



US Army Corps
of Engineers

INFORMATION SUMMARY, AREA OF CONCERN: SAGINAW RIVER AND SAGINAW BAY

by

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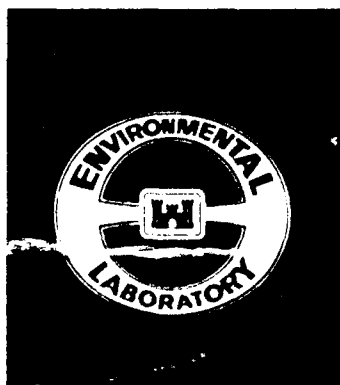
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The approach used by WES was to bring together WES scientists who have been conducting research on the various aspects of contaminant mobility in the aquatic environment and develop a list of information required to evaluate the potential for contaminant mobility. A team of WES scientists then visited the RAP coordinator and associated staff for each AOC. Corps Districts responsible for the navigation projects in each AOC were also visited. This report summarizes the information obtained for the Saginaw River and Saginaw Bay AOC. The report attempts to retrieve information by subject in a quick and easy manner (GLNPO Subject-Reference Matrix). Data and information from numerous reports have been included as figures and tables. Wherever possible, references are given for the included data and information.

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EXECUTIVE SUMMARY

The Water Quality Act of 1987, Section 118, authorizes the Great Lakes National Program Office (GLNPO) to carry out a 5-year study and demonstration project, Assessment and Remediation of Contaminated Sediments (ARCS), with emphasis on the removal of toxic pollutants from bottom sediments. Information from the ARCS program is to be used to guide the development of Remedial Action Plans (RAPs) for 42 identified Great Lakes Areas of Concern (AOC) as well as Lake-wide Management Plans. The AOCs are areas where serious impairment of beneficial uses of water or biota (drinking, swimming, fishing, navigation, etc.) is known to exist, or where environmental quality criteria are exceeded to the point that such impairment is likely. Priority consideration was given to the following five AOCs: Saginaw Bay, MI; Sheboygan Harbor, WI; Grand Calumet River, IN; Ashtabula River, OH; and Buffalo River, NY.

The ARCS Program is to be completed during the period 1988-1992. The overall objectives of the ARCS program are:

- a. To assess the nature and extent of bottom sediment contamination at selected Great Lakes AOC.
- b. To evaluate and demonstrate remedial options, including removal, immobilization, and advanced treatment technologies, as well as "No-Action" alternatives.
- c. To provide guidance on assessment and remedial action to the various levels of government in the US and Canada in the implementation of Remedial Action Plans (RAPs) for the areas of concern, as well as direction for future evaluations in other areas.

The Environmental Laboratory (EL) of the US Army Engineer Waterways Experiment Station (WES) was asked to review existing data and information for each of the five priority AOCs. The approach used by WES was to bring together WES scientists who have been conducting research on the various aspects of contaminant mobility in the aquatic environment and develop a list of information (Table 1) required to evaluate the potential for contaminant mobility. All contaminant migration pathways were considered and are shown in Figure 1. A team of WES scientists then visited the RAP coordinator and

associated staff for each AOC. Corps Districts responsible for the navigation projects in each AOC were also visited. During these meetings discussions centered around what information was available for each item on the list of information developed by WES. Sources of additional information were obtained from the discussions.

This report summarizes the information obtained for the Saginaw River and Saginaw Bay AOC. The report attempts to retrieve information by subject in a quick and easy manner (GLNPO Subject-Reference Matrix). Data and information from numerous reports have been included as figures and tables. Wherever possible, references are given for the included data and information. The entire reference section from the Michigan Department of Natural Resources Remedial Action Plan for Saginaw River and Saginaw Bay Area of Concern 1988 is included herein (Appendix 3).

PREFACE

This report presents a summary of existing data and information related to the Saginaw River and Saginaw Bay Area of Concern. The study was conducted by the US Army Engineer Waterways Experiment Station (WES) during the period August 1988 through 15 December 1988 and August 1989 through September 1989 by Dr. C.R. Lee, Soil Scientist; Dr. J.W. Simmers, Research Biologist; Dr. H.E. Tatem, Aquatic Biologist, Mr. D.L. Brandon, Statistician, and Mr. J.G. Skogerboe, Physical Scientist, of the Contaminant Mobility and Regulatory Criteria Group (CMRCG) under the supervision of Dr. L.H. Saunders, Chief, CMRCG; Mr. D.L. Robey, Chief, Ecosystem Research and Simulation Division (ERSD); and Dr. J. Harrison, Chief, Environmental Laboratory. The study was initially conducted under the general supervision of Mr. D. Cowgill, NCD, and Mr. T. Kizlauskas, USEPA Great Lakes National Program Office (GLNPO), and later under the supervision of Mr. J. Miller, NCD, and Mr. D. Cowgill, USEPA GLNPO.

Generous cooperation and assistance in locating existing data and information were given by Mr. D. Cowgill, USEPA GLNPO; Mr. J. Miller, US Army Engineer District, Chicago; Ms. P. Bedore, Operations Division; Mr. D. Bowman, Planning Division; and Mr. F. Snitz, Planning Division; US Army Engineer District, Detroit; Messrs. B. Day, G. Goudy, and R. Lundgren, MDNR; and Ms. D. Klemans, MDNR.

Directors of WES during the preparation of this report were COL Dwayne G. Lee, EN, and COL Larry B. Fulton, EN. Technical Director was Dr. Robert W. Whalin.

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CONVERSION FACTORS, NON-SI TO SI (METRIC)
UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI
(metric) units as follows:

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
avoirdupois pounds (mass)	0.4536	kilograms
acres	0.4047	hectares
cubic yards	0.7646	cubic meters
gallons (US liquid)	3.7854	liters
inches	2.5400	centimeters
miles (US statute)	1.6093	kilometers
short tons (US weight)	0.9072	metric tons
square miles	2.5900	square kilometers

INFORMATION SUMMARY, AREA OF CONCERN:
SAGINAW RIVER AND SAGINAW BAY

INTRODUCTION

Background

The Water Quality Act of 1987, Section 118, authorizes the Great Lakes National Program Office (GLNPO) to carry out a 5-year study and demonstration project, Assessment and Remediation of Contaminated Sediments (ARCS), with emphasis on the removal of toxic pollutants from bottom sediments. Information from the ARCS program is to be used to guide the development of Remedial Action Plans (RAPs) for 42 identified Great Lakes Areas of Concern (AOC) as well as Lake-wide Management Plans (Figure 2).

The AOCs are areas where serious impairment of beneficial uses of water or biota (drinking, swimming, fishing, navigation, etc.) is known to exist, or where environmental quality criteria are exceeded to the point that such impairment is likely. Priority consideration was given to the following five AOCs: Saginaw Bay, MI; Sheboygan Harbor, WI; Grand Calumet River, IN; Ashtabula River, OH; and Buffalo River, NY.

Each state has established RAP coordinators to develop a RAP for each AOC. Most RAP coordinators state that there is a need to develop guidance to interpret the information in a manner that will allow decisions to be made about each AOC. The following summarizes the status of the RAP reports for the five priority AOCs:

<u>Area of Concern</u>	<u>Status</u>
Saginaw Bay, MI	Final RAP - September 1988
Grand Calumet River, IN	Draft RAP - January 1988
Sheboygan Harbor, WI	Draft RAP - December 1988
Buffalo River, NY	Final RAP - November 1989
Ashtabula River, OH	Draft RAP - September 1989

Purpose

The purpose of this report is to summarize the information collected during meetings with RAP Coordinators and Corps Districts to find out what information was available on contaminant migration at each of the five priority AOCs.

Scope

Information collected during visits to RAP Coordinators and Corps Districts is summarized. Sources of additional information have been referenced so that these sources could be contacted at a later date. Documents that were mentioned during meetings with RAP coordinators, but were not available at that time, are referenced so that these documents can be obtained, if desired. Retrieval of information by subject in a quick and easy manner was a goal of this report.

