
42 46 00.0 086 10 00.0
LAKE MACATAWA
26 MICHIGAN

11EPALES 2111202
6 0000 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	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/09/18	11 00	0000			36	363	8.20	109	0.090	0.130	0.092	0.028
	11 00	0004	18.9			370	8.20	109	0.090	0.160	0.096	0.029
	11 00	0015	18.9	6.9		370	8.30	111	0.090	0.170	0.091	0.027
	11 00	0021	18.8	6.5		380	8.20	112	0.100	0.240	0.090	0.030

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/09/18	11 00	0000	59.6J

J VALUE KNOWN TO BE IN ERROR

APPENDIX D

TRIBUTARY and WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 75/02/04

2648A1 LS2648A1
42 46 30.0 086 12 30.0
BLACK RIVER
26 15 HOLLAND
O/LAKE MACATAWA
BANK SAMPLE OF OUTLET CHANLW OF HOLLAND
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
72/10/28	10 00		0.395	1.000	0.176	0.021	0.080
72/11/20	19 30		0.945	3.400	0.409	0.054	0.105
72/12/22	12 45		1.240	3.900	0.790	0.100	0.150
73/02/05	19 40		1.240	1.540	0.440	0.067	0.130
73/03/05	20 05		1.220	1.440	0.515	0.083	0.140
73/04/11	10 00		0.920	1.200	0.012	0.015	0.105
73/04/23	08 30		0.620	1.000	0.280	0.044	0.090
73/05/16	11 18		0.300	2.500	0.026	0.008	0.085
73/05/31			0.336	1.200	0.036	0.032	0.090
73/06/14			0.019	1.150	0.034	0.014	0.075
73/06/29			0.168	1.200	0.270	0.054	0.135
73/07/24			0.018	1.200	0.038	0.016	0.077
73/08/24			0.010K	1.300	0.017	0.033	0.135
73/09/28			0.120	0.480	0.049		0.050

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 75/02/04

2648A2 LS2648A2
42 48 00.0 086 06 30.0
BLACK RIVER
26 15 HOLLAND
I/LAKE MACATAWA
BUTTERNUT DRIVE BRDG EDGE OF HOLLAND
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
72/10/28	11	15	1.690	2.750	0.500	0.126	0.290
72/11/20	21	05	2.200	4.400	0.345	0.048	0.198
73/02/05	21	15	2.000	1.655	0.350	0.084	0.240
73/03/05	21	25	2.400	1.890	0.370	0.066	0.175
73/04/11	10	45	1.000	1.260	0.147	0.063	0.195
73/04/23	09	35	1.340	1.900	0.084	0.230	0.500
73/05/16	10	00	1.060	1.380	0.450		
73/05/31			1.660	2.500	0.399	0.190	0.440
73/06/14			0.720	2.500	0.540	0.220	0.380
73/06/29			0.440	3.360	0.910	0.260	0.450
73/07/24			0.189	2.460	0.210	0.060	0.270
73/08/23			0.300	2.150	0.180	0.126	0.340
73/09/28			0.270	1.540	0.220		

STORET RETRIEVAL DATE 75/02/04

2648A3 LS2648A3
42 46 30.0 086 01 00.0
BLACK RIVER
26 15 HOLLAND
T/LAKE MACATAWA
AT 96TH AVE BRDG 2 MI S ZEELAND
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
72/10/28	10 20		2.600	3.250	0.300	0.025	0.140
72/11/20	20 00		2.600	4.400	0.540	0.052	0.168
72/12/22	13 10		2.470	3.000	0.445	0.154	0.260
73/02/05	20 15		2.800	1.700	0.273	0.042	0.135
73/03/05	20 15		3.300	2.100	0.300	0.069	0.240
73/04/11	11 30		1.220	1.700	0.200	0.080	0.225
73/04/23	08 20		2.000	2.100	0.084	0.120	0.350
73/05/16	11 30		2.700	1.540	0.042	0.018	0.065
73/05/31			2.600	2.100	0.189	0.060	0.160
73/06/14			2.300	1.350	0.029	0.026	0.095
73/06/29			2.600	3.800	0.430	0.027	0.120
73/08/23			3.900	1.700	0.126	0.054	0.155
73/09/28			2.400	0.760	0.050	0.019	0.055

