LAKE HURON BASIN

AU SABLE RIVER - MICHIGAN

WATER QUALITY DATA
1965 SURVEY

Clean Water Series LHBO-18-A

U.S. DEPARTMENT OF THE INTERIOR

Federal Water Pollution Control Administration

Great Lakes Region

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JANUARY 1969

U.S. DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
Great Lakes Region
Lake Huron Basin Office
U. S. Naval Air Station
Grosse Ile, Michigan
48138

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INTRODUCTION

The water quality data contained in this report are the results of field investigations and other studies conducted in 1965 and 1966 to provide information for a water pollution control plan for the Lake Huron Basin. The Lake Huron Basin Study is a part of the Great Lakes-Illinois River Basins Project, directed by the Great Lakes Region, Federal Water Pollution Control Administration (FWPCA) and under authority of Public Law 84-660 (33 U.S.C. 466 et seq.).

> Sec. 3. (a) The Secretary shall, after careful investigation, and in cooperation with other Federal agencies, with State water pollution control agencies and interstate agencies, and with the municipalities and industries involved, prepare or develop comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof and improving the sanitary condition of surface and underground waters. In the development of such comprehensive programs due regard shall be given to the improvements which are necessary to conserve such waters for public water supplies, propagation of fish and aquatic life and wildlife, recreational purposes, and agricultural, industrial, and other legitimate uses. For the purpose of this section, the Secretary is authorized to make joint investigations with any such agencies of the condition of any waters in any State or States, and of the discharges of any sewage, industrial wastes, or substance which may adversely affect such waters.

Total water quality planning begins in the headwaters of the individual river basins and continues downstream through the major tributaries to and including the Great Lakes. The extent and complexity of the Great Lakes and tributaries are shown on Figures 1, 2, and 3.

Water quality standards for interstate waters (Lake Huron) have been adopted by the State of Michigan and approved by the Secretary

of the Interior. Intrastate standards for Michigan are being implemented by the Michigan Water Resources Commission. These standards will form a basis for long-range plan for controlling pollution and maintaining water quality for Lake Huron and its tributaries.

ACKNOWLEDGMENTS

The principal agencies taking an active part in providing assistance in the preparation of the report are as follows:

State Agencies - Michigan Water Resources Commission
Michigan Department of Public Health

Federal Agencies - U.S. Department of Commerce
Weather Bureau
Office of Business Economics
Bureau of Census

U.S. Department of the Interior
Bureau of Commercial Fisheries
Bureau of Sport Fisheries and Wildlife
Bureau of Outdoor Recreation
Geological Survey

For further information, contact the following:

Lake Huron Basin Office
Federal Water Pollution Control Administration
U.S. Naval Air Station
Grosse Ile, Michigan 48138

Michigan Water Resources Commission
Stevens T. Mason Building
Lansing, Michigan 48926

Michigan Department of Public Health
3500 N. Logan
Lansing, Michigan 48914

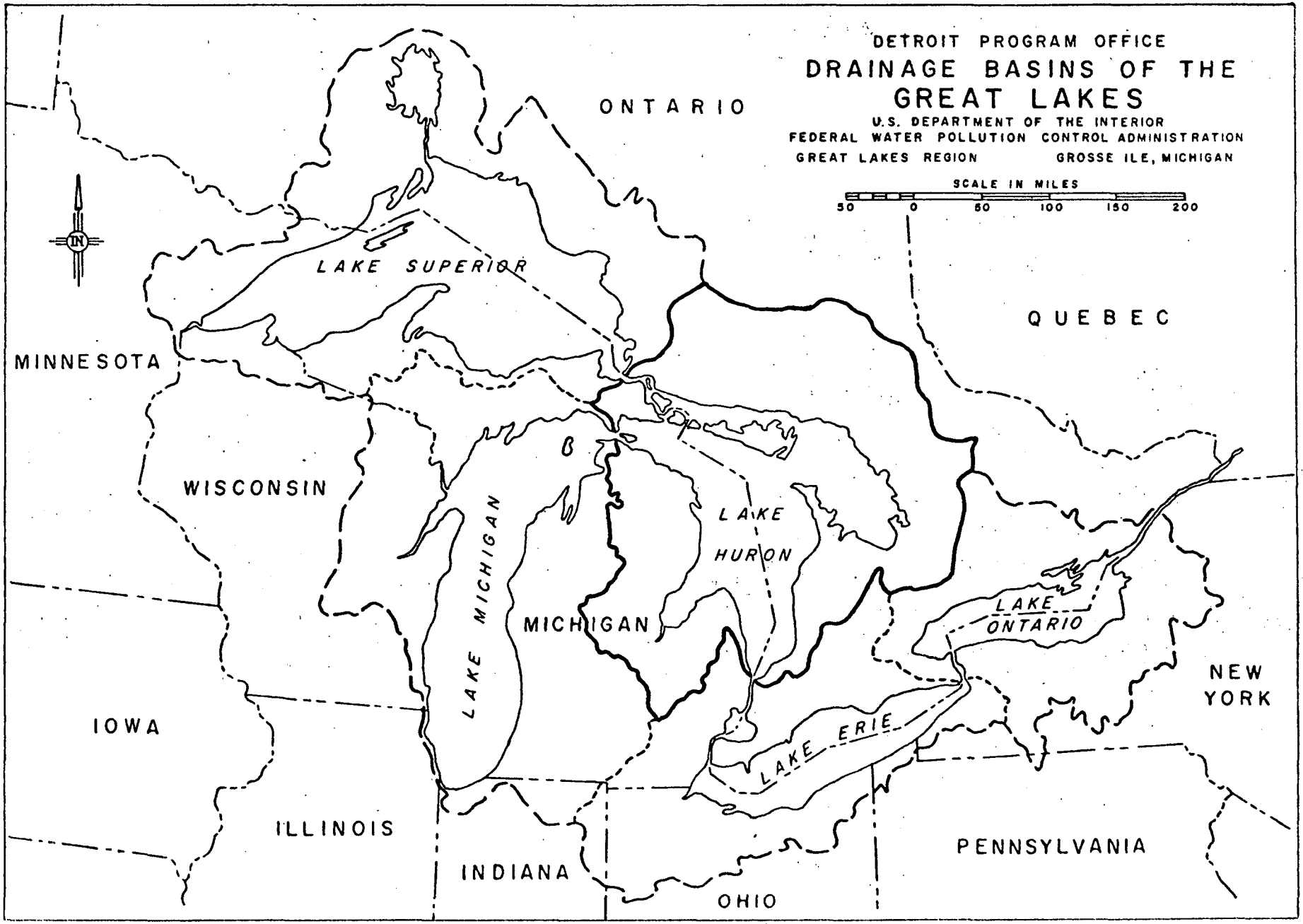
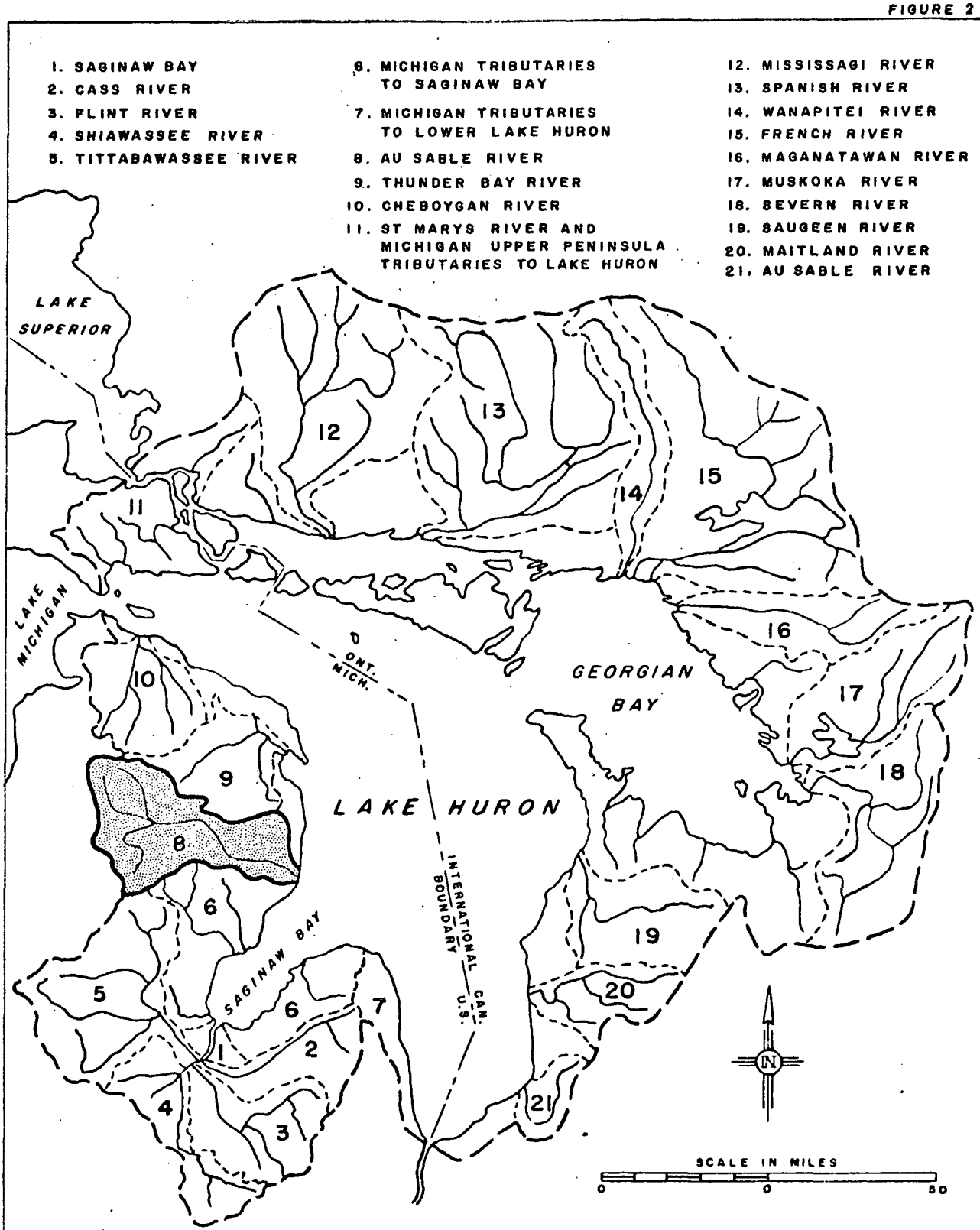

DETROIT PROGRAM OFFICE
DRAINAGE BASINS OF THE GREAT LAKES
U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
GREAT LAKES REGION
GROSSE ILE, MICHIGAN
SCALE IN MILES
50 0 50 100 150 200
IN
ONTARIO
LAKE SUPERIOR
QUEBEC
MINNESOTA
WISCONSIN
LAKE MICHIGAN
LAKE HURON
MICHIGAN
LAKE ONTARIO
NEW YORK
IOWA
LAKE ERIE
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA

FIGURE 1

FIGURE 2



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LAKE HURON BASIN

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GREAT LAKES REGION GROSSE ILE, MICHIGAN