SUMMARY OF INFORMATION

AOC Boundary

The boundary of the Saginaw River and Saginaw Bay AOC is shown in Figure 3. Saginaw Bay is 52 miles¹ long with a width which varies between 13 and 26 miles. The surface area is 1,143 square miles. The Saginaw Bay watershed includes portions of 22 counties. This 8,709 square mile watershed is 15% of Michigan's total land area. The 1980 census indicated that 1,458,339 people live in counties totally or partially within the Saginaw Bay watershed. Twenty-eight rivers, creeks or drains flow directly into Saginaw Bay from three drainage basins - the East Coastal basin, West Coastal basin, and Saginaw River basin (Figure 4). These basins make up 10%, 18%, and 72% respectively of the Saginaw Bay watershed. However, 75% of the hydraulic flow to Saginaw Bay comes from the Saginaw River (Michigan Department of Natural Resources, 1988).

Contaminants of Concern

The primary sediment contaminants of concern are: PCBs, polybrominated biphenyls (PBB), DDT, Tris (triisopropyl phosphate ester), and heavy metals. The primary fishery contaminants of concern are: PBB, DDT and its metabolites, hexachlorobenzene, polychlorinated dibenzofurans, dibenzo-p-dioxins, diphenyl ethers, styrenes, and terphenyls. Excessive phosphorus inputs to Saginaw Bay have impacted biota by creating eutrophic conditions (Great Lakes Water Quality Board Report to the International Joint Commission 1987). Landfill, hazardous waste and superfund sites are affecting surface water, groundwater, wetlands, and other resources in the Saginaw Bay basin. The contaminants of concern are: PCBs, TCDD, TCDF, PAHs, Xylene, Toluene, Dioxins, Chloroethane, Dichlorobenzene, and heavy metals (Michigan Department of Natural Resources, 1988).

¹ A Table of factors for converting non-SI units of measurement to SI (metric) units is presented on page 19.

Level of Contaminants

Michigan has established ambient water, surface water quality, drinking water and public health fish consumption advisory criteria. Tables 2a through 4 list these criteria. Table 5a lists the USEPA pollution criteria for Great Lakes Harbor sediments (Michigan Department of Natural Resources, 1988). Michigan is currently developing sediment assessment procedures. Bulk sediment chemistry has been used as the main indicator of "contaminated" sediment. Chemistry results may be compared to a variety of yardsticks: USEPA criteria for dredged material disposal, and past or present background concentrations in Great Lakes sediments (Report of the Sediment Subcommittee and its Assessment Work Group to the Water Quality Board, 1988). The Report to the Great Lakes Water Quality 1987 provides background sediment concentrations for Saginaw Bay (Table 5b).

Volume of Contaminated Sediments

No estimate of the total amount of contaminated sediment in the Saginaw River/Bay system has been found. Approximately 3.7 metric tons of PCB remain in the active sediment in inner Saginaw Bay (Michigan Department of Natural Resources, 1988). The US Army Corps of Engineers Maintenance Dredging Program removes (on average) more than 500,000 cubic yards of contaminated sediment each year from the Saginaw River and Bay (Cowgill, 1989). Figures 5b through 5g could be used to estimate the volume of inner Saginaw Bay sediment contaminated by heavy metals.

Sediment Data

Sediment data have been collected by a number of federal, state and local agencies as well as researchers. Most of the recent Saginaw River/Bay sediment sampling activities are summarized in Table 6a (Cowgill, 1989). Figures 5a through 5g, 6 and Table 6b show PCB and/or heavy metal data from Saginaw Bay (Michigan Department of Natural Resources, 1988). Concentrations at many sampling locations exceed the USEPA heavily polluted criteria for PCBs and metals. The Report of the Sediment Subcommittee and its Assessment Work

Group to the Water Quality Board (1988) provides additional sediment concentrations from Saginaw River and Saginaw Bay (Table 6c). At least one site exceeded the USEPA heavily polluted criteria for Ba and Fe. Additional sampling has been conducted on many of the tributaries which empty into Saginaw Bay. These sampling locations are shown in Figures 7 through 17b. The sediment concentrations appear in Tables 7 through 17c. Concentrations from several locations exceed the USEPA heavily polluted criteria for PCB, As, Zn, Cr, Cu, CN, Cd, Ni, Fe, Pb, TKN, or volatile solids (%) (Michigan Department of Natural Resources, 1988). Additional sediment locations from the Saginaw River are presented in Figures 18a and 18b. These locations are similar to those shown in Figures 17a and 17b. Table 18a provides a verbal description of the sample locations and physical characteristics. Tables 18b and 18c list the heavy metals and PCB results, respectively. Concentrations from several locations exceeded the USEPA heavily polluted criteria for As, Zn, Cr, Cu, P, Pb, O&G, COD, TKN, or volatile solids (%) (US Army Corps of Engineers, Detroit, 1988). No sediment data were found from any river in the West Coastal Basin or the East Coastal Basin nor the Chippewa, Bad, and Cass rivers in the Saginaw River Basin. These data have to be viewed in light of the fact that a 500-year storm event occurred in 1986. This storm event could have caused considerable movement of contaminated sediments within the Saginaw River/Bay system.

Additional data can be retrieved from many sources. Data from some of the activities listed in Table 6a are not currently available. Dow Chemical Company has conducted extensive research on the environmental impacts of dioxin. USGS has collected sediment data at a gaging station along the Saginaw River. The Great Lakes Information System contains additional heavy metal data from Saginaw Bay. Both the US Army Corps of Engineers and MDNR have sediment data from the 1970s which are not presented herein. The US Army Corps of Engineers conducted sediment sampling during 1989. The USACE Detroit District has additional bulk chemistry data in its files, but not in report format. USEPA Great Lakes National Program Office 1990 describes sediment sampling efforts planned for Saginaw River/Bay in summer 1990. Figures 19a and 19b depict the sedimentation rate in inner Saginaw Bay (Robbins, 1986; GLIS). Also, publications like Bremer 1979 have additional information.

Water Quality Data

Both physical and chemical water quality data were collected at several stations in the Saginaw River/Bay system (Figures 4 and 19a). The physical parameters measured were taste, odor, temperature, BOD, DO, turbidity, suspended solids, and total solids. The chemical parameters were P, N, Cu, Pb, Zn, and chloride. These results are summarized in Figures 20 through 31d and Tables 19a through 19f. Cd, Cr, Cu, Fe, Pb, Ni, and Zn concentrations from tributary locations did not exceed the Rule 57(2) guideline levels (Tables 2a and 2c; Table 19g). Table 19h shows bacteriological data from several areas within the AOC (Michigan Department of Natural Resources, 1988). Additional information may be available through the National Water Data Exchange (NAWDEX) program office, Branch of Water Information Transfer, USGS.

Waterway Hydraulics Data

Figures 32a, 32b, and 33 depict common flow patterns and bathymetry within Saginaw Bay. Morphometric data for Saginaw Bay is presented in Table 20. Saginaw Bay receives an average total tributary input of 153.7 cubic meters per second (Smith et al., 1977). Approximately 75% or 114.5 cms is contributed by the total adjusted average discharge of the four major tributaries at their confluence to form the Saginaw River. Water discharge records for many of the Saginaw Bay tributaries are listed in Table 21 (Michigan Department of Natural Resources, 1988). The University of Michigan and USEPA Large Lakes Research Station have modeled the phosphorus load-concentration relationship in Saginaw Bay. This information will assist in the development of a target load reduction for the basin. The USEPA Large Lakes Research Station produced a PCB mass balance budget and a mathematical model of the PCB load-concentration relationship in Saginaw Bay. A consulting firm under contract to ECMPDR performed similar studies on the Saginaw River. The study indicated that 350 kg/a of PCBs was being delivered by the Saginaw River to Saginaw Bay (Great Lakes Water Quality Board Report to the International Joint Commission, 1987).