STORET RETRIEVAL DATE 75/02/04

264881 LS264881
42 48 00.0 086 08 30.0
PINE CREEK
26 15 HOLLAND
T/LAKE MACATAWA
LAKEWOOD BLVD BRDG W OF BEECHWOOD
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
72/10/28	11 00		0.720	1.180	0.310	0.022	0.085
72/11/20	20 55		0.940	3.700	0.735	0.032	0.085
72/12/22	13 45		1.040	2.200	0.310	0.034	0.105
73/02/05	21 05		0.890	1.180	0.330	0.026	0.065
73/03/05	21 15		1.000	1.320	0.280	0.033	0.090
73/04/11	10 30		0.780	1.050	0.080	0.021	0.069
73/04/23	09 10		0.860	1.400	0.027	0.063	0.190
73/05/16	11 00		1.000	1.570	0.290	0.028	0.050
73/05/31			0.900	1.400	0.260	0.039	0.075
73/06/14			1.340	0.860	0.088	0.028	0.060
73/06/29			1.260	0.820	0.078	0.015	0.042
73/07/24			1.380	0.840	0.046	0.019	0.035
73/08/23			1.320	1.600	0.280	0.031	0.070
73/09/28			1.520	1.400	0.072	0.019	0.045

STORET RETRIEVAL DATE 75/02/04

2648C1 LS2648C1
42 49 00.0 086 02 30.0
UNNAMED CREEK
26 15 HOLLAND
T/LAKE MACATAWA
BRDG .5 MI W ZEELAND ABOV STP
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
72/10/28	10 45		1.170	2.350	0.252	0.100	0.180
72/11/20	20 25		1.720	4.400	0.495	0.072	0.147
73/02/05	20 40		2.000	1.680	0.190	0.073	0.160
73/03/05	20 55		1.860	2.000	0.340	0.138	0.290
73/04/11	11 00		0.860	1.200	0.126	0.097	0.185
73/04/23	09 00		0.940	1.470	0.132	0.132	0.240
73/05/16	11 30		3.400	2.310	0.048	0.052	0.110
73/05/31			1.900	1.600	0.110	0.100	0.175
73/06/14			5.400	1.260	0.046	0.063	0.110
73/06/29			4.100	1.940	0.540	0.077	0.210
73/07/24			4.500	1.100	0.042	0.063	0.120
73/08/23			4.200	1.260	0.097	0.130	0.240
73/09/28			3.100	1.150	0.082	0.380	0.510

STORET RETRIEVAL DATE 75/02/04

2648C2 LS2648C2
42 48 00.0 086 03 00.0
UNNAMED CREEK
26 15 HOLLAND
T/LAKE MACATAWA
RD BRDG 1.5 MI SW ZEELAND BELOW STP
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
72/10/28	10 30		1.300	1.500	0.252	0.220	0.430
72/11/20	20 15		3.200	2.400	0.243	0.231	0.410
73/02/05	20 30		2.000	2.100	0.820	0.390	0.575
73/03/05	20 50		1.880	2.200	0.510	0.140	0.315
73/04/11	11 15		1.020	1.600	0.290	0.120	0.260
73/04/23	08 40		1.460	1.700	0.280	0.260	0.470
73/05/16	10 30		3.300	2.040	0.617	0.096	0.210
73/05/31			2.500	1.890	0.126	0.115	0.250
73/06/14			4.300	2.100	0.280	2.700	3.200
73/06/29			3.600	1.900	0.198	0.370	0.660
73/07/24			5.200	1.500	0.096	0.140	0.300
73/08/23			3.700	1.700	0.190	0.294	0.560
73/09/28			5.600	1.950	0.510	1.890	2.300