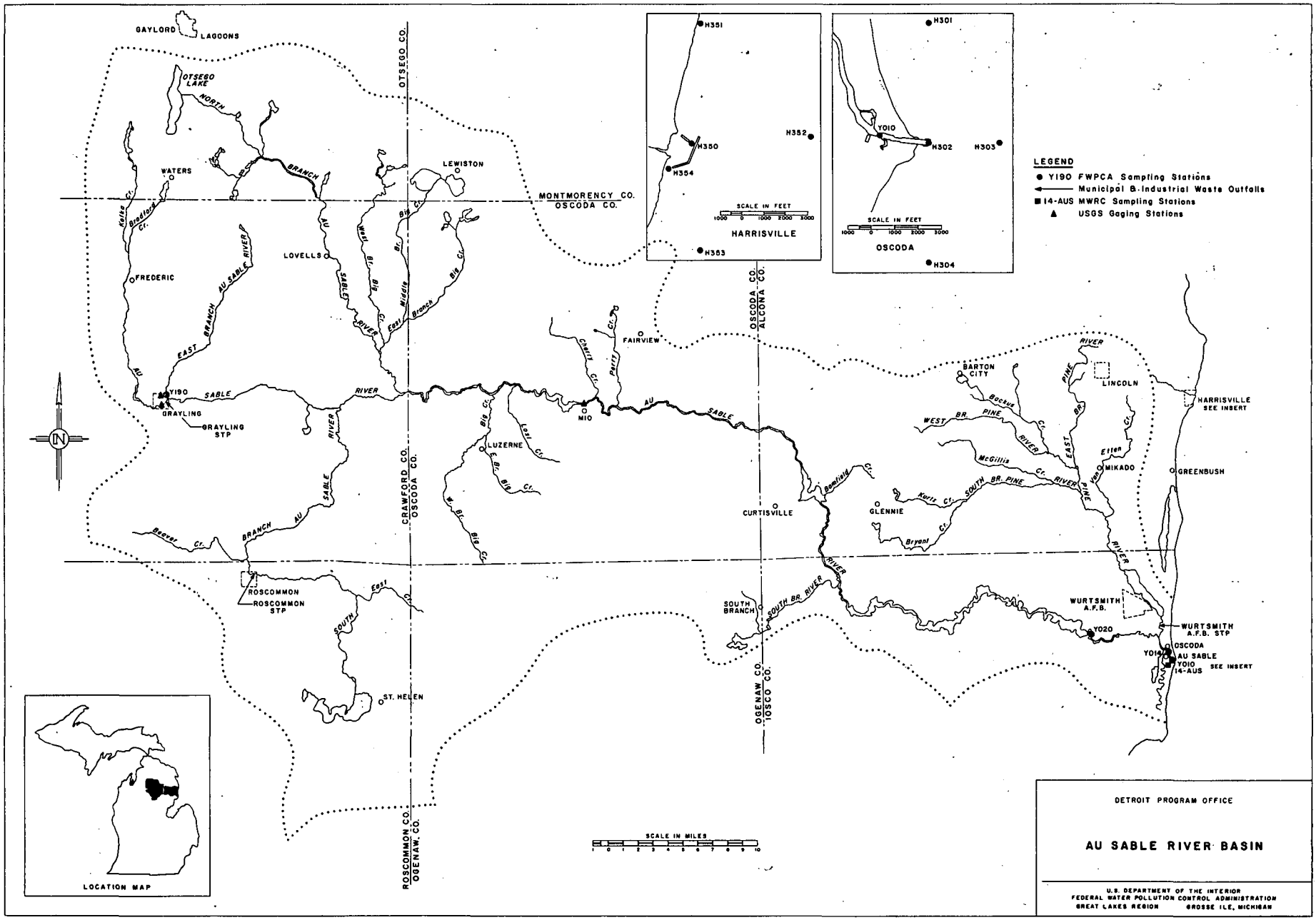
GAYLORD LAGOONS
OTSEGO LAKE
NORTH BRANCH
WATERS
LEWISTON
OTSEGO CO.
MONTMORENCY CO.
OSCODA CO.
Kolke Cr.
Bradford Cr.
FREDERIC
AU SABLE RIVER
EAST BRANCH AU SABLE
LOVELLS
SABLE RIVER
West Br. Big Cr.
Big Cr.
East Middle Branch
Big Cr.
H351
H350
H354
H352
H353
SCALE IN FEET
HARRISVILLE
H301
Y010
H302
H303
H304
SCALE IN FEET
OSCODA
LEGEND
Y190 FWPCA Sampling Stations
Municipal & Industrial Waste Outfalls
14-AUS MWRC Sampling Stations
USGS Gaging Stations
FAIRVIEW
Cheese Cr.
Parris Cr.
OSCODA CO.
ALCONA CO.
BARTON CITY
Pine River
LINCOLN
HARRISVILLE SEE INSERT
Y190
GRAYLING
GRAYLING STP
SABLE RIVER
MIO
AU SABLE
Bockus Cr.
WEST BR. PINE RIVER
EAST BR. PINE RIVER
Ellen Cr.
MIKADO
GREENBUSH
McGillis Cr.
Bowfield Cr.
Kurtz Cr.
SOUTH BR. PINE RIVER
Bryant Cr.
CURTISVILLE
GLENNIE
Big Cr.
Lost Cr.
LUZERNE
E. Br. Big Cr.
W. Br. Big Cr.
CRAWFORD CO.
OSCODA CO.
Beaver Cr.
AU SABLE BRANCH
ROSCOMMON
ROSCOMMON STP
South East Br.
SOUTH BRANCH
SOUTH BR. RIVER
WURTSMITH A.F.B.
Y020
WURTSMITH A.F.B. STP
OSCODA
Y014
AU SABLE
Y010
14-AUS
SEE INSERT
ST. HELEN
OGEMAW CO.
IOSCO CO.
ROSCOMMON CO.
OGEMAW CO.
SCALE IN MILES
LOCATION MAP
DETROIT PROGRAM OFFICE
AU SABLE RIVER BASIN
U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
GREAT LAKES REGION GROSSE ILE, MICHIGAN

FIGURE 3

GENERAL DESCRIPTION

Area Description

The Au Sable River Basin (Figure 3), with a drainage area of 2,035 square miles, lies in the northeastern part of the lower peninsula. It is comprised of parts of Otsego, Crawford, Roscommon, Ogemaw, Oscoda, Montmorency, Alcona, and Iosco Counties. Grayling, the major city, is in the center of one of the leading recreational areas of the State of Michigan. With headwaters in southeastern Otsego County, the Au Sable River flows southerly, then easterly, and finally southeasterly to its mouth into Lake Huron.

The basin, irregular in shape, is 80 miles long and 40 miles wide, measuring at the longest and widest parts. It is bounded on the north by Thunder Bay Basin; on the east by Lake Huron; on the south by the Tittabawassee Basin, Rifle River Basin, Au Gres River Basin, and by land adjacent to Lake Huron; on the west by Manistee River Basin; and on the southwest by the Muskegon River Basin. The major tributaries include the North Branch Au Sable, Middle Branch Au Sable, South Branch Au Sable, and Pine Rivers.

Much of the Au Sable River Basin is sparsely populated and is occupied by Thunder Bay River, Pigeon River, and Au Sable River State Forests and Huron National Forest; Hanson Military Reserve; and the Artillery Range. Three major population centers in this part of the basin are: Gaylord - near Otsego Lake, the headwaters of North Branch Au Sable River; Grayling - at the confluence of the East Branch Au Sable

with the Au Sable River; and Roscommon - on the South Branch Au Sable River.

In addition to the permanent residents there is a large transient population, the National Guard at Camp Grayling brings a temporary population of 10,000 to the area. Campgrounds and other recreational facilities attract a heavy tourist trade. There are no large industries in the area. Population reached a peak in the 1920's and, after the decline of lumbering, remained stable until the 1950's when small industries moved into the area. The population has since increased, principally from the prospering tourist and recreational developments.

The drainage basin below Grayling and Roscommon remains sparsly settled, with Mio the only community along the Au Sable River. Mio does not have community collection or disposal system. At Mio, a dam forms an impoundment of 860 acres for hydroelectric power. Most of this section of drainage area is in public ownership - Thunder Bay River State Forest and Huron National Forest. Many campsites are located along the river bank. The river flows southward through Bamfield Pond, a 1,075-acre impoundment created for hydroelectric power. The numerous gravel pits, abandoned railroads, and dirt roads in the xurrounding area are indications of man's former activities in the basin. Small settlements are present throughout this area.

The river then flow eastward through a series of impoundments which change the character of the river to that of the lake, with only short reaches of free-flowing streams. These impoundments and the surface area in acres are: Loud Basin - 790, Five Channels Basin - 250, Cooke

Dam Basin - 1850, and Foote Basin - 1800. Alpena State Forest and Huron National Forest comprise most of the land in this increment of drainage.

The river character changes below Foote Basin Dam to that of swift stream coursing within steep banks to the outlet of the lake. There are a number of small communities in this area, including Lincoln and Mikado. Van Etten Creek-Pine River is impounded near Wurtsmith Air Force Base (AFB) to form Van Etten Lake, a recreational lake. The outflow is known as Van Etten Creek. The character of the basin is changed from the forested areas in the upper reaches. The major activity in this area is the air base. From the confluence of Van Etten Creek to the mouth of the Au Sable River at Lake Huron, the area is rapidly developing, due in part to the presence of Wurtsmith AFB. The communities of Oscoda and Au Sable are located at the mouth of the Au Sable River. A navigation channel is maintained from the US-23 bridge to the 12-foot contour of Lake Huron. A number of marinas and boat-service facilities are located along this stretch of the river.

Climate

The climate of the Au Sable River is greatly modified by the upper Great Lakes, which warm the air in the winter and cool it in the summer. The climate is typical of the entire upper Great Lakes area and can be described as having a wide seasonal variation, many storms, and a constant yearly precipitation distribution. In the winter, this precipitation is in the form of snow. Mean yearly temperature is 43°F.

There is an average yearly precipitation of 32.4 inches, with a growing season of 150 days.

Hydrology

There are three U.S. Geological Survey (USGS) stream gaging stations located in the Au Sable River Basin.

The first of these gaging stations is the Au Sable River at Grayling located on the right bank, 65 feet upstream from the bridge on US-27 at Grayling and three-quarters of a mile upstream from East Branch. Prior to October 1954, it was referred to as Middle Branch Au Sable River. It has a drainage area of 110 square miles. The station has been in operation since October 1942.

The second USGS gaging station is the East Branch of the Au Sable River at Grayling, 0.4 miles upstream from the mouth and has a drainage area of 76 square miles. The station has been in operation since April 1958.

The third gaging station is the Au Sable River at Mio located on the right bank, 150 feet upstream from the bridge on M-33. The station has a drainage area of 1,100 square miles and has been in operation since 1952.

The ranges of observed discharges and yields for these gaging stations are shown on Table 1.

The low-flow average discharge for one, seven, and thirty consecutive days duration, with a recurrence interval of ten years, has been calculated by use of Gumbel's logarithmic extremal probability paper. The stations used were the Au Sable River at Grayling and Au Sable River

at Mio (Table 1).

Figure 4 is the flow duration curve for the Au Sable River at Mio. The shape of the curve, with a shallow gradient, indicated the stable nature of streamflow in the Au Sable River and a relatively constant yield. This is also indicated by the high drought flow yield.

USGS gages and sampling station locations are shown on Figure 3 and sampling stations are described on Table 2.