Point Source Discharges

Permits regulating direct discharges to Michigan surface waters are issued under the National Pollutant Discharge Elimination System (NPDES). This information is maintained on the USEPA Permit Compliance System (PCS). There are 127 wastewater treatment facilities and 87 industries that discharge directly into the Saginaw River/Bay system. Eighteen major municipal WWTPs discharged an average of 155.5 million gallons per day of treated effluent in 1986. These data are presented in Table 22. Tables 23 through 26 provide additional point source discharge data. Intermittent point sources have historically contributed a substantial percentage of pollutants to the Saginaw River/Bay system (Table 27). No data were available on the amount of pollutants entering the Saginaw River/Bay system through intermittent point source discharges. The majority of these sources are within highly urbanized areas, but sources occur throughout the watershed. Figure 34 describes the Combined Sewer Overflow and retention basins in the City of Saginaw. Additional information on dischargers in the Saginaw River/Bay system is available from the USEPA Industrial File Index System (Michigan Department of Natural Resources, 1988). Additional information is available from the Great Lakes Information System (GLIS) (Figure 35). The MDNR manages this system.

Non-Point Source Discharges

Urban and agricultural runoff account for a large portion of non-point discharges into the Saginaw River/Bay system. No data on contaminant loads from runoff specific to the Saginaw River/Bay watershed are available. Suspended solids, and phosphorus loads to Saginaw Bay are presented in Figures 36 and 37. Limno-Tech Inc., under contract to East Central Michigan Planning and Development Region (ECMPDR), calibrated a mathematical model which quantifies the amount of phosphorus delivered by runoff from agricultural lands to Saginaw Bay (Great Lakes Water Quality Board Report to the International Joint Commission, 1987). Tables 28 through 30 provide volumes of non-point discharges from soil erosion, soil phosphorus, and animal waste. Additional information on soil erosion and recession rates is available through the GLIS (Figure 38). All proposed discharges to groundwater are

reviewed by MDNR. Several companies have used injection wells to dispose of waste. Based on estimates from the geology department of Western Michigan University, there exists a relatively high potential for groundwater contamination from some of these wells (Western Michigan University, 1981). Current groundwater rules are being revised (Michigan Department of Natural Resources, 1988). Additional groundwater information can be obtained through Badalamenti et al., 1988 and the Regional Aquifer-System Analysis (RASA) Program, Office of Ground Water, USGS. Bierman et al. (1984) provides additional phosphorus loading information. Tables 31a through 31c describe models which may be useful in predicting loadings in areas where no data currently exist.

Spills

MDNR maintains a Pollution Emergency Alerting System (PEAS) to receive reports of accidental discharges and related problems. PEAS records from January 1984 to October 1986 show that 101 discharge incidents occurred in the Flint River drainage basin. The discharged material included oil, industrial and sewage waste. There were 23 discharge incidents to Saginaw Bay during the same period (Michigan Department of Natural Resources, 1988).

Air Quality

Atmospheric deposition may be sizable and perhaps the major source of organic and inorganic pollutants to the Great Lakes (Eisenreich et al., 1981). Data on atmospheric deposition were collected as part of the Great Lakes Atmospheric Deposition (GLAD) sampling network. Tables 32 through 34 provide deposition rates for pollutants in the Saginaw River/Bay system. Figures 39 and 40 provide information on air movement within Saginaw Bay. Tables 35 and 36 provide precipitation pH and average quantity at several locations in the watershed (Michigan Department of Natural Resources, 1988). Saginaw Bay receives large amounts of acid rain and area precipitation has low pH values (USEPA, 1980). Additional information may be available from the Office of Atmospheric Deposition Analysis, USGS.

Landfill, Hazardous Waste, and Superfund Sites

Over 100 hazardous waste sites and 13 Environmental Protection Agency Superfund sites exist in the Saginaw Bay watershed (Tables 37 through 40; Figure 41). These tables list the pollutant(s) and resource(s) affected by each hazardous waste site in the AOC. Figure 42 shows landfills within the Saginaw River/Bay system. However, no comprehensive list of landfills exists (Michigan Department of Natural Resources, 1988). The Great Lakes Information System may provide additional information.

Land Use Within the AOC

The diverse land usages in this AOC include urban, agricultural, industrial, and recreational. Figures 43 through 45 show the areas within the AOC devoted to recreational, mining, and agricultural usage, respectively. Tables 41 and 42 provide the acreage for various crops and livestock (Michigan Department of Natural Resources, 1988). Additional information is available through the GLIS (Figure 46).

Bioassay Data

The results from Pontoporeia and Hexagenia bioassays mentioned in Table 6a have not been obtained by the authors. No other bioassay data have been located at this time. USEPA GLNPO 1990 mentions bioassays planned by the Toxicity/Chemistry Work Group of the ARCS program.

Biological Data

Fish

Populations of lake trout and walleye are maintained through stocking hatchery-reared fish and artificial propagation. MDNR issued fish consumption advisories for six locations within the AOC in 1988 (Table 43). There are no consumption advisories for walleye or yellow perch, the principal sport fish in Saginaw Bay. Tables 44 through 52, and Figure 47 show fish tissue levels of PCBs, pesticides, and heavy metals from various locations within the AOC (Michigan Department of Natural Resources, 1988). Tissue concentrations from some of these locations exceed the fish consumption advisory trigger. DeVault et al., 1988 (Tables 53 and 54), Kononen, 1989 (Table 55), and Kuehl et al., 1989 (Table 56), contain additional fish tissue data from Saginaw Bay.

Many of these concentrations also exceed the fish consumption advisory trigger. Figure 48a shows the Saginaw Bay fish spawning areas (GLIS). Figures 48b and 48c show changes in commercial fish catches in Saginaw Bay.

Benthic

Benthic macroinvertebrates have been collected in the Saginaw Bay Navigation Approach Channel. These sampling locations are shown in Figure 6. Saginaw Bay benthic results are summarized in Tables 57 and 58. Several other researchers collected macroinvertebrates in Saginaw Bay. Table 59 shows a comparison between studies conducted in 1956 and 1978. Benthic macroinvertebrate taxa were also collected in the Saginaw River. The sampling locations are shown in Figures 17a and 17b. Saginaw River benthic results are summarized in Tables 60 and 61. Two 3-year benthic macroinvertebrate surveys are being conducted in Saginaw Bay to assess the present benthic community structure. Michigan's Fisheries Division began a survey in 1986. The National Oceanic and Atmospheric Administration (NOAA) began field collections in 1987. These studies are coordinated (Great Lakes Water Quality Board Report to the International Joint Commission, 1987).

Plankton

Phytoplankton results are summarized in Figures 49 through 51 and Table 62a. Rotifer results are presented in Figures 52 through 54, and Table 62b. Crustacean plankton results are in Figures 55, 56, and Table 63. Figures 57a, 57b, 58a, and 58b provide a comparison of plankton and benthic invertebrates from segments of the Pine and Saginaw Rivers. Michigan Department of Natural Resources (1988) provides additional references and an in-depth discussion of benthic invertebrates, phytoplanktons, and zooplanktons.

Birds

Herring gulls, double-crested cormorants, caspian terns, and black-crowned night heron inhabit Channel/Shelter Island and/or Little Charity Island (Figure 59). A more detailed description of the Channel/Shelter Island (confined disposal facility) is given in inset map 'B,' Figure 18b. Tables 64a, 64b, 65, and 66 list contaminant concentrations found in herring gull eggs, common terns, and mallard carcasses from Channel/Shelter Island and/or

Little Charity Island. Michigan Department of Natural Resources (1988) suggests the use of caution in interpreting these data. Simmers (1982) discusses avian botulism and a botulism management plan for Channel/Shelter Island. Twenty species of waterfowl use Saginaw Bay habitats during the breeding and migratory season. Currently, there are no standards for the consumption of waterfowl. This AOC has several thousand acres of wetland habitat managed for waterfowl (Figure 43; Michigan Department of Natural Resources, 1988).

Plants

Phytoplankton and algae data are presented in a previous section. No additional plant data have been found.