STORET RETRIEVAL DATE 75/02/04

264850 P0264850 P025000
42 47 00.0 086 07 30.0
HOLLAND
26 15 HOLLAND
D/LAKE MACATAWA
LAKE MACATAWA
11EPALES 2141204
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	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
72/12/25	08 00								
CP(T)-			0.490	16.800	2.000	1.030	1.500	3.800	4.270
72/12/25	19 00								
73/01/23	00 00								
CP(T)-			0.750	5.460	0.120	1.100	1.470	5.100	5.000
73/01/24	24 00								
73/02/21	00 00								
CP(T)-			0.150	9.800	0.950	1.200	1.700	4.300	4.500
73/02/21	24 00								
73/03/29	00 00								
CP(T)-			0.075	8.600	0.950	2.100	3.300	4.130	4.200
73/03/30	24 00								
73/04/28	00 00								
CP(T)-			0.945	9.600	0.460	1.200	1.500	4.500	4.500
73/04/28	24 00								
73/05/26	00 00								
CP(T)-			0.090	7.500	0.510	5.200	5.800	3.740	4.190
73/05/26	24 00								
73/06/17	00 00								
CP(T)-			0.150	11.500	1.130	0.760	1.000	3.690	4.650
73/06/17	24 00								
73/07/23	00 00								
CP(T)-			0.063	12.500	1.260	1.050	1.550	4.110	4.300
73/07/23	24 00								
73/08/20			0.105	17.000	1.280	1.740	2.700	4.660	4.210
73/09/18	00 00								
CP(T)-			0.165	7.900	0.096	1.800	2.500	4.240	4.500
73/09/18	24 00								
73/10/25	00 00								
CP(T)-			0.065	13.500	0.032	0.800	1.750	4.120	4.300
73/10/25	24 00								
73/11/30	00 00								
CP(T)-			0.120	12.500	0.200	1.150	2.300	4.310	4.000
73/11/30	24 00								
73/12/28	00 00								
CP(T)-			0.130	10.500	0.210	1.800	5.000	4.500	4.300
73/12/28	24 00								

STORET RETRIEVAL DATE 75/02/04

264851 P0264851 P005000
42 48 30.0 086 02 00.0
ZEELAND
26 15 HOLLAND
T/LAKE MACATAWA
UNNAMED STREAM
11EPALES 2141204
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	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/01/30 00 00									
CP(T)-			0.040	24.000	18.000	29.000	30.000	0.665	0.722
73/01/30 24 00									
73/02/26 00 00									
CP(T)-			0.170	28.000	12.000	0.177	3.000	0.527	0.540
73/02/26 24 00									
73/03/30 08 00									
CP(T)-			0.640	18.900	5.800	0.840	4.700	0.704	0.629
73/03/30 16 00									
73/05/23 00 00									
CP(T)-			8.600	9.300	2.900	0.640	1.320	0.545	0.672
73/05/23 24 00									
73/06/28 00 00									
CP(T)-			8.800	4.800	0.540	5.200	7.950	0.575	0.552
73/06/28 24 00									
73/07/31 00 00									
CP(T)-			15.800	3.200	0.173	9.500	15.000	0.560	0.562
73/07/31 24 00									
73/08/29 00 00									
CP(T)-				3.200	0.044	0.630	2.100	0.520	0.532
73/08/29 24 00									
73/09/28 00 00									
CP(T)-			7.900	16.050	12.600	45.000	51.250	0.580	0.530
73/09/28 24 00									
73/10/31 00 00									
CP(T)-			23.000	2.400	0.038	0.970	2.300	0.330	0.370
73/10/31 24 00									
73/11/30 00 00									
CP(T)-			7.200	12.000	0.046	0.920	2.050	0.421	0.347
73/11/30 24 00									
73/12/31 00 00									
CP(T)-			15.000	6.500	1.050	0.350	1.350	0.390	0.405
73/12/31 24 00									
74/01/30 00 00									
CP(T)-			6.300	7.200	2.510	28.000	28.800	0.748	0.548
74/01/30 24 00									

STORET RETRIEVAL DATE 75/02/04

264851 P0264851 P005000
42 48 30.0 086 02 00.0
ZEELAND
26 15 HOLLAND
T/LAKE MACATAWA
UNNAMED STREAM
11EPALES 2141204
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	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
74/02/28	00	00							
CP(T)-			11.000	4.900	0.220	0.540	10.500	0.715	0.571
74/02/28	24	00							