TABLE 1. FLOW CHARACTERISTICS
Au Sable River Basin

Location		USGS Records Flow (cfs)	USGS Records Yield (cfsm)	Computed Drought (low) Flows* Duration (days)	Computed Drought (low) Flows* Flows (cfs)	Computed Drought (low) Flows* Yield (cfsm)
Au Sable River at Grayling 110 square miles - 1942 to 1960	Maximum	274	2.491	1	42	.382
	Minimum	28	.255	30	48	.436
	Average	73	.663	7	46	.418
East Branch of the Au Sable River at Grayling 76 square miles - 1958 to 1960	Maximum	135	1.776	-	-	-
	Minimum	16	.211	-	-	-
	Average	39	.517	-	-	-
Au Sable River at Mio 1100 square miles 1952 - 1960	Maximum	3,450	3.136	1	500	.455
	Minimum	456	.415	30	640	.582
	Average	906	.824	7	580	.527

* Recurrence interval of once in 10 years for period of record plotted on Gumbel's logarithmic extremal probability.

FIGURE 4

FLOW DURATION CURVE
AU SABLE RIVER AT MIO
1953-1964

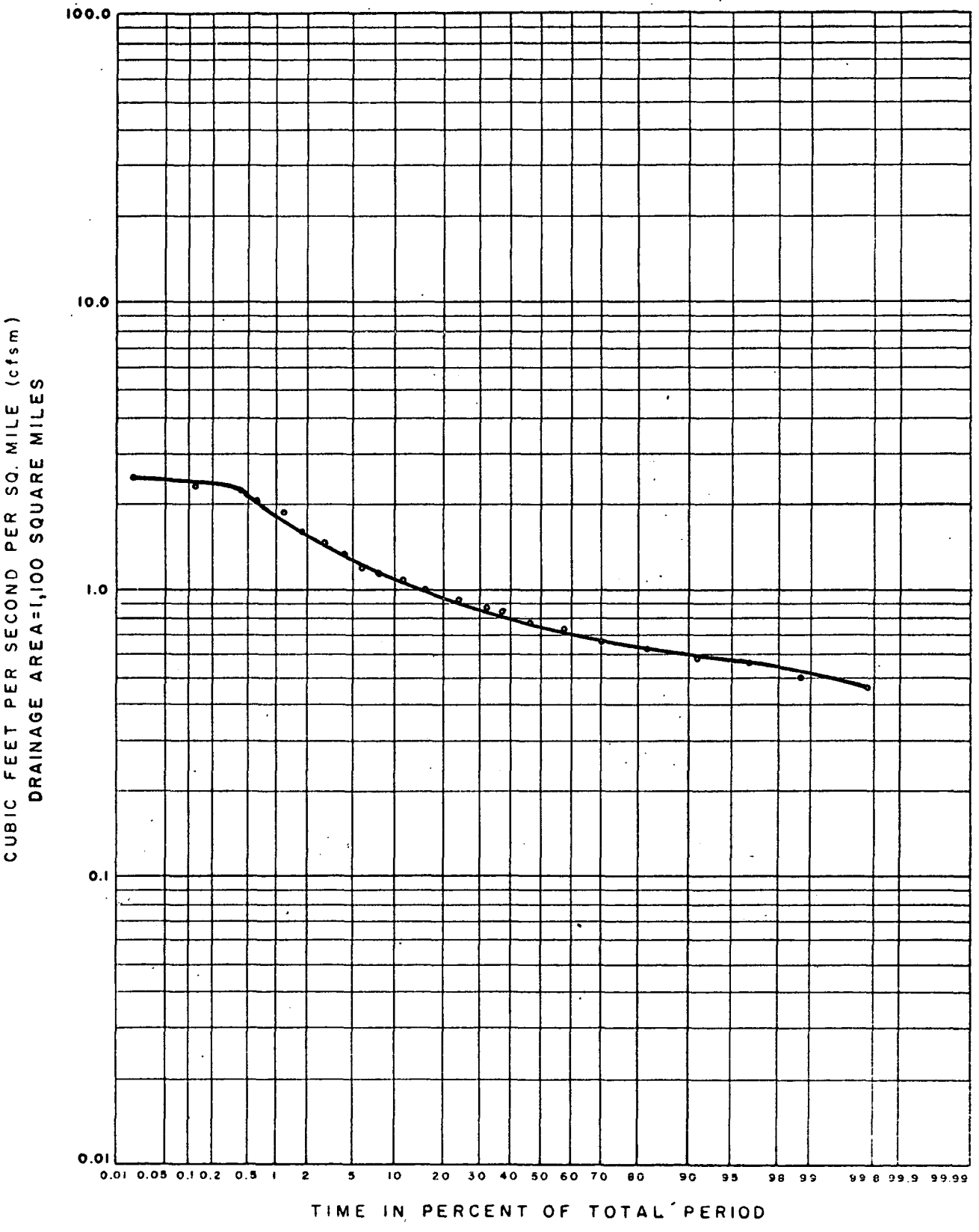

TABLE 2. AU SABLE RIVER SAMPLING STATIONS

Mainstream Stations

Station	Mile Point	Location
Y010	0.3	US-23 bridge - Oscoda
Y014	0.9	Mill Street bridge - Oscoda
Y020	11.0	Bissonette Road bridge below Foote Dam
Y190	113.4	East Branch Au Sable River - foot bridge behind Mercy Hospital in Grayling (USGS gage # 4-1356)
#14-AuS MWRC	0.3	Same location as Y010

Nearshore Stations

Oscoda		
H301		5,000' north of breakwater light
H302		At breakwater light
H303		3,000' east of breakwater light
H304		5,000' south of breakwater light
Harrisville		
H350		North entrance to harbor, center of channel
H351		5,000' north of north end of breakwater
H352		5,000' east of north end of breakwater
H353		5,000' south of north end of breakwater
H354		10' from southwest end of main breakwater

WATER USE

Municipal

The Au Sable River Basin and adjacent shoreline area has a population of 7,500 served by public water supplies. Camp Grayling, the National Guard Camp, serves a population of 10,000 during the summer training sessions. The estimated population served, excluding Camp Grayling, by 1990 and 2020 is 14,300 and 23,800, respectively.

Present water supplies are listed in Table 3 and projections of water use are shown on Table 4.

Industrial

There is little manufacturing in the Au Sable River Basin. The water used for other than domestic purposes is purchased from the local municipal source. Projections of the quantity used are included in the municipal projections on Table 4.

Water-Related Recreation

The Au Sable River is probably the most famous recreational stream in Michigan. Its popularity began in the 1800's, when fishing for grayling (trout) became popular. This popularity has continued even as the predominant species of fish changed from grayling to the more hardy and adaptable species of trout.

The use of the river by canoeists is also popular with annual rentals at the liveries exceeding 18,000. The stream is a recognized canoe trail by the Michigan Tourist Council and Michigan Department of Conservation. Campsites have been developed along the stream for the

use of canoeists. Thousands of visitors annually take the popular tour along M-72 down the beautiful Au Sable River Valley from Grayling to the Lake Huron shore. A more detailed discussion of basin recreation is contained in the Bureau of Outdoor Recreation publication "Water-Oriented Outdoor Recreation Lake Huron Basin (1967)."

Commercial Shipping

Harrisville with 97,215 tons of jet fuel and the Au Sable Harbor with 118 tons of fresh fish represent the commercial navigation recorded for the Au Sable River Basin. This is only .3% of the Michigan total for the Lake Huron Basin.

TABLE 3. MUNICIPAL WATER SUPPLIES*

Au Sable River Basin and Adjacent Shoreline Areas

Community	1960 Pop.	Owner	Source
Oscoda Township	700	T	Wells in drift 30' to 51' deep
Wurtsmith AFB	7400**	US	Wells in drift 53' to 65' deep
Gaylord	2568	M	Wells in drift 110' to 198' deep
Northern Michigan TB Sanitorium	225	S	Wells in drift 234' deep
Grayling	2015	M	Wells in drift 50' deep
Camp Grayling	10,000**	US	Wells in drift 50' to 176' deep
Roscommon	867	M	Wells in drift 42' to 103' deep
Harrisville	487	M	Wells in drift 40' to 57' deep
Hawes Township	Resort	P	Well in drift 160'

* Taken from "Data on Public Water Supplies in Michigan," Engineering Bulletin No. 4 by the Michigan Department of Public Health.

** Intermittent Use.

T - township
US - Federal
M - city or village
S - State
P - private

The well water supplies did not receive any treatment.

TABLE 4. PROJECTED WATER USE
(MGD)

Au Sable River Basin and Adjacent Shoreline Areas

	1965	1990	2020
Municipal*	0.8	1.7	3.5
Industrial	0	2.0	5.0
Total	0.8	3.7	8.5

* Includes water for small industries.

SOURCES AND CHARACTERISTICS OF WASTES

Municipal

In 1965, there were three municipal systems which were sources of waste in the upper reaches of the Au Sable River Basin - Gaylord, Grayling, and Roscommon. The treatment system at Gaylord was a lagoon with no provision for overflow to surface waters. Grayling and Roscommon had primary sewage treatment plants with separate sewer systems. Wurtsmith Air Force Base was the major community in the basin. Secondary treatment was provided for domestic wastes, and aircraft washings were treated by oil and grease separation, then discharged to a separate stormwater system (Table 5). Effluent was discharged to Van Etten Creek. The townships of Au Sable and Oscoda, near the mouth of the Au Sable River, and the township of Mikado in the upper reaches of Van Etten Creek were cited by the MWRC in December 1966 for the discharge of undetermined quantities of raw and semi treated sewage from various residences and commercial establishments.

Municipal waste treatment plants are described in Table 5. The information is based on 1965 records of the Michigan Department of Public Health. Prior to January 1967, all plants were required to practice disinfection from May 15 to September 15. Since that date, continuous year-round disinfection is required by the Department of Public Health regulation. Effluent characteristics based on the 1965 plant operating records are also listed on Table 5, and outfall locations are shown on Figure 3.

Industrial

There were no significant sources of industrial waste in the basin at the time of this survey.

Federal Installations

There are 17 Federal installations located in the Au Sable River Basin, 10 of which are campground areas. The major installation in the basin is the Wurtsmith Air Force Base which has secondary treatment and chlorination. A pumping station and primary settling tank are to be constructed, followed by diverting the effluent to another drainage basin. As listed in Table 6, there are some septic tanks and a few drain fields at the Department of Agriculture, Forest Service installations.

TABLE 5. MUNICIPAL WASTE TREATMENT PLANTS
1965 Effluent Characteristics
Au Sable River Basin

Community and Population Served	Type of Treatment	Flow (MGD)	Temp °F	BOD_5 (mg/l)	COD (mg/l)	Cl. (mg/l)	Total PO_4 (mg/l)	NH_3-N (mg/l)	Org-N (mg/l)	pH
Gaylord 2800	Lagoon	- No discharge - No records -					-	-	-	-
Grayling 2000	Primary	.31	47	145	324	100	49	17	12	8.0
Roscommon 900	Primary	.15	45	83	266	110	42	16	13	7.7
Wurtsmith AFB 7400	Secondary	.55	-	-	-	-	-	-	-	-
Oscoda Township 600	Septic tanks and dry well	-	-	-	-	-	-	-	-	-
Au Sable Township 60	Septic tanks and dry well	-	-	-	-	-	-	-	-	-
Mikado Township 4000	Septic tanks and dry well	-	-	-	-	-	-	-	-	-

NOTE: Data for Grayling and Roscommon based on 1966 MWRC Survey.