Mammals

A reduction of the range of some mammals has occurred in the Saginaw River/Bay watershed. The loss of habitat due to urbanization may account for some of this. However, contaminants may have contributed to some of the declines. Michigan Department of Natural Resources 1988 provides further discussion.

Endangered Species

Cormorants are listed as a threatened species in the state of Michigan (Michigan Department of Natural Resources, 1988).

Wildlife Habitat

In addition to the Federal and state refuges shown in Figure 43, the Channel/Shelter Island and Sebewaing confined disposal facilities (CDF) will ultimately be used as wildlife habitat (Figure 60). Both CDFs contain waterfowl nesting habitat.

Risk Assessment

Water

In addition to the three water intakes identified in Figure 19a, East Tawas and Port Austin have intakes within Saginaw Bay. The Saginaw-Midland water intake accounts for 85% of the water drawn from Saginaw Bay for human

use. In 1985, USEPA conducted a study of public drinking water in the Saginaw River/Bay system. Plans are underway to close the Pinconning intake and establish an intake for the Village of Caseville. Three cities have water intakes along tributaries of Saginaw Bay. The City of Alma maintains a water intake on the Pine River. The City of Saginaw has an emergency intake in the Saginaw River. The Genesee County Water Supply has an emergency intake in the Flint River at Flint. Coliforms are monitored along public beaches in several counties which border Saginaw Bay. No public beaches were closed along Saginaw Bay during water years 1984-1987. Water is also withdrawn from waterways within the AOC for agricultural and industrial uses. Estimates of water withdrawal for these uses are not readily available (Michigan Department of Natural Resources, 1988).

Ecosystem

Many of the elements needed to perform a risk assessment have been presented previously. These include the potential exposure to contaminants through drinking water, industrial discharges, fish consumption, waterfowl consumption, and bacterial contamination. Table 67 lists chemicals found in the Great Lakes which may have adverse impacts on human health in the event of high local contamination. Many of these contaminants are present in the Saginaw River/Bay system. Some of the contaminants of primary concern are PCB, DDT, Mirex, Lindane, Dioxin, and Toxaphene. Appendices 1 and 2 provide the populations of each township within the AOC and the industrial group and employment range for each county. Figure 61 shows the location of cities and villages within the AOC (Michigan Department of Natural Resources, 1988). Figure 62 shows the 100-year and 500-year flood zones for Bay County, Michigan (GLIS). No overall risk assessments have been found for the entire Saginaw River/Bay system. USEPA GLNPO 1990 mentions assessments planned by the Risk Assessment/Modeling Work Group of the ARCS program.

Remedial Actions

Several remedial actions have occurred in this AOC. Remedial dredging has been conducted in three Saginaw Bay tributaries. In 1972, 70,000 cubic yards were removed from the St. Louis Reservoir on the Pine River. Between 1976 and 1981, USACE removed PCB-contaminated sediment from the Saginaw

navigation channel. In 1982, PCB-contaminated sediment was dredged from the South Branch of the Shiawassee River near Howell. Also, several companies which owned contaminated property performed remedial cleanups. Programs have been developed to improve agricultural land and animal waste management. Many municipalities have received construction grants to improve WWTPs within the AOC (Table 68). The state banned the use of phosphate detergents in 1977 (Michigan Department of Natural Resources, 1988). These actions will improve the water quality within the Saginaw River/Bay system.

GLNPO SUBJECT-REFERENCE MATRIX

AREA OF CONCERN Saginaw River and Saginaw Bay

SUBJECT REFERENCE R1, R2 (1, 2*) / POINT OF CONTACT P1, P2

SEDIMENT R7, R19 (51, 52, 53, 54, 75, 76, 101, 135, 154, 197, 199, 202, 258, 259, 266, 267, 291, 320, 321, 324, 329, 348, 350, 355, 372) / P15, P6, P12

METALS R11, R12, R17 (44, 275, 276)

PCBs R3, R11, R12, R17 (40, 198, 260, 261, 262, 263, 264) / P14

PAHs R11

PESTICIDES R11, R17

TOC

others (specify) COD, OG, PERCENT SOLIDS, VOLATILE SOLIDS R12 ; CN R11

CONFINED DISPOSAL FACILITY (CDF) R4 (142, 321, 322, 323) / P9, P13

PARTICLE SIZE R11, R17 / P11

ENGINEERING PROPERTIES R17 / P11

DEPOSITION DATA R11 (268, 269)

TRANSPORT DATA (264)

DEPTH DATA R11, R17

HORIZONTAL DISTRIBUTION R11

VOLUME TO BE CONSIDERED R11

WATER QUALITY R7 (7, 16, 26, 41, 68, 77, 78, 83, 92, 98, 100, 102, 103, 104, 118, 133, 136, 137, 138, 139, 140, 141, 143, 154, 163, 164, 165, 166, 167, 168, 169, 172, 188, 195, 207, 212, 216, 217, 218, 220, 224, 225, 226, 227, 228, 239, 243, 272, 295, 300, 314, 315, 330, 331, 332, 333, 337, 339, 341, 342, 343, 344, 345, 346, 347, 357, 363) / P15, P6, P5

* Number Refers To Literature Cited In Appendix 3.

PHYSICAL DATA R11 (3)
 TEMPERATURE R11 (3)
 DO R11
 CONDUCTIVITY
 HARDNESS R11
 TOTAL SOLIDS R11
 CHEMICAL DATA R1, R2
 PH
 TOC
 METALS R11
 PCBs, PBB R11 (198)
 PAHs
 PESTICIDES R11
 BOD R11
 OTHERS (specify) Groundwater R1, R20 (9)
 Phosphorus R11 (106)
 Silica (32)
 LIMNOLOGY R11 (10, 13, 14, 24, 43, 45, 46, 47, 79, 80, 97, 107, 124,
 153, 154, 159, 160, 162, 186, 187, 231, 252, 257, 279, 281, 282, 294, 306,
 307, 308, 309, 310, 311, 312, 359, 365, 370)
 BACTERIA R11 / P12
 DRINKING WATER (11)
 WATERWAY HYDRAULICS R2 (81) / P1, P10, P11
 FLOW DATA R11, R16 (1, 34, 42, 280)
 WATER DEPTH R11
 FLOOD DATA / P5
 POINT DISCHARGES R11 (27, 28, 29, 66, 112, 203, 211, 219, 277, 278, 348,
 349, 350) / P5
 CONCENTRATION DATA / P7

VOLUME DATA R11

WASTE LOAD DATA R11 / P7

RADIOACTIVE WASTE (8, 58)

NON-POINT DISCHARGES R11, R20 (57, 112, 223, 292, 319, 374)

CONCENTRATION DATA

VOLUME DATA R11

WASTE LOAD DATA R11 (299)

SPILLS R11

WATERSHED HYDROLOGY R11 (9, 157, 205, 297, 298, 325, 326, 327, 340, 356, 364)

RAINFALL DATA R11 (191, 242, 358)

ACID RAIN R11 (334)

RUNOFF DATA R11 (95, 170, 171, 173, 175, 256)

VOLUME

SOLIDS R11

CHEMICAL DATA (161)

(SPECIFY)

SNOWFALL (15, 240)

AIR

AIR QUALITY DATA R11, R18 (154, 213, 233)

ATMOSPHERIC DEPOSITION R11, R6 (36, 37, 59, 233, 234, 235)

SUPERFUND SITES R11 / P6

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DIVERSITY

QUANTITY

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DIVERSITY

ABUNDANCE

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Table 1.
Information Required to Evaluate the Potential for Contaminant Mobility

1. SEDIMENT DATA

Water Content	OG
Hydrous oxides (Manganese, ferrous)	EC
Total PAHs	Redox
Total PCBs (Aroclors and Congeners)	Sulfides
TOC	SOD
Total Solids	Volatile Solids
OM	Salinity
EP Test	NH3
CEC (plus calcium, magnesium phosphorus, potassium concentration in extractant)	
Atterberg Limits	
Specific Gravity Determination	
Dispersion Coefficients	
Sediment Particle Density	
Bulk Density	
Permeability	
Particle Size Distribution (hydrometer method); (include sand, fine sand, silt and clay)	
Wet Sediment PH (1:2 sediment to distilled water solution)	
Dry Sediment PH (1:2 sediment to distilled water solution)	
% Base Saturation	
% Free Calcium Carbonate	
Potential pH or Lime Requirement Using Titration or Similar Method	
Total Carbon Content	
Total Soluble Heavy Metal Content	
Total Heavy Metal Content	
Surface Runoff Suspended Solids	
Wet Sediment Extractable Heavy Metal Content (DTPA preferred)	
Dry Sediment Extractable Heavy Metal Content (DTPA preferred)	
Depth (thickness) of Mixed Top Sediment Layer	
Depth (thickness) of Contaminated sediment layers	
Sedimentation Rate (possibly through core dating)	
Sediment Deposition History	
Suspended Solids Settling Rates (possibly through sediment traps)	
Consolidation Characteristics	
Sediment Porosity (mixed layer and deeper layers)	
Pesticides	
Priority Pollutants (40 CFR Part 136)	
Dioxin	
Reference Site	

Table 1. Continued.