TABLE 6. INVENTORY OF WASTE WATER DISPOSAL
AT FEDERAL INSTALLATIONS
Au Sable River Basin

Installation (Municipality and County)	Type of Wastes	Receiving Waters	Treatment Provided	Remarks
Wurtsmith Air Force Base (Oscoda, Iosco Co.)	Sanitary 660,000 GPD	Van Etten Creek Tributary of Lake Huron	Secondary treatment and Chlorination	Contract has been let to construct new pumping station laboratory and primary settling tank. The construction phase of this work will begin at the end of August 1968, and completion is expected by Spring of 1969. These improvements will not be sufficient to accomplish the goals set by the State of Michigan for quality of effluent discharged to Van Etten Creek, a spawning ground for salmon. The above improvements are interim measures pending construction of facilities to divert the effluent from Van Etten Creek to the ground in another drainage basin. The diversion design phase has already been

TABLE 6. INVENTORY OF WASTE WATER DISPOSAL
AT FEDERAL INSTALLATIONS (Cont'd)
Au Sable River Basin

Installation (Municipality and County)	Type of Wastes	Receiving Waters	Treatment Provided	Remarks
Wurtsmith Air Force Base (Oscoda, Iosco Co.) (Cont'd)				been completed and funds have been requested for this construction. Pending early approval of funds, the expected completion date is FY 1971.
Glennie Warehouse (Alcona Co.)	Sanitary 75 GPD	Ground	Septic Tanks, Drain Field	
Pine River Compound (Alcona Co.)	Sanitary	Ground	Pit Toilet	Compound capacity 25 people
Horseshoe Lake Campground (Alcona Co.)	Sanitary	Ground	Pit Toilet	Campground capacity 10 people
Monument Campground (Iosco Co.)	Sanitary	Ground	Septic Tanks, Drain Field	Campground capacity 65 people
Rollway Campground (Iosco Co.)	Sanitary	Ground	Pit Toilet	Campground capacity 95 people
Rollway Picnic Area (Iosco Co.)	Sanitary 300 GPD	Ground	Septic Tanks, Drain Field	
Lumberman's Monument (Iosco Co.)	Sanitary 1,200 GPD	Ground	Pit Toilet	

TABLE 6. INVENTORY OF WASTE WATER DISPOSAL
AT FEDERAL INSTALLATIONS (Cont'd)
Au Sable River Basin

Installation (Municipality and County)	Type of Wastes	Receiving Waters	Treatment Provided	Remarks
District Ranger Office (Mio, Oscoda Co.)	Sanitary 75 GPD	Ground	Septic Tanks, Drain Field	
Rangers Dwelling (Mio, Oscoda Co)	Sanitary 225 GPD	Ground	Septic Tanks, Drain Field	
Asst. Ranger Dwelling (Mio, Oscoda Co.)	Sanitary 450 GPD	Ground	Septic Tanks, Drain Field	
Warehouse (Mio, Oscoda Co.)	Sanitary 45 GPD	Ground	None	
Loon Lake Campground (Oscoda Co.)	Sanitary	Ground	Septic Tanks, Drain Field	Campground capacity 215 people. New septic tank and drain field installed in 1967.
Island Lake Campground (Oscoda Co.)	Sanitary	Ground	Pit Toilet	Campground capacity 145 people
Mack Lake Campground (Oscoda Co.)	Sanitary	Ground	Pit Toilet	Campground capacity 30 people
Wagner Lake Campground (Oscoda Co.)	Sanitary	Ground	Pit Toilet	Campground capacity 50 people
Boy Scout Organization Camp (Oscoda Co.)	Sanitary	Ground	Pit Toilet	Camp capacity 50 people

POPULATION AND WASTELOAD PROJECTIONS

Demographic studies were conducted by the Great Lakes-Illinois River Basins Project, Chicago, Illinois for the Lake Huron Basin. Population trends on a national, regional, and county basis were analyzed, and population projections were developed for the various areas of the Lake Huron Basin. In 1960, approximately 1.2 million persons lived in the Lake Huron watershed, about double the 1920 population. By the year 2020, it is estimated that the population of the watershed will be approximately 3.2 million.

The population centers in the Au Sable River Basin and adjacent shoreline areas are Grayling (2015), Roscommon (867), Gaylord (2568), and Harrisville (487) according to the 1960 census figures. For this report, each area was analyzed assuming that by 2020 the area will be urbanized and served by water and sewer systems. The individual areas were added to yield the total population served in the basin. The 1965 population served by sewer systems was estimated to be 6,500 and projected to be 14,300 by the year 1990 and 23,800 by the year 2020. Population served should not be construed as being total population of the basin.

Table 7 shows the estimated waste flow in million gallons per day (MGD) for the Au Sable River Basin and adjacent shoreline areas, and on Figure 5 appears the projections for population and wasteflow excluding adjacent shoreline areas.

BOD_5 projections were based on present day inventory information obtained from the Michigan Water Resources Commission, Michigan Department

of Public Health, and the Federal Water Pollution Control Administration. Municipal and industrial water use growth rates and BOD_5 production in terms of population were determined from studies on the Lake Michigan Basin and applied to the inventory data obtained for the Au Sable River Basin. The results of these projections are shown on Table 8. The municipal BOD_5 load for 1965 was calculated on the basis of .17 pounds per day of BOD_5 per person served, and the 1990 and 2020 load factors, .18 and .20 pounds per day of BOD_5 per person. For example, in 1965 a total of 1100 pounds per day of BOD_5 is produced in the area of which 59 percent is removed by treatment, leaving 470 pounds of BOD_5 being discharged to the river. By the year 2020, with the same percentage of treatment, 2000 pounds would reach the river. In order to show an improvement over present water quality, 90 percent or more removal will be necessary at that time.

Although at present there are no significant industrial waste sources in the basin, an assumption that industries would develop in the basin and adjacent shoreline areas was made for projection purposes.

TABLE 7. WASTE FLOW PROJECTIONS (MGD)
Au Sable River Basin and Adjacent Shoreline Areas

	1965	1990	2020
Municipal			
Residential	0.7	1.7	3.3
Commercial	-	0.1	0.2
Total Municipal	0.7	1.8	3.5
Industrial	-	2.0	5.0
Total Industrial and Municipal	0.7	3.8	8.5

FIGURE 5

POPULATION AND MUNICIPAL WASTE FLOW PROJECTIONS FOR THE AU SABLE RIVER BASIN

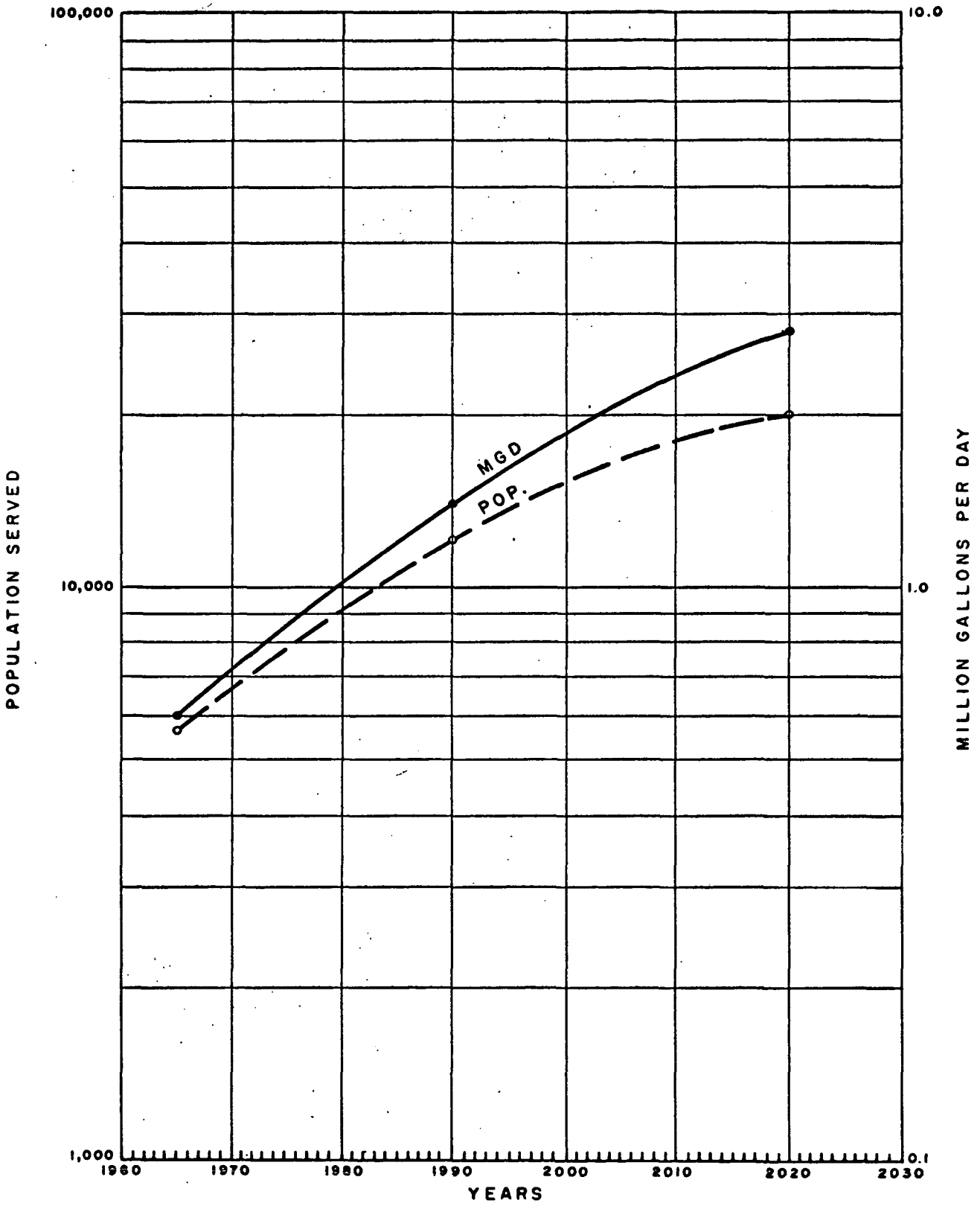

TABLE 8. BOD_5 PROJECTIONS
(Pounds per Day)
Au Sable River Basin and Adjacent Shoreline Areas

Untreated BOD_5	Percent Removal	1965	1990	2020
Municipal				
Residential		1,110	2,565	4,750
Commercial		23	63	150
Total		1,133	2,628	4,900
Industrial		-	10,500	25,000
Total Untreated BOD_5		1,133	13,128	29,900
Treated BOD_5				
Municipal	59 (present)	468	1,085	2,024
	90	113	263	490
	95	57	131	245
	99	11	26	49
Industrial	35	-	6,825	16,250
	90	-	1,050	2,500
	95	-	525	1,250
	99	-	105	250
Total Treated BOD_5	present	468	7,910	18,274
	90	113	1,313	2,990
	95	57	656	1,495
	99	11	131	299

WATER QUALITY DATA

The Federal Water Pollution Control Administration conducted surveys of the Au Sable River and adjacent waters of Lake Huron during 1965 to determine the quality of these waters. Station locations are shown on Figure 3 and described in Table 2. Samples collected were analyzed for physical, chemical, microbiological, and biological parameters.

One location (Station Y010), a quarter-of-a-mile above the mouth of the Au Sable River, was sampled on a monthly basis from January through November. A second location (Station Y190), on the East Branch Au Sable River at Grayling near the confluence with the main stream, was sampled periodically from May through November. A third location (Station Y020), on the Au Sable River just below Foote Dam eleven miles upstream from the mouth, was sampled once. An additional station, Y014, was sampled for biological parameters.