2. POINT DISCHARGES INTO WATERWAY
 - Contaminant Loads Based on Concentration and Volumetric Flow Rates
 - Surface Runoff During Storm Events
 - Combined Sewer Overflow
3. NON-POINT DISCHARGES INTO WATERWAY
 - Groundwater: Information on Geohydrology and Groundwater Characteristics
 - Atmospheric Deposition
4. LAND USE OF ADJACENT PROPERTIES
5. CONTAMINATED SITES
 - Hazardous Waste
 - Superfund
 - Spill
6. WATERSHED HYDROLOGY
 - Wetlands
7. WATERWAY HYDRAULICS & FLOW
 - Hydrology or Flows Through the System
 - Area of Bottom Contamination
 - Water Depth at Area of Contamination
 - Contaminant Waste Loads to System
 - Floods
8. WATER QUALITY DATA
 - DOC TOC
 - DO Hardness
 - BOD pH
 - Metals Conductivity
 - PAHs Temperature
 - PCBs Total Solids
 - Total Suspended Solids (distributed in time and space)
 - Best Estimates of Partition Coefficients for Low (water column) and High (bottom sediments) Sediment Concentrations
 - Sediment-Water Contaminant Distribution Coefficients
 - Bacteriological Quality
 - Priority Pollutants
 - Interstitial Water Contaminant Concentration
9. BIOASSAY TEST DATA
 - Rapid:
 - microtox
 - Daphnia
 - Ceriodaphnia
 - Pontoporeia
 - Ames Test

Table 1. Continued.

Chronic:

C. tentans
Daphnia
fathead minnows
macroinvertebrate

Plant bioassay data:

Total PCB Content (aroclor content)
Specific PCB Congeners
PAHs
Heavy Metal Uptake

10. BIOLOGICAL DATA

Fisheries surveys, including:

body weight/size
diet/stomach contents
feeding type
lipid content
phytoplankton
zooplankton

Benthic Community

overall benthic "health"
benthic indicators/low diversity

11. Miscellaneous Information

Climatological Data
Air Quality

12. RISK ASSESSMENT

Human Health
Ecological

13. WILDLIFE USAGE

Birds
Mammals

14. ENDANGERED SPECIES

Federal
State

Table 2a
Ambient Water Criteria (ug/l) for Selected
Toxic Organic Substances

Parameter	Michigan Rule 57(2) Guideline Levels (1988)					USEPA Ambient Water Quality Criteria (1985)	IJC WQA of 1978 Objectives (1978)
	Hardness (mg/l)						
	200	250	300	350	400		
<u>INORGANICS</u>							
Arsenic			150.0 ^a			190.0	50.0
Cadmium	0.64	0.77	0.90	1.02	1.14	---	0.2
Chromium	92.6	111.5	129.7	147.4	164.7	---	50.0
VI			6.0 ^a			11.0 ^b	---
III			---			230.43 ^b	---
Copper	39.7	48.9	58.1	67.1	76.1	13.2 ^b	5.0
Cyanide			5.0 ^a			5.2	---
Iron			---			---	300.0
Lead	8.9	12.5	16.6	21.0	25.7	3.76 ^b	20.0 ^c
Mercury			0.0006 ^a			0.012	0.2
Nickel	147.6	181.2	214.3	247.0	279.3	105.6 ^d	25.0
Selenium			13.0 ^a			35.0 ^e	10
Silver			0.15 ^a			5.08 ^d	---
Zinc	176.5	213.4	249.2	284.1	318.2	118.4 ^b	30.0
<u>ORGANICS</u>							
Aldrin/Dieldrin			---			---	0.001
Chlordane			---			---	0.06
DDT			0.00013 ^a			---	---
+ metabolites			---			---	0.003
PCB			0.00002 ^a			---	0.1
Phenol			230.0 ^a			---	1.0
2,3,7,8-TCDD		1.0 x 10 ⁻⁷	ug/l ^f			"no safe level"	---

^aValue is the same at all hardness levels.

^bFour day average concentration not to be exceeded more than once every three years on the average; calculated at hardness equal to 114 mg/l CaCO₃ based on 1986 Saginaw River water sample, Midland St. (MDNR, unpublished data).

^cLake Huron.

^dUSEPA, 1980 criteria; 24 hour average not to be exceeded at any time; calculated at hardness of 114 mg/l CaCO₃ based on 1986 Saginaw River water sample, Midland St. (MDNR, unpublished data).

^eUSEPA, 1980 criteria; 4 day average not to be exceeded at any time.

^fMDNR, 1987.

Table 2b
Summary of Michigan Surface Water Quality Standards
(from Part 4 of P.A. 245 of 1929, as amended in 1986)

Parameter	Limit
Turbidity Color Oil films Solids (floating, suspended or settleable) Foams Deposits	Waters of the state shall not have any of these unnatural physical properties in quantities which are or may become injurious to any designated use.
Total dissolved solids (TDS)	The addition of any dissolved solids shall not exceed concentrations which are or may become injurious to any designated use. In no instance shall they exceed 500 mg/l monthly average or 750 mg/l maximum for any waters of the state.
Chlorides	A maximum of 125 mg/l monthly average is allowed for waters of the state designated as public water supply sources, except for the Great Lakes and their connecting waters where chlorides shall not exceed a 50 mg/l monthly average.
Hydrogen Ion Concentration (pH)	6.5-9.0 in all waters of the state. Any artificially induced variation in natural pH shall remain within this range and shall not exceed 0.5 units of pH.
Taste and Odor	Waters of the state shall contain no taste-producing or odor-producing substances in concentrations which impair or may impair their use for a public, industrial or agricultural water supply source or which impair the palatability of fish.
Toxic Substances	Substance specific as determined by Rule 57 guidelines (see Table III-2).
Radioactive Substances	Standards prescribed by the U.S. Nuclear Regulatory Commission and the U.S. Environmental Protection Agency.
Phosphorus	1.0 mg/l as a maximum monthly average for effluent discharges.

(Continued)

Table 2b. (Concluded)

Parameter	Limit
Nutrients	In addition to the maximum phosphorus discharge levels allowed, nutrients shall be limited to the extent necessary to prevent stimulation of growths of aquatic rooted, attached, suspended and floating plants, fungi or bacteria, which are or may become injurious to the designated uses of the waters of the state.
Fecal Coliform	All waters of the state shall contain not more than 200 fecal coliform per 100 milliliters. This concentration may be exceeded if such concentration is due to uncontrollable nonpoint sources. The WRC may suspend this limit from November 1 through April 30 upon determining that designated uses will be protected.
Dissolved Oxygen (DO)	7 mg/l in all Great Lakes and connecting waterways and designated coldwater lakes and streams. In all other waters a minimum of 5 mg/l shall be maintained.
Temperature	No heat load which would warm receiving waters at the edge of the mixing zone more than 3 degrees Fahrenheit above existing natural water temperature for the Great Lakes and their connecting waters; 2 degrees Fahrenheit for coldwater streams; and 5 degrees Fahrenheit for warmwater streams.

Table 2c

Water Hardness Values and Associated Michigan Rule 57(2)
Metal Guideline Levels for Selected Saginaw Bay Tributaries

Tributary	Hardness	Metals					
		Cadmium	Chromium	Copper	Lead	Nickel	Zinc
Saginaw River	249	0.77	111.1	48.7	12.4	180.6	212.7
Cass River	312	0.93	134.0	60.2	17.6	222.2	257.6
Flint River	200	0.64	92.6	39.7	8.9	181.2	176.5
Shiawassee River	278	0.84	121.8	54.1	14.7	199.8	233.6
Tittabawassee River	250	0.77	111.5	48.9	12.5	147.6	213.4
Tawas River	152	0.51	73.8	30.6	5.9	114.7	139.8
Au Gres River	402	1.15	165.3	76.5	25.9	280.5	319.6
Rifle River	214	0.68	98.0	42.3	9.9	157.1	187.0
Pine River	258	0.79	114.4	50.4	13.1	186.6	219.2
Pinconning River	341	1.00	144.2	65.9	20.1	241.1	277.9
Kawkawlin River	234	0.73	105.5	46.0	11.3	170.5	201.7
Sebewaing River	325	0.96	138.6	62.6	18.7	230.7	266.7
Pigeon River	339	1.00	143.5	65.1	20.0	239.8	276.5
Pinnebog River	371	1.07	154.7	70.9	22.9	260.6	298.5
Taft Drive	352	1.03	148.1	67.5	21.1	248.3	285.5

Table 2d
Trophic Condition Classification Criteria
for Total Phosphorus (LTI 1983)

Trophic Condition	<u>Total Phosphorus Concentration (ug/l)</u>	
	Carlson (1977)	USEPA (1981)
Eutrophic	>24	>20
Mesotrophic	12 - 24	10 - 20
Oligotrophic	<12	<10

Table 3
Maximum Contaminant Levels for Drinking Water Supplies
in Michigan (from P.A. 399, 1976)

Parameter	Maximum Contaminant Level (mg/l)
INORGANICS	
Arsenic	0.050
Barium	1.0
Cadmium	0.010
Chromium	0.050
Fluoride	2.4
Lead	0.050
Mercury	0.002
Selenium	0.010
Silver	0.050
ORGANICS	
Endrin	0.0002
Lindane	0.004
Methoxychlor	0.1
Toxaphene	0.0005
2,4-Dichlorophenoxyacetic Acid (2,4-D)	0.1
2,4,5-Trichlorophenoxy -proprionic Acid (2,4,5-TP)	0.01
Trihalomethanes	0.1

Table 4
Contaminant Trigger Levels (mg/kg) Currently Used
in Establishment of Public Health Fish Consumption Advisories
(Kreis and Rice 1985; Humprey Hesse 1986)

Chemical	FDA	MDPH	IJC
Chlordane	0.3	0.3	
DDT	5.0	5.0	0.1
DDT metabolites (DDE, DDD)	5.0	5.0	
Dieldrin	0.3	0.3	0.1
Dioxin (2,3,7,8-TCDD)	No formal tolerance	0.00001	
Endrin	0.3	0.3	
Heptachlor	0.3	0.3	
Mercury	1.0	1.5	0.1
Mirex	0.3	0.3	
PCB	2.0	2.0	0.1
Toxaphene	5.0	5.0	

Table 5a
USEPA Pollution Criteria (mg/kg dry wt) for Great Lakes
Harbor Sediments (modified from Rossmann et al. 1983)

Parameter	Classification		
	Non-Polluted	Moderately Polluted	Heavily Polluted
Volatile Solids (%)	<5	5-8	>8
COD	<40,000	40,000-80,000	>80,000
TKN	<1,000	1,000-2,000	>2,000
Oil & Grease (Hexane solubles)	<1,000	1000-2000	>2,000
Ammonia	<75	75-200	>200
CN	<0.10	0.10-0.25	>0.25
Pb	<40	40-60	>60
Zn	<90	90 -200	>200
P	<420	420-650	>650
Fe	<17,000	17,000-25,000	>25,000
Ni	<20	20-50	>50
Mn	<300	300-500	>500
As	<3	3-8	>8
Cd	-	-	>6
Cr	<25	25-75	>75
Ba	<20	20-60	>60
Cu	<25	25-50	>50
Hg	-	-	≥1
PCBs (Total)	-	1 ≤10 (determined on case-by-case)	≥10 CDF (≥50 HWF)

Basin Specific Background Levels of Pollutants in Sediments of the Great Lakes (mg/kg). Additional Work is Necessary to Quantify Background Levels of Pollutants in the Basins Where No Data Currently Exists
(Report to the Great Lakes Water Quality Board 1987)

[illegible]

Table 6a
Sediment Monitoring Activities in Saginaw Bay
and Saginaw River, Michigan (Cowgill 1989)

<u>Dates</u>	<u>Agency</u>	<u>Area Sampled</u>	<u># Samples</u>	<u>Parameters</u>
1980	U.S. ACOE	River	27	PCBs
1980	Michigan DNR	River	16	PCBs
1980-81	U. of Michigan for EPA GLNPO	River	72 grabs 18 cores	PCBs
1983	U.S. ACOE	River	38 7	PCBs, total PAHs, metals, nutrients dioxins, dibenzofurans
7/83	U.S. ACOE	River Bay	37 11	benthic community structure
1984	U.S. F&WS	River and Bay	composite	tumor incidence in native fish, dioxins and dibenzofurans
1987, 1988	NOAA	Bay	30 sites sampled 3 times a year	benthic community structure
Fall 1987	NOAA	Bay	8	<u>Pontoporeia</u> bioassays
Fall 1987	U.S. F&WS	Bay	8	<u>Hexacenia</u> bioassays
1987	U.S. EPA LLRS and U.S. F&WS	Bay CDF	3	PCB congeners, caged biomonitors
1987	U.S. ACOE	Bay CDF		permeability tests using dye studies
7/88	NOAA	Bay	4	<u>Pontoporeia</u> bioassays
5/88	U.S. Army Corps of Engineers	River	30	PCB Aroclors, metals, nutrients, oil and grease
1988	U.S. EPA LLRS with U.S. F&WS	Bay CDF	PCB congeners, caged biomonitors	9 sites
11/88	NOAA	Bay	2	<u>Pontoporeia</u> bioassays
6/88-12/88	Michigan Department of Natural Resources	River Bay Tributaries	12 cores, 70 grabs 10 cores, 70 grabs 70 grabs	PCB congeners, pesticides, TOC, grain size, metals

Table 6b
Average Concentrations (mg/kg) of Metals in Surface
Sediments of Inner Saginaw Bay and Southern Lake
Huron, 1980 (Robbins 1986)

Metal	Location	
	Saginaw Bay	Lake Huron
As	16	27
Ba	422	432
Cd	2.4	2.97
Cr	63	66
Cu	25	37
Mn	0.050	0.13
Ni	31.9	50.6
Pb	45.3	73.6
Zn	96.3	116.3

Table 6c

Summary of Contaminants (ug/g) in 42 Areas of Concern Within the Great Lakes Basin (as provided in the IJC Regional Office as of October 1987; Report of the Sediment Subcommittee and its Assessment Work Group to the Water Quality Board, 1988)