Sampling was also carried out in nearshore Lake Huron at four locations near Oscoda and five locations near Harrisville, and collected on a monthly basis from May through October.

In addition to the FWPCA 1965 sampling program, the MWRC maintains a water quality monitoring station at the mouth of the Au Sable River (MWRC-AuS-14). This location coincided with the FWPCA station. Data was collected on a monthly basis. In 1966, the MWRC made extensive studies of the Au Sable River below Grayling and the South Branch of the Au Sable below Roscommon to study the effects

of pollution from the primary plants at these two cities.

Data from the various surveys during 1965 are listed on Tables 9 through 12.

Au Sable River

The dissolved oxygen level in the Au Sable River was high, with an average of 90 percent saturation at the sites studied during the 1965 survey. There was no indication that photosynthesis was a factor in the oxygen level as no samples indicated super-saturation. Dissolved oxygen levels ranged from 7.2 mg/l to 13.0 mg/l, with an average of 10.8 mg/l at the MWRC location near the mouth of the river. At the FWPCA station, the range was from 7.3 to 11.4 mg/l, with an average of 9.3 mg/l. The FWPCA samples were collected during the warmer months of the year, accounting for the lower maximum level, (Table 9). These levels indicated adequate dissolved oxygen in the river.

Organic matter, expressed in terms of BOD_5 and oxidizable nitrogen (organic, ammonia and nitrite), indicated excellent water quality. BOD_5 levels averaged from 1 to 2 mg/l, with a maximum of 3 mg/l. The oxidizable nitrogen levels were similarly low, averaging less than .5 mg/l (Table 9). There were no major sources of organic pollution upstream of the sampling site on the East Branch of the Au Sable River. The site near the mouth of the Au Sable River is 100 miles downstream from the primary treatment plants at Grayling and Roscommon and 10 miles downstream from the secondary plant at

Wurtsmith AFB. Organic matter from this source would have the opportunity for assimilation before reaching the sampling site.

Nutrient levels in terms of nitrate-nitrogen and total and soluble phosphorus as phosphate were indicative of minor pollution, with average levels less than .1 mg/l. The site in the upper basin was, however, upstream of main sources of nutrients - the Grayling and Roscommon primary treatment plants. Near the mouth of the river, which would include any residual nutrients from these plants as well as that from the air force base, the levels were low due in part to the dilution provided by additional stream-flow at this point. Nitrate levels were similary low, averaging .2 mg/l.

Chlorides and other dissolved solids indicated excellent water quality at all sites measured. Average chloride level was 3 mg/l near the mouth of the Au Sable River and 3 mg/l in the East Branch Au Sable River. Dissolved solids averaged 180 mg/l in the basin, with conductivity of 290 μmhos/cm. High dilution is available in the stream for effluents from the treatment plants.

Bacterial quality of the river was impaired near the mouth. Median total coliform density was 6,000 org/100 ml, with a fecal coliform level of 200 org/100 ml on a yearly basis. As the sampling station was a considerable distance downstream from the Grayling and Roscommon municipal plants, bacteria most probably were caused by discharge from the Wurtsmith AFB treatment plant and miscellaneous sources in the Oscoda area such as individual disposal systems, and

runoff. Separation of the microbiological data into two groups - that collected during the chlorination of Wurtsmith treatment plant effluent, and that collected when no chlorination was practiced - indicated a considerable reduction in bacteria during the chlorination season. The median coliform level was 18,000 org/100 ml during nondisinfection and was reduced to 1,100 org/100 ml during disinfection. Similar reductions occurred in the fecal coliform and fecal strep levels (Table 10).

Suspended and volatile suspended solids and phenols indicated minor amounts of pollution.

Oscoda Nearshore Area

Data (Table 11) collected during a study of the nearshore waters of Lake Huron near the mouth of the Au Sable River indicated that the Au Sable River imposed a minor pollution load on Lake Huron that could not be distinguished in the waters of Lake Huron within a mile of the river mouth. In comparing the data from the breakwater station (H302) with that of the other three stations (H301, H303, H304) which are located on an arc less than a mile from the breakwater, the higher level of pollutants near the mouth was readily apparent. Dissolved oxygen was less at the breakwater, 8.7 mg/l (88 percent saturation), than offshore, 10.8 mg/l (102 percent saturation). Total solids, suspended solids, hardness, conductivity, bacterial levels, and temperature were higher at the breakwater than offshore. Levels of nutrients (nitrogens and phosphates) were uniformly low at all locations.

Harrisville Nearshore Area

Data collected during the study of the nearshore waters of Lake Huron near Harrisville, 17 miles north of the mouth of the Au Sable River, (Table 12) indicated that only a minor amount of pollution was generated in the shoreline area adjacent to the Au Sable River Basin. Any decrease in water quality in the immediate vicinity of Harrisville harbor was quickly masked by the waters of Lake Huron. Samples collected near the breakwater (H350 and H354) and on an arc about a mile from the breakwater (H351, H352, H353), showed a minor water quality problem in the harbor. BOD_5 and oxidizable nitrogen levels were slightly higher, as were total solids and suspended solids. Bacterial levels were higher in the harbor. For other parameters, there was no difference in levels. Along the beach at Harrisville State Park, MWRC sampling indicated a maximum coliform density of 70,000 org/100 ml, with a median of 100 org/100 ml for 12 samples.

1966 MWRC Au Sable River Study

In 1966, the Michigan Water Resources Commission studied the Au Sable River. Samples were collected on an around-the-clock basis for 48 hours from 23 stations on the main stream and tribtutaries. The survey included 45 miles of the main river from above Grayling to the dam at Mio, 20 miles of the South Branch Au Sable River from Roscommon to the confluence with the main branch, and various stretches of other tributaries. Chemical quality in the stream was excellent, with the exception of phosphate levels in the Main Branch and South Branch.

The phosphate levels increased immediately below the primary plants at Grayling and Roscommon and then declined gradually. Within fifteen miles of the waste sources, phosphates were no longer detectable. Bacterial quality was excellent, except in the vicinity of Grayling where statistical mean levels exceeded 1,000 total coliforms/100 ml.

Dissolved oxygen levels were high throughout the stream. On the basis of average dissolved oxygen level, there was a characteristic dissolved oxygen depression below Grayling. The depression was minor, amounting to less than 1 mg/l. The minimum average level was 7.6 mg/l below Grayling, with a minimum single value of 4.4 mg/l. The dissolved oxygen level was deceptive as photosynthetic production of dissolved oxygen occurred. At one location, the dissolved oxygen varied from 4.4 to 12.0 mg/l, with an average of 8 mg/l. Minimum levels of less than 5 mg/l occurred at a number of sites during nighttime, although during daylight supersaturation occurred. An extended period of minumum light conditions, such as overcast days, could conceivably reduce photosynthesis to the point that respiration of algae would reduce the dissolved oxygen to critical levels for trout.

BOD_5 and oxidizable nitrogen levels were low, indicating that the prime pollution problem from the treatment plants would be a secondary effect of the nutrients in creating algae growth, which would result in an oxygen demand. The nutrients also caused the growth of aquatic weeds and grasses which interfered with boating, swimming, and fishing in the river.

Biological Studies

Three station on the Au Sable River and seven nearshore Lake Huron stations were sampled periodically between October 1964 and September 1965. Four of these nearshore stations were at Harrisville and three at Oscoda. Benthic macroinvertebrates, plankton algae, and attached algae were collected and preserved for later identification and enumeration (Tables 13 through 16).

The average depth of the Au Sable River was six feet at the sampling stations below Foote Dam. The bottom was composed of sand, gravel and rock. Secchi disc transparencies extended to the bottom at more than half the stations sampled. Nearshore stations at Oscoda had a secchi disc visibility limit of three feet. Lake Huron waters near Harrisville, in contrast, had transparencies of over 13 feet. The reason for this apparent reduction in water clarity near the Au Sable River mouth was probably increased algal populations. Table 13 lists the physical observations noted during this study.

Benthic macroinvertebrate populations were not abundant in this study area. Standing crops ranged from only 3 per square foot (/sf) to 186 per square foot. Sludgeworm populations were small, averaging less than 10 per square foot of bottom sampled. Pollution-sensitive organisms such as certain mayflies and caddisflies were widespread. A variety of aquatic organisms was recovered in the bottom dredgings from this study area. Fish-food organisms such as bloodworms were present at every station sampled, both in the river and nearshore (Table 14).

Phytoplankton populations were relatively low throughout the study area except for a spring influx of green flagellates and some filamentous blue-greens. Sudden increases in standing algal crops are sometimes due to natural causes such as the flushing of stagnant areas by heavy rains. Excluding the spring samples, the phytoplankton standing crop averaged 1,090 organisms per milliliter (/ml). Including four spring counts, the average phytoplankton population counts were over 2,000 org/ml (Table 15).

Attached algae were not observed in great quantity in the lower Au Sable River. The only station where some growths were found was below Foote Dam (Table 16).

Although biological studies by the MWRC in 1966 on the Au Sable River near Grayling and Roscommon found locally degraded areas, much of the lower Au Sable River was free from biological degradation. Samples of the adjacent Lake Huron waters near Oscoda and Harrisville revealed no evidence of biological damage to the benthic invertebrate populations.

Radiochemistry

Radiochemistry results for the Au Sable River Basin and adjacent shoreline area from data based on the 1965 sampling program are listed in Tables 17 through 19. The samples were analyzed for suspended (non-filtrable) and dissolved (filtrable) portions when filtered with a 1.2 micromembrane filter and reported for alpha and beta activity levels in picocuries per liter (pc/l). Most samples were composites rather than individual samples. Maximum activity levels of alpha

emitters on water samples were $<.05$ pc/l dissolved and .6 pc/l suspended. Maximum beta emitters were 5.9 pc/l dissolved and 1.8 pc/l suspended.

The counting error was as high or higher or in the magnitude of the activity and indicated the activity was 0 or below the sensitivity of the test. The data indicated no apparent problem of radioactivity.

KEY
FOR
WATER QUALITY TABLES

Station-Location shown on Figure 3.

Chemical Parameters - all results milligrams per liter (mg/l) (exceptions noted)

Phosphate - reported as phosphate (PO_4)
Total Phosphate - includes ortho, poly, biological, and organic.
Total Soluble Phosphate - includes soluble ortho, soluble poly, and soluble organic.

Vol. Susp. Solids - Volatile Suspended Solids.

Phenol - reported as micrograms per liter (µg/l).

pH - measure of hydrogen ion activity - acidic (0), alkaline (14), neutral (7).

% Saturation - reported as percent.

Total Iron - reported as micrograms per liter (µg/l)

Total Hardness - reported as Calcium Carbonate ($CaCO_3$)

Conductivity - micromhos per centimeter (µmhos/cm)

Microbiological Parameters - values obtained by membrane filter technique, unless otherwise noted.

Median values shown in Average column

Total Coliform)
Fecal Coliform) reported as organisms/100 ml
Fecal Streptococcus)

Total Plate Count - number of bacteria/ml

Michigan Water Resources Commission reported values in terms of MPN/100 ml (most probable number/100 ml)

TABLE 9. WATER QUALITY DATA
Au Sable River Basin - 1965

Y010 near Oscoda

Parameters	NS	Avg.	Low	High	Parameters	NS	Avg.	Low	High
Dissolved Oxygen	5	9.3	7.3	11.4	Temperature (°C)	11	9.0	0.0	22.0
Biochemical Oxygen Demand	4	1	1	2	% Saturation	5	87	76	96
Ammonia Nitrogen	2	-	.14	.17	Total Iron	2	-	<100	500
Organic Nitrogen	2	-	.10	.16	Sodium	2	-	4	5
Nitrate Nitrogen	2	-	.1	.3	Potassium	2	-	1	2
Nitrite Nitrogen	1	.01	-	-	Calcium	2	-	46	48
Total Phosphate	2	-	.08	.1	Magnesium	2	-	10	13
Total Sol. Phosphate	2	-	.08	.1	Sulfate	2	-	1	11
Total Solids	2	-	180	190	Total Hardness	2	-	140	160
Suspended Solids	2	-	7	11	Conductivity	2	-	260	290
Vol. Susp. Solids	2	-	4	6	Total Coliform	11	6,000	460	45,000
Chlorides	2	-	4	6	Fecal Coliform	11	200	12	7,200
Phenol	2	-	3	4	Fecal Strep	11	46	10	400
pH	2	-	7.8	8.0	Total Plate Count 20°C	0	-	-	-
Chemical Oxygen Demand	0	-	-	-	Total Plate Count 35°C	0	-	-	-

TABLE 9. WATER QUALITY DATA
Au Sable River Basin - 1965

Y190 East Branch

Parameters	NS	Avg.	Low	High	Parameters	NS	Avg.	Low	High
Dissolved Oxygen	0	-	-	-	Temperature (°C)	6	13.5	2.0	18.5
Biochemical Oxygen Demand	0	-	-	-	% Saturation	0	-	-	-
Ammonia Nitrogen	2	-	.08	.38	Total Iron	2	-	100	1,000
Organic Nitrogen	2	-	.10	.31	Sodium	2	-	2	4
Nitrate Nitrogen	6	.2	.1	.4	Potassium	2	-	1	2
Nitrite Nitrogen	5	-	<.01	.01	Calcium	3	47	46	48
Total Phosphate	6	-	<.04	.8	Magnesium	3	13	10	18
Total Sol. Phosphate	6	-	<.04	.2	Sulfate	4	12	2	19
Total Solids	6	180	160	200	Total Hardness	1	150	-	-
Suspended Solids	6	8	2	21	Conductivity	6	290	270	300
Vol. Susp. Solids	3	4	0	11	Total Coliform	0	-	-	-
Chlorides	6	3	2	4	Fecal Coliform	0	-	-	-
Phenol	0	-	-	-	Fecal Strep	0	-	-	-
pH	6	7.9	7.6	8.3	Total Plate Count 20°C	0	-	-	-
Chemical Oxygen Demand	0	-	-	-	Total Plate Count 35°C	0	-	-	-

TABLE 9. WATER QUALITY DATA
Au Sable River Basin - 1965

AuS #14 at Oscoda (MWRC)

Parameter	NS	Avg.	Low	High	Parameter	NS	Avg.	Low	High
Dissolved Oxygen	10	10.8	7.2	13.0	Temperature (°C)	10	7.5	0.0	23.0
Biochemical Oxygen Demand	7	2	1	3	% Saturation	10	88	71	103
Ammonia Nitrogen	9	.00	.00	.00	Total Iron	0	-	-	-
Organic Nitrogen	0	-	-	-	Sodium	1	16	-	-
Nitrate Nitrogen	9	.1	.0	.2	Potassium	1	2	-	-
Nitrite Nitrogen	0	-	-	-	Calcium	1	44	-	-
Total Phosphate	9	.03	.00	.10	Magnesium	1	12	-	-
Total Sol. Phosphate	0	-	-	-	Sulfate	1	8	-	-
Total Solids	0	-	-	-	Total Hardness	1	160	-	-
Suspended Solids	7	8	3	15	Conductivity	9	290	220	350
Vol. Susp. Solids	1	2	-	-	Total Coliform	7	15,000	4,300	39,000
Chloride	9	1	0	3	Fecal Coliform	0	-	-	-
Phenol	0	-	-	-	Fecal Strep	0	-	-	-
pH	10	8.1	7.9	8.3	Total Plate Count 20°C	0	-	-	-
Chemical Oxygen Demand	0	-	-	-	Total Plate Count 35°C	0	-	-	-

TABLE 9. WATER QUALITY DATA
Au Sable River Basin - 1965

Y020

Parameters	NS	Avg.	Low	High	Parameters	NS	Avg.	Low	High
Dissolved Oxygen	1	9.6	-	-	Temperature	1	12.0	-	-
Biochemical Oxygen Demand	1	1	-	-	% Saturation	1	89	-	-
Ammonia Nitrogen	1	.09	-	-	Total Iron	0	-	-	-
Organic Nitrogen	1	.14	-	-	Sodium	1	4	-	-
Nitrate Nitrogen	1	<.1	-	-	Potassium	1	1.0	-	-
Nitrite Nitrogen	0	-	-	-	Calcium	0	-	-	-
Total Phosphate	1	.09	-	-	Magnesium	0	-	-	-
Total Sol. Phosphate	1	.09	-	-	Sulfate	0	-	-	-
Total Solids	1	180	-	-	Total Hardness	0	-	-	-
Suspended Solids	1	7	-	-	Conductivity	1	270	-	-
Vol. Susp. Solids	1	-	-	-	Total Coliform	0	-	-	-
Chloride	1	3	-	-	Fecal Coliform	0	-	-	-
Phenol	1	5	-	-	Fecal Strep	0	-	-	-
pH	1	8.1	-	-	Total Plate Count 20°C	0	-	-	-
Chemical Oxygen Demand	0	-	-	-	Total Plate Count 35°C	0	-	-	-

TABLE 10. WATER QUALITY DATA
Au Sable River Basin
1965 Seasonal Coliform Variation

Season/ Location	Total Coliform			Fecal Coliform			Fecal Streptococci		
	Median	Low	High	Median	Low	High	Median	Low	High
Jan. - April									
Y010	18,000	7,600	45,000	2,900	970	7,200	160	130	400
May - Sept.									
Y010	820	460	6,000	74	40	200	30	14	46
Oct. - Dec.									
Y010	3,400	800	42,000	40	12	3,700	32	10	190
Annual									
Y010	6,000	460	45,000	200	12	7,200	46	10	400

TABLE 11. WATER QUALITY DATA
Au Sable River Basin - 1965

Oscoda Harbor
H301

Parameters	NS	Avg.	Low	High	Parameters	NS	Avg.	Low	High
Dissolved Oxygen	5	11.0	9.0	12.4	Temperature (°C)	5	12.5	8.0	20.0
Biochemical Oxygen Demand	5	2	1	2	% Saturation	5	102	100	104
Ammonia Nitrogen	5	.12	<.05	.21	Total Iron	5	-	< 100	300
Organic Nitrogen	5	.17	.10	.34	Sodium	4	4	4	4
Nitrate Nitrogen	5	-	< .1	.2	Potassium	4	1.8	1.2	2.3
Nitrite Nitrogen	3	-	<.01	<.01	Calcium	5	28	27	30
Total Phosphate	5	-	<.04	.2	Magnesium	5	10	9	12
Total Sol. Phosphate	5	-	<.04	.1	Sulfate	5	15	12	20
Total Solids	5	140	120	150	Total Hardness	5	100	92	110
Suspended Solids	5	5	3	10	Conductivity	5	200	170	230
Vol. Suspended Solids	5	2	0	5	Total Coliform	5	69	<1	290
Chloride	5	7	5	18	Fecal Coliform	2	-	<1	< 2
Phenol	3	5	<2	10	Fecal Strep	2	-	1	2
pH	5	8.0	7.6	8.3	Total Plate Count 20°C	4	160	110	200
Chemical Oxygen Demand	0	-	-	-	Total Plate Count 35°C	4	77	38	170

TABLE 11. WATER QUALITY DATA
Au Sable River Basin -1965

Oscoda Harbor
H302

Parameters	NS	Avg.	Low	High	Parameters	NS	Avg.	Low	High
Dissolved Oxygen	5	8.7	6.9	10.1	Temperature (°C)	5	16.5	12.0	22.5
Biochemical Oxygen Demand	5	1	1	2	% Saturation	5	88	72	98
Ammonia Nitrogen	5	.20	.14	.32	Total Iron	5	-	<100	1,000
Organic Nitrogen	5	.13	.06	.19	Sodium	4	4	4	5
Nitrate Nitrogen	5	-	<.1	.1	Potassium	4	1.6	1.2	2.0
Nitrite Nitrogen	3	-	<.01	<.01	Calcium	5	40	35	46
Total Phosphate	5	-	<.04	.1	Magnesium	5	14	13	17
Total Sol. Phosphate	5	-	<.04	.1	Sulfate	5	10	2	18
Total Solids	5	180	170	200	Total Hardness	5	140	120	150
Suspended Solids	5	8	2	19	Conductivity	5	260	200	290
Vol. Susp. Solids	5	3	1	8	Total Coliform	5	460	190	3,500
Chloride	5	4	3	5	Fecal Coliform	5	26	4	130
Phenol	2	-	2	3	Fecal Strep	5	36	10	51
pH	5	8.1	7.9	8.4	Total Plate Count 20°C	4	2,000	1,500	2,700
Chemical Oxygen Demand	0	-	-	-	Total Plate Count 35°C	4	950	620	1,400

TABLE 11. WATER QUALITY DATA
Au Sable River Basin - 1965

Oscoda Harbor
H303

Parameters	NS	Avg.	Low	High	Parameters	NS	Avg.	Low	High
Dissolved Oxygen	5	10.8	9.2	11.9	Temperature (°C)	5	13.0	10.0	20.0
Biochemical Oxygen Demand	5	1	1	2	% Saturation	5	102	96	106
Ammonia Nitrogen	5	.19	.06	.43	Total Iron	5	-	<100	800
Organic Nitrogen	5	.20	.05	.51	Sodium	4	4	4	5
Nitrate Nitrogen	5	.1	.1	.2	Potassium	4	1.7	1.2	2.0
Nitrite Nitrogen	3	-	<.01	<.01	Calcium	5	28	24	35
Total Phosphate	5	-	<.04	.6	Magnesium	5	10	8	12
Total Sol. Phosphate	5	-	<.04	.6	Sulfate	5	17	7	36
Total Solids	5	150	130	170	Total Hardness	5	110	96	140
Suspended Solids	5	4	0	9	Conductivity	5	220	180	260
Vol. Susp. Solids	5	1	0	3	Total Coliform	5	18	<1	130
Chloride	5	6	4	10	Fecal Coliform	2	-	<1	2
Phenol	2	-	<2	4	Fecal Strep	2	-	1	2
pH	5	8.0	7.8	8.1	Total Plate Count 20°C	4	510	140	2,800
Chemical Oxygen Demand	0	-	-	-	Total Plate Count 35°C	4	210	4	600

TABLE 11. WATER QUALITY DATA
Au Sable River Basin - 1965

Oscoda Harbor
H304

Parameters	NS	Avg.	Low	High	Parameters	NS	Avg.	Low	High
Dissolved Oxygen	5	10.9	9.1	11.8	Temperature (°C)	5	13.0	9.5	20.0
Biochemical Oxygen Demand	5	1	1	2	% Saturation	5	102	101	104
Ammonia Nitrogen	5	.19	.10	.30	Total Iron	5	-	<100	200
Organic Nitrogen	5	.15	<.05	.26	Sodium	4	4	4	5
Nitrate Nitrogen	5	-	<.1	.2	Potassium	4	1.7	1.1	2.1
Nitrite Nitrogen	3	-	<.01	<.01	Calcium	5	28	26	29
Total Phosphate	5	-	<.04	.2	Magnesium	5	9	8	10
Total Sol. Phosphate	5	-	<.04	.1	Sulfate	5	17	12	24
Total Solids	5	130	110	140	Total Hardness	5	100	96	100
Suspended Solids	5	5	1	11	Conductivity	5	200	170	220
Vol. Susp. Solids	5	2	1	4	Total Coliform	5	11	<2	49
Chloride	5	7	5	11	Fecal Coliform	3	<2	<1	3
Phenol	3	-	<2	3	Fecal Strep	3	<2	<1	5
pH	5	8.0	7.8	8.2	Total Plate Count 20°C	4	200	100	550
Chemical Oxygen Demand	0	-	-	-	Total Plate Count 35°C	4	23	10	290