	SAGINAW R. & B.	COLLINGWOOD H.	PEWEE- STURGEON B.	SPANISH R.	LAKE HURON ³	ST. MARYS R.	ST. CLAIR R.	DETROIT R.	CLINTON R.	ROUGE R.	MAISON R.	MAUMEE R.	BLACK R.	CUYAHOGA R.	ASHTABULA R.	WHEATLEY H.	LAKE ERIE ⁴
Ammonia													389	>200			
Arsenic	16				3						12	10.1	18.9	>8	>8		
Barium	422									550							
Cadmium	2.4	4.5			0.4			+		96	3.0	9	18.32	>6	>6		2.0
Copper	25	59		>25	31		>25	+	130	293	14000	>50	167.5	>50	>50	>25	40
Chromium	63	37			30		>25	+	280	420	11000		146.75	>75	>75	>25	
Cyanide						0.015						125	2.32	>0.25			
Iron		21000			32200	+				40000		>25000	41200	>25000			
Lead	45.3	214			14.4		42	0.55	290	710	310	75	101.6	760	>60		28
Manganese	0.05				400				820					>500			600
Mercury					0.08		58	1.16		2.4	0.89	0.6	0.425	+	>1		0.1
Nickel	31.9	33.3		>25	29.9			+	200	138	5800	50	96	>50		>25	
Radium																	
Thorium																	
Uranium																	
Zinc	96.3	180			60	654	>100	+	590	978	1000	194	404	>200	>200	>100	110
COB									54900			>83300	131000	>80000			
Phosphorus		2000			700							1660	2400	>650		>1000	1100
Nitrogen		2600			4270				720			3900	3200	>2000		>2000	1500
Oil/Grease						+			>2000		24000	5200	25900	>2000		>1500	
PCB	27	0.9		>0.05		0.3	5.3	13.9		9.7	17.0	+	0.34	2.2	>50	>0.05	
PAM						+				125			915.40	75.7			
Chlordane													<0.10			+	
DDT								0.4					<0.02	+		+	
Benzidene																	
BaP								19.2					77.7				
Ether Solubles						+											
2,3,7,8 TCDD							+										
Dieldrin								0.01									
HCB								0.1		30			<0.02				
No. of Identified Contaminants	10	10	0	3	12	7	7	12	9	12	10	14	21	19	8	10	8

- Note:
- Values exceeding standards/guidelines are reported as (>) greater than the applicable value.
 - Numbers represent the highest concentrations reported.
 - A plus (+) indicates that presence only was reported.
 - Lake values are from a major depositional zone as noted below and represent concentrations below the "Ambrosia" level (i.e. in sediments deposited prior to 1860).
 - X denotes average value reported.

*Keweenaw Basin-Superior
 *Southern Basin-Michigan
 *Saginaw Basin -Huron

*Central Basin-Erie
 *Niagara Basin-Ontario

Table 7a

Organic Contaminant Concentrations (ug/kg dry weight) found in Sediments of the
South Branch Shiawassee River Below Howell, 1974 (MDNR 1977)

Station	Station Location	PCB ^a 1242	PCB ^a 1254	PCB 1260	Phthalate DEHP	Phthalate DBP	Phthalate BBP	Oil (ug/kg)	Diel- drin	Chlor- dane	En- drin
Marion and Genoa Drain											
M&G-1	Pisk Road, Control	<400	<100	<50	800	<1,000	<100	850	<1	<30	<3
M&G-2	Above Howell WTP	<200	640	<50	1,700	<1,000	310	6,000	<1	ND	<3
M&G-3	Below Howell WTP	ND	1,000	<50	13,000	<1,000	300	9,900	<1	ND	<3
M&G-5	Mouth	<1,800	1,600	<50	33,000	<1,000	<100	6,000	<1	ND	<3
South Branch Shiawassee River											
SRS-1	Sexton Road, Control	<100	<100	<50	<100	<1,000	<100	1,400	<1	30	<3
SRS-2	Above Marion & Genoa Drain	<400	420	<50	2,100	<1,000	<100	4,900	<1	30	<3
SRS-3	Morton Road	<6,000	1,200	<50	20,000	ND	390	7,300	ND	ND	<3
SRS-4	Grand River Road	<1,500	400	<50	11,000	<1,000	<100	5,000	<1	ND	<3
SRS-5	Bowen Road, Below Cast Forge	530,000	<11,000	<50	ND	ND	ND	20,000	ND	ND	<3
SRS-6	Mart Road	97,000	<5,000	<50	14,000	<1,000	<100	4,400	<1	ND	<3
SRS-7	Chase Lake Road	59,000	<400	<50	<100	<1,000	<100	2,100	<1	ND	<3
SRS-8	Oak Grove Road	16,000	<400	<50	1,200	<1,000	<100	660	<1	ND	<3
SRS-9	Cohoctah Road	2,900	700	<50	<100	<1,000	<100	<500	<1	ND	<3

ND: Not determined due to interference by other chemicals.

^a Interfering chemicals resulted in less sensitivity at some stations.

Table 7b

Metal and Nutrient Concentrations (mg/kg dry weight) Found in Sediments from
Marion and Genoa Drain and South Branch Shiawassee River, 1974 (MDNR 1979a)

Station Location	As	Cu	Hg	Cd	Total Cr	Zn	Ni	Pb	CN	Z Volatile Solids	Total	
											Kjeld. N	PO ₄ -P
Marion and Genoa Drain												
M&G-1 Fisk Road Control	43	32	0.3	<1	11	140	36	21	0.3	19	8,200	80
M&G-2 Above Howell WWTP	31	150	0.2	5	1,200	1,200	40	600	1.1	12	8,600	80
M&G-3 Below Howell WWTP	29	160	0.2	5	1,800	1,300	40	720	2.2	4.2	6,400	170
M&G-5 Mouth	20	230	0.3	8	6,000	1,600	52	720	0.2	15	8,100	340
South Branch Shiawassee River												
SRS-1 Sexton Road, Control	125	24	<0.1	1	17	140	53	46	<0.7	12	19,000	170
SRS-2 Above Marion & Genoa Drain	36	30	<0.1	<1	36	200	34	46	<0.5	1.9	12,000	160
SRS-3 Norton Road	20	180	<0.1	6	4,200	1,400	48	520	4.6	12	8,600	400
SRS-4 Grand River Road	21	160	0.1	6	3,800	1,200	54	460	3.0	13	9,300	500
SRS-5 Bowen Road	11	84	<0.1	3	1,600	660	30	240	1.4	13	5,600	450
SRS-6 Marr Road	18	60	<0.1	3	1,700	740	38	260	1.4	9.5	5,700	220
SRS-7 Chase Lake Road	18	60	0.2	3	1,300	620	42	170	1.1	17	7,800	280
SRS-8 Oak Grove Road	12	34	0.2	1	420	240	28	100	0.3	7.9	5,800	200
SRS-9 Cohoctah Road	20	14	0.1	1	130	100	16	24	<0.2	4.5	3,200	68

Table 8
Organic Contaminant Concentrations (mg/kg dry weight) Found
in Sediments of the South Branch Shiawassee River Below
Howell, August 1977 (MDNR 1979)

Station*	Parameter					
	PCB 1242	PCB 1254	PCB 1260	DEHP	DBP	Total PCB
1A	13.0	5.6	<5.0	<2.0	<2.0	19.5
5-TR-1-5	27.0	10.4	<5.0	<2.0	<2.0	37.4
5-TR-1-2	13.6	5.6	<5.0	<2.0	<2.0	19.2
5-TR-1-3	45.2	18.3	<5.0	<2.0	<2.0	63.5
5-TR-2-5 (Bowen Road)	64.8	20.3	<5.0	<2.0	<2.0	85.1
5-TR-2-2	16.2	15.4	<5.0	<2.0	<2.0	31.6
5-TR-2-3	23.8	9.0	<5.0	<2.0	<2.0	32.8
5-200	53.6	12.4	<5.0	<2.0	<2.0	66.0
5-400	64.0	15.7	<5.0	<2.0	<2.0	78.7
5-600	40.0	8.8	<5.0	<2.0	<2.0	49.4
5-800	20.3	<5.0	<5.0	<2.0	<2.0	20.3
5-1000	43.0	8.1	<5.0	<2.0	<2.0	51.1
CF-CON (M-59 Control Station)	0.5	0.8	<0.5	<2.0	<2.0	0.8
CF-DIS-1	23.0	8.7	<5.0	<2.0	<2.0	31.7
CF-DIS-2	35.3	6.7	<5.0	<2.0	<2.0	42.0
CF-DIS-3	31.0	7.8	<5.0	<2.0	<2.0	38.8

* Station 1A corresponds to Willson and Powers 1974 Survey; Station 5-TR-1 & 2 are core samples; 5-TR-200 & 1000 are sludge bed samples.
CF-CON is the control station immediately above M-59.
CF-DIS - 1, 2, 3 samples were taken 50, 100, and 150 yards downstream from Cast Forge old discharge channel.