TABLE 12. WATER QUALITY DATA
Au Sable River Basin - 1965

Harrisville Harbor
H350

Parameter	NS	Avg.	Low	High	Parameter	NS	Avg.	Low	High
Dissolved Oxygen	4	10.3	8.8	11.7	Temperature (°C)	4	13.0	10.5	19.0
Biochemical Oxygen Demand	4	2	1	2	% Saturation	4	98	92	109
Ammonia Nitrogen	4	.17	.14	.19[a]	Total Iron	4	200	<100	300
Organic Nitrogen	4	.21	.11	.30	Sodium	3	4	4	5
Nitrate Nitrogen	4	.2	.1	.3	Potassium	3	1.9	1.4	2.4
Nitrite Nitrogen	2	-	<.01	<.01	Calcium	4	28	26	30
Total Phosphate	4	-	<.04	.08	Magnesium	4	9	9	9
Total Sol. Phosphate	4	-	<.04	.08	Sulfate	4	18	13	21
Total Solids	4	130	130	140	Total Hardness	4	100	92	110
Suspended Solids	4	10	6	16	Conductivity	4	200	180	210
Vol. Susp. Solids	4	2	2	2	Total Coliform	4	90	<2	290
Chloride	4	5	5	6	Fecal Coliform	4	12	<2	150
Phenol	1	<2	-	-	Fecal Strep	4	7	4	100
pH	4	8.0	7.8	8.1	Total Plate Count 20°C	3	3,800	1,600	4,300
Chemical Oxygen Demand	0	-	-	-	Total Plate Count 35°C	3	380	89	550

a - One value of 2.20 not used in computing the data.

TABLE 12. WATER QUALITY DATA
Au Sable River Basin - 1965

Harrisville Harbor
H351

Parameter	NS	Avg.	Low	High	Parameter	NS	Avg.	Low	High
Dissolved Oxygen	4	11.0	9.8	11.9	Temperature (°C)	4	12.5	10.0	18.0
Biochemical Oxygen Demand	4	2	1	2	% Saturation	4	104	97	108
Ammonia Nitrogen	4	.12	.05	.18	Total Iron	4	200	<100	400
Organic Nitrogen	4	.19	.08	.28	Sodium	2	-	4	5
Nitrate Nitrogen	4	.2	.1	.3	Potassium	2	-	2.0	2.3
Nitrite Nitrogen	2	-	<.01	<.01	Calcium	4	30	27	36
Total Phosphate	4	-	<.04	.3	Magnesium	4	9	8	9
Total Sol. Phosphate	4	-	<.04	.06	Sulfate	4	15	8	19
Total Solids	4	120	120	.20	Total Hardness	4	98	94	100
Suspended Solids	4	6	1	10	Conductivity	4	190	170	200
Vol. Susp. Solids	4	2	0	4	Total Coliform	4	3	<2	7
Chloride	4	5	5	5	Fecal Coliform	4	<1	<1	<2
Phenol	1	<2	-	-	Fecal Strep	3	<2	<1	<2
pH	4	7.9	7.7	8.1	Total Plate Count 20°C	3	100	52	220
Chemical Oxygen Demand	0	-	-	-	Total Plate Count 35°C	3	57	7	90

NS = Number of Samples

TABLE 12. WATER QUALITY DATA
Au Sable River Basin - 1965

Harrisville Harbor
H352

Parameters	NS	Avg.	Low	High	Parameters	NS	Avg.	Low	High
Dissolved Oxygen	4	10.9	9.7	11.8	Temperature (°C)	4	12.0	10.0	18.0
Biochemical Oxygen Demand	4	1	1	2	% Saturation	4	102	96	105
Ammonia Nitrogen	4	.12	.05	.17	Total Iron	4	100	<100	200
Organic Nitrogen	4	.15	.06	.30	Sodium	3	4	3	4
Nitrate Nitrogen	4	.2	.1	.3	Potassium	3	1.6	1.0	2.0
Nitrite Nitrogen	2	-	<.01	<.01	Calcium	4	27	26	29
Total Phosphate	4	-	<.04	.06	Magnesium	4	9	8	9
Total Sol. Phosphate	4	-	<.04	.06	Sulfate	4	21	10	40
Total Solids	4	120	110	130	Total Hardness	4	97	94	100
Suspended Solids	4	5	2	8	Conductivity	4	190	170	200
Vol. Susp. Solids	4	4	0	7	Total Coliform	4	<2	<1	3
Chloride	4	5	5	6	Fecal Coliform	2	-	<1	<2
Phenol	2	-	<2	4	Fecal Strep	2	-	<1	<2
pH	4	7.9	7.8	8.0	Total Plate Count 20°C	3	80	29	150
Chemical Oxygen Demand	0	-	-	-	Total Plate Count 35°C	3	7	1	40

TABLE 12. WATER QUALITY DATA
Au Sable River Basin - 1965

Harrisville Harbor
H353

Parameters	NS	Avg.	Low	High	Parameters	NS	Avg.	Low	High
Dissolved Oxygen	4	11.0	9.7	11.9	Temperature (°C)	4	12.5	10.0	18.0
Biochemical Oxygen Demand	4	1	1	2	% Saturation	4	103	97	108
Ammonia Nitrogen	4	.20	.06	.38	Total Iron	4	200	<100	500
Organic Nitrogen	4	.16	.06	.34	Sodium	3	4	4	5
Nitrate Nitrogen	4	.1	.1	.1	Potassium	3	2.3	1.3	3.4
Nitrite Nitrogen	2	-	<.01	<.01	Calcium	4	27	24	30
Total Phosphate	4	-	<.04	1.6	Magnesium	4	9	8	9
Total Sol. Phosphate	4	-	<.04	1.3	Sulfate	4	14	11	17
Total Solids	4	120	110	130	Total Hardness	4	94	90	100
Suspended Solids	4	7	5	10	Conductivity	4	190	170	200
Vol. Susp. Solids	4	3	1	4	Total Coliform	4	<2	<1	3
Chloride	4	5	5	5	Fecal Coliform	2	-	<1	<2
Phenol	2	-	<2	3	Fecal Strep	2	-	<1	<2
pH	4	7.9	7.8	8.1	Total Plate Count 20°C	3	140	72	540
Chemical Oxygen Demand	0	-	-	-	Total Plate Count 35°C	3	12	5	54

TABLE 12. WATER QUALITY DATA
Au Sable River Basin - 1965

Harrisville Harbor
H354

Parameter	NS	Avg.	Low	High	Parameter	NS	Avg.	Low	High
Dissolved Oxygen	4	10.5	9.3	11.8	Temperature (°C)	4	13.5	10.0	20.0
Biochemical Oxygen Demand	4	3	2	6	% Saturation	4	101	92	112
Ammonia Nitrogen	4	.25	.18	.38	Total Iron	4	300	<100	900
Organic Nitrogen	4	.25	.15	.38	Sodium	3	4	4	5
Nitrate Nitrogen	4	.2	.1	.3	Potassium	3	1.8	1.4	2.1
Nitrite Nitrogen	2	-	<.01	.01	Calcium	4	28	24	32
Total Phosphate	4	-	.04	.6	Magnesium	4	9	9	10
Total Sol. Phosphate	4	-	<.04	.4	Sulfate	4	16	12	19
Total Solids	4	170	140	220	Total Hardness	4	100	100	110
Suspended Solids	4	35	10	94	Conductivity	4	210	180	220
Vol. Susp. Solids	4	6	0	15	Total Coliform	4	19	<1	350
Chloride	4	5	5	5	Fecal Coliform	3	16	<2	131
Phenol	2	-	<2	4	Fecal Strep	3	18	2	64
pH	4	8.0	7.7	8.3	Total Plate Count 20°C	3	2,000	1,500	2,600
Chemical Oxygen Demand	0	-	-	-	Total Plate Count 35°C	3	270	190	580

TABLE 13. BIOLOGICAL DATA - PHYSICAL OBSERVATIONS
Au Sable River Basin - 1964-1965

Station	Average Depth (feet)	Average Secchi Disc (feet)	Bottom Types
Au Sable River			
Y010	8	5	Sand, detritus
Y014	7	6	Sand
Y020	7	6	Sand, gravel, rock
Nearshore Oscoda			
H301	20	3	Sand
H303	15	3	Sand
H304	14	4	Sand
Nearshore Harrisville			
H351	20	13	Sand
H352	31	15	Sand, silt
H353	21	15	Rock

TABLE 14. BIOLOGICAL DATA - BENTHIC MACROINVERTEBRATES
Au Sable River Basin
1964 - 1965

Station/ Date	(Organisms per Square Foot) Sludge-worms	Blood-worms	Sow bugs	Snails Pulm.	Snails Proso.	Finger-nail Clams	Scuds	May-flies	Caddis flies	Others*	Total
Nearshore Oscoda											
H301 4/21/65	11	4	-	-	-	-	-	-	-	(s)X	15
H303 4/21/65	3	3	-	-	-	-	-	-	-	(e)X	6
Au Sable River											
Y010 7/13/65	-	36	-	9	-	6	9	X	11	(j)15	86
9/16/65	-	**	-	-	-	**	**	-	**	-	-
Y014 10/22/64	1	3	-	-	-	-	-	3	-	(a)1	8
4/21/65	-	3	-	-	-	-	-	-	-	-	3
7/13/65	3	10	-	-	-	X	-	-	-	-	13
9/16/65	**	12	3	-	-	-	-	**	-	-	15

* See explanation, page 56
** Present only in qualitative samples
X. Less than one per square foot

TABLE 14. BIOLOGICAL DATA - BENTHIC MACROINVERTEBRATES
Au Sable River Basin
1964 - 1965

Station/ Date	(Organisms per Square Foot) Sludge-worms	Blood-worms	Sow bugs	Snails Pulm.	Snails Proso.	Fingernail Clams	Scuds	Mayflies	Caddis flies	Other*	Total
Au Sable River (Cont'd)											
Y020											
10/22/64	1	24	1	-	-	-	6	-	6	(r)1 (k)4	43
4/21/65	1	29	-	-	-	-	1	-	11	(e)1 (b)1 (d)X	44
7/13/65	**	35	-	9	-	6	9	1	11	(j)15 (n)**	86
9/16/65	**	24	-	**	-	3	14	-	97	(j)48	186
Nearshore Harrisville											
H351											
7/13/65	4	16	-	-	-	-	-	X	1	(e)X	21
H353											
7/13/65	96	36	-	-	X	7	3	-	-	(e)37	179

* See explanation, page 56
** Present only in qualitative samples
X. Less than one per square foot

EXPLANATION LIST FOR
BENTHIC MACROINVERTEBRATES (Table 14)

a. Ceratopogonidae

b. Tipulidae

c. Hirudinea

d. Turbellaria

e. Nematoda

f. Hydracarina

g. Anisoptera

h. Corixidae

i. Elmidae

j. Diptera

k. Coleoptera

l. Zygoptera

m. Plecoptera

n. Decapoda

o. Hemiptera

p. Porifera

q. Isopoda

r. Lumbriculidae

s. Cladocera

TABLE 15. BIOLOGICAL DATA - PHYTOPLANKTON
Au Sable River Basin
October 1964-November 1965

Station/ Date	Numbers per Milliliter: Centric Diatoms	Pennate Diatoms	Green Coccoids	Blue-Green Coccoids	Blue-Green Filamentous	Green Flagelletes	Brown Flagelletes	Total	Predominant Genera (10% or more)*
Nearshore Oscoda									
H301									
7/13/65	1,260	1,340	800	20	-	40	40	3,500	a,f,z
H302									
7/13/65	250	500	130	40	60	80	20	1,080	a,h,f
H303									
4/21/65	340	500	40	-	-	10,900	-	11,780	z
7/13/65	40	340	40	20	20	-	40	500	f,i,e
H304									
7/13/65	80	340	100	-	20	20	40	600	a,e,s
Au Sable River									
Y010									
2/24/65	300	60	-	-	-	80	-	440	a,z
4/12/65	150	380	-	-	-	250	-	780	la,a,f,g,h
4/16/65	130	130	40	-	7,060	-	-	7,360	w
5/13/65	440	400	60	-	-	250	20	1,170	a,z
6/10/65	150	100	40	-	-	210	230	730	la,a,y
7/7/65	80	270	40	40	-	400	60	890	z,i
7/13/65	360	230	230	170	100	-	-	1,090	s,g
10/20/65	270	130	20	-	-	340	-	760	y
11/30/65	130	190	20	-	-	80	-	420	a,c,z

TABLE 15. BIOLOGICAL DATA - PHYTOPLANKTON
Au Sable River Basin
October 1964-November 1965

Station/ Date	Numbers per Milliliter: Centric Diatoms	Pennate Diatoms	Green Coccoids	Blue-Green Coccoids	Blue-Green Filamentous	Green Flagelletes	Brown Flagelletes	Total	Predominant Genera (10% or more)*
Au Sable River (Cont'd)									
Y014									
10/22/64	110	150	-	20	-	1,140	-	1,420	z
4/21/65	270	270	-	-	-	-	-	540	a,g,h
9/16/65	230	150	20	20	20	-	-	440	g,a
Y020									
4/21/65	80	210	-	-	7,850	-	40	8,180	w
7/13/65	190	170	20	-	-	-	-	380	a,h,e
9/16/65	190	20	20	-	-	-	-	230	a
Nearshore Harrisville									
H350									
7/13/65	360	3,460	270	20	-	-	440	4,550	g,h,la
H352									
7/13/65	-	60	40	-	-	-	20	120	-
H353									
7/13/65	130	270	360	-	20	-	60	840	a

*See explanation list, page 59

EXPLANATION LIST FOR PREDOMINANT PHYTOPLANKTON GENERA (Table 15)

Centric Diatoms

a. Cyclotella - Stephanodiscus
b. Rhizosolenia

Pennate Diatoms

c. Asterionella
d. Diatoma
e. Fragilaria
f. Gomphonema
g. Navicula
h. Nitzschia
i. Synedra
j. Tabellaria
k. Unidentified

Green Coccoids

l. Actinastrum
m. Ankistrodesmus
n. Closterium
o. Coelsphaerium
p. Golenkinia
q. Gomphosphaeria
r. Oocystis
s. Scenedesmus
t. Tetraedon

Blue-Green Coccoids

u. Anacystis

Blue-Green Filamentous

v. Oscillatoria
w. Phormidium

Green Flagellates

x. Euglena
y. Trachelomonas
z. Unidentified

Brown Flagellates

la. Dinobryon

TABLE 16. BIOLOGICAL DATA - ATTACHED ALGAE
Au Sable River Basin
1964 - 1965

Station	Date	Vegetation Type
Y010	9/16/65	No vegetation observed
Y014	10/22/64	No visible algae or slime
	9/16/65	No vegetation observed, small amount of green algae on rocks
Y020	10/7/64	No emergent vegetation
	10/22/64	No vegetation or algae
	4/21/65	*Mougeotia sp.*
	7/13/65	No vegetation
	9/16/65	No emergent vegetation

TABLE 17. WATER QUALITY DATA - RADIOACTIVITY - 1965
Au Sable River Basin
Au Sable River

Parameters	Y010 NS*	Y010 Avg.	Y010 Low	Y010 High	Y190 NS**	Y190 Avg.	Y190 Low	Y190 High	NS	Avg.	Low	High
Dissolved												
ALPHA	3	0.05	0.05	0.05	1	0.05	-	-				
Error	3	1.3	0.7	2.2	1	0.8	-	-				
BETA	3	4.5	3.2	5.9	1	0.05	-	-				
Error	3	2.9	1.5	5.5	1	1.5	-	-				
Suspended												
ALPHA	3	0.05	0.05	0.05	1	0.05	-	-				
Error	3	0.5	0.2	1.1	1	0.2	-	-				
BETA	3	0.27	0.05	0.70	1	0.05	-	-				
Error	3	2.1	0.8	4.5	1	0.8	-	-				

* Y010 - Results from 5 samples composited into 3.
** Y190 - Results from 2 samples composited into 1.

TABLE 18. WATER QUALITY DATA - RADIOACTIVITY - 1965
Au Sable River Basin
Oscoda Nearshore

Parameters	H301				H302				H303			
	NS*	Avg.	Low	High	NS*	Avg.	Low	High	NS *	Avg.	Low	High
Dissolved												
ALPHA	2	-	<0.05	<0.05	2	-	<0.05	<0.05	2	-	<0.05	<0.05
Error	2	-	0.7	0.7	2	-	0.7	0.7	2	-	0.5	0.5
BETA	2	-	3.6	4.2	2	-	3.3	4.3	2	-	3.9	3.9
Error	2	-	1.4	1.4	2	-	1.4	1.6	2	-	1.4	1.4
Suspended												
ALPHA	2	-	<0.05	<0.05	2	-	<0.05	<0.05	2	-	<0.05	<0.05
Error	2	-	0.2	0.3	2	-	0.2	0.3	2	-	0.2	0.3
BETA	2	-	0.4	1.2	2	-	1.0	1.1	2	-	0.8	1.3
Error	2	-	0.8	0.9	2	-	0.9	1.0	2	-	0.9	0.9

* H301, H302, and H303 - Results from 5 samples composited into 2.

TABLE 18. WATER QUALITY DATA - RADIOACTIVITY - 1965
Au Sable River Basin
Oscoda Nearshore

Parameters	H304 NS*	Avg.	Low	High	NS	Avg.	Low	High	NS	Avg.	Low	High
Dissolved												
ALPHA	2	-	<0.05	<0.05								
Error	2	-	0.6	0.7								
BETA	2	-	3.6	5.2								
Error	2	-	1.4	1.5								
Suspended												
ALPHA	2	-	<0.05	0.30								
Error	2	-	0.3	0.4								
BETA	2	-	0.2	0.2								
Error	2	-	0.8	0.8								

* H304 - Results from 5 samples composited into 2.

TABLE 19. WATER QUALITY DATA - RADIOACTIVITY - 1965
Au Sable River Basin
Harrisville Nearshore

Parameters	H350				H351				H352			
	NS *	Avg.	Low	High	NS*	Avg.	Low	High	NS *	Avg.	Low	High
Dissolved												
ALPHA	2	-	<0.05	<0.05	2	-	<0.05	<0.05	2	-	<0.05	<0.05
Error	2	-	0.5	0.7	2	-	0.5	0.5	2	-	0.5	0.6
BETA	2	-	2.2	3.9	2	-	2.6	4.1	2	-	4.1	4.9
Error	2	-	1.4	1.4	2	-	1.3	1.4	2	-	1.4	1.5
Suspended												
ALPHA	2	-	<0.05	<0.05	2	-	0.5	0.6	2	-	<0.05	<0.05
Error	2	-	0.1	0.3	2	-	0.4	0.5	2	-	0.3	0.3
BETA	2	-	<0.05	0.40	2	-	<0.05	<0.05	2	-	0.2	0.8
Error	2	-	0.8	0.8	2	-	0.8	0.9	2	-	0.8	0.9

* H350, H351, and H352 - Results from 4 samples composited into 2.

TABLE 19. WATER QUALITY DATA - RADIOACTIVITY - 1965
Au Sable River Basin
Harrisville Nearshore

Parameters	H353 NS*	H353 Avg.	H353 Low	H353 High	H354 NS	H354 Avg.	H354 Low	H354 High	NS	Avg.	Low	High
Dissolved												
ALPHA	2	-	<0.05	<0.05	1	<0.05	-	-				
Error	2	-	0.5	0.7	1	0.5	-	-				
BETA	2	-	3.3	5.2	1	1.6	-	-				
Error	2	-	1.4	1.6	1	1.3	-	-				
Suspended												
ALPHA	2	-	<0.05	<0.05	1	<0.05	-	-				
Error	2	-	0.2	0.3	1	0.1	-	-				
BETA	2	-	<0.05	1.80	1	0.9	-	-				
Error	2	-	0.9	1.0	1	0.9	-	-				

* H353 - Results from 4 samples composited into 2.

WATER QUALITY PROBLEMS

Areas of degraded water quality were found below cities in the interior of the basin and immediate harbor areas at Oscoda. There were no significant sources of pollution to Lake Huron in the Au Sable - Oscoda area except those discharging to the Au Sable River. Those sources in the immediate area included the discharge from individual septic systems and plane washings effluent from Wurtsmith Air Force Base sewage treatment plant, storm runoff, and urban drainage.

Wastes from municipalities and other sources in the upper parts of the basin had a deleterious effect on water quality. These included the conservative pollutants such as chlorides, and the semiconservative pollutants such as nutrients which persist in the stream through many cycles. These contaminants have not resulted in gross pollution but have created problems in local areas. The fact that the Au Sable River demands the highest water quality, because of its prime recreational use for trout fishing and canoeing, makes the addition of even the slightest pollution a problem. The nutrients from the waste effluents of Grayling and Roscommon have been cited as the principal cause of the increased algal levels in the stream. To these point sources must be added the many incremental sources which are increasing rapidly along the banks of the mainstream and tributaries from recreational development. Septic tank systems add a considerable nutrient load to the stream. The attractiveness of the stream is now threatened by those who come to the area to enjoy the waters. It may be expected

that present quantities of wastes generated in the basin will increase significantly in the future. Projections indicate that waste from municipal systems will double by 1990 and more than quadruple by 2020.

In the adjacent Lake Huron shoreline area, a significant potential source of pollution exists less than a mile north of Harrisville. This is the submerged pipeline which extended 1½ miles from shore. Fuel tankers anchor in the 30 to 35-feet deep water, engage and raise the flexible end of the pipeline, and pump the cargo to a fuel farm located onshore. On November 13, 1966, a tanker carrying jet fuel, to supply Wurtsmith Air Force Base, accidently cut the pipeline with its anchor pumping 162,000 gallons of jet fuel into the water. Fortunately, this fuel was volatile and no lasting effects occurred. However, a heavier fuel, such as bunker or crude oil, would have caused considerable damage to the aquatic environment and the shoreline.

There were no significant sources of pollution nor were there any major water quality problems in the shoreline tributaries to Lake Huron.