Table 9
PCB Concentrations (dry weight) in Sediments of the South
Branch Shiawassee River from Howell to Corunna,
October 1977 (MDNR 1977)

Station Number	Station Location	PCB (mg/kg)			
		Aroclor			Total
		1242	1254	1260	
1	Marr Road	35.00	8.70	<0.50	43.70
2	Chase Lake Road	17.00	3.20	<0.50	20.20
3	Oak Grove Road	4.10	<0.50	<0.50	4.10
4	Lillie Road	0.96	<0.50	<0.50	0.96
5	Byron Road	2.60	<0.50	<0.50	2.60
6	Durand Road	0.54	<0.50	<0.50	0.54
7	Cole Road	0.50	<0.50	<0.50	0.50
8	Shiatown Res.	0.60	<0.50	<0.50	0.66
9	Corunna Imp.	0.50	<0.50	<0.50	0.50

Table 10

Metal Concentrations (mg/kg) Found in Shiawassee River Sediments, Owosso, 1980 (MDNR 1980)

Site	Metal					
	Cadmium	Chromium	Copper	Nickel	Lead	Zinc
Shiawassee River at Lytle Rd., Shiawassee Co., Michigan	<2.0	12.0	6.0	6.0	10.0	50.0
Shiawassee River at Division St., City of Owosso	<2.0	23.0	13.0	10.0	28.0	70.0
Shiawassee River at Alkan St., City of Owosso - particulate matter scraped from inside of County Drain outfall pipe	80.0	170.0	15,000.0	1,500.0	100,000.0	740.0
Shiawassee River at Alkan St., approximately 10.0 m downstream from County Drain outfall	<2.0	<10.0	12.0	8.0	80.0	60.0
Shiawassee River at Alkan St., approximately 20.0 m downstream from County Drain outfall	<2.0	10.0	8.0	7.0	30.0	50.0
Shiawassee River at Alkan St., approximately 30.0 m downstream from County Drain outfall	<2.0	<10.0	7.0	7.0	20.0	50.0
Shiawassee River at Harmon - Partridge Park, City of Owosso	<2.0	10.0	8.0	5.0	40.0	60.0

Table 11
Metal Concentrations (mg/kg) in Shiawassee River
Sediments Collected Near Owosso, 1972
(MDNR 1979a)

Metal	Station							
	2	3	4 North	4 Middle	4 South	5	6	7
Pb	36	27	18	136	378	26	136	40
Zn	25	15	26	18	26	17	44	33
Cu	7.2	4.6	5.4	3.4	4.8	2.6	6.6	6.2
Cr	12	13	7.2	9.0	7.6	7.4	11	10
Cd	2.2	2.8	1.0	1.0	1.0	1.0	2.4	1.8

Table 12

Metal and Phosphorus Concentrations (mg/kg) in Tittabawassee River Sediments, 1981

(Rossmann et al 1983; see Figures 12, 13a, and 13b)

Station	River Mile	Metal						Total	
		As	Cu	Hg	Cd	Cr	Zn	Ni	Pb
1	25	0.614	1.59	.106 ²	.0378	6.65	14.6	4.10	3.97 ²
2	23.5	0.793	5.82	.186	.0555	13.5	20.3	5.76	10.0
3	20.9	1.81	3.26	.0109 ²	.0202	8.59	19.1	3.56	4.99
4	18.9	2.41	4.04	.0165	.0210	13.4	21.8	6.56	3.86 ²
5	17	4.15	5.79	.199 ²	.0320	20.5	36.8	11.6	10.8
6	14.8	37.4	6.52	.280	.189	117.0	48.6	15.0	40.8
7	13	6.49	18.6	.0516 ²	.147	31.6	43.9	15.2	19.5
8	11.4	3.12	8.79	.0209 ²	.0193	26.4	42.7	6.92	6.71
9	6.6	0.672	7.22	.0164 ²	.0212	8.96	21.9	3.58 ¹	4.20 ²
10	4	1.78	7.48	.0250	.0398	9.91	32.7	5.64	6.89 ²
Mean		5.9	6.9	.091	.058	26	30	7.8	11
Standard Deviation		11.2	4.6	.097	.060	33	12	4.5	11

¹ Sylvester (1974).² One or more samples from core below limit of detection.

Table 13

Organic Concentrations (ug/kg) in Tittabawassee River Sediments
and Flood Plain Samples (see Figures 12, 13a, and 13b)

	Station											
	TR-1 Above Ash Pond	TR-2 Below Ash Pond	TR-3 Above Lingle Drain	FP-1 Flood Plain @ T. Pond	TR-4 Smith's Crossing Bridge	FP-2 Flood Plain at White and Debolt Mills	TR-5 Up- stream of Brown Mills land	TR-6 Free- Ti. Road	FP-3 Flood Plain at T. Gratiot Road	TR-7 Ti. Road	TR-8 Road	TR-9 Center Road
Benzene	-	-	-	-	-	-	-	-	5	-	-	-
Methylene chloride*	2400	32	29	85	17	-	46	16	57	40	99	-
Toluene	5.2	-	-	-	-	-	-	-	-	-	-	-
Xylenes	-	-	-	-	-	-	-	-	-	5	-	-
Bis(2-ethylhexyl)phthalate*	870	-	-	-	-	-	-	-	-	10	10	-
Di-n-butyl phthalate*	10	-	-	-	-	-	-	-	-	-	-	-
Di-n-octyl phthalate*	-	-	840	450	-	-	-	-	-	-	-	-
Diethyl phthalate*	-	-	-	-	-	3100	-	-	10	-	-	10
4,4'-DDT	14	17	8.3	6.6	-	-	-	-	-	-	-	-
4,4'-DDE	20	19	19	-	12	88	-	-	-	-	-	-
4,4'-DDD	15	14	-	7.3	-	-	-	-	-	-	-	-

* Not detected

All other organic priority pollutants not detected

* Presence may be due to laboratory or field contamination

Table 14
Conventional Metal and Organic Parameter Concentrations
(mg/kg dry weight) in Flint River Sediments, 1974
(MDNR 1977; see Figure 14)

	Station			
	F-6 Elms Road	F-8 Mt. Morris Road	F-11 East Burt Road	F-13 Mich. 13
Arsenic	5.4	14.0	1.7	4.0
Copper	140.0	110.0	20.0	8.4
Mercury	0.4	0.3	0.2	0.2
Cadmium	6.0	4.0	<1.0	<1.0
Chromium	200.0	88.0	18.0	11.0
Zinc	1500.0	1100.0	130.0	54.0
Nickel	82.0	92.0	18.0	10.0
Lead	780.0	620.0	70.0	20.0
Total Solids (%)	29.0	29.0	76.0	71.0
Volatile Solids (%)	4.2	5.3	0.8	0.6
Total Kjeldahl-Nitrogen	6200.0	7000.0	770.0	830.0
Total Phosphorus	530.0	610.0	120.0	140.0
Dieldrin	< 0.001	< 0.001	< 0.001	< 0.001
Chlordane	< 0.001	< 0.001	< 0.001	< 0.003
DDD	ND	ND	ND	< 0.003
DDE	ND	ND	ND	< 0.001
o,p - DDT	ND	ND	ND	< 0.003
p,p - DDT	ND	ND	ND	< 0.003
Total DDT + Analogs	ND	ND	ND	< 0.010
PCB 1242	ND	ND	ND	ND
PCB 1254	0.420	0.420	0.089	< 0.003
PCB 1260	< 0.003	< 0.003	< 0.003	< 0.003
Total PCB	< 0.423	< 0.423	< 0.092	< 0.006
DEHP	18.000	18.000	0.840	2.400
DBP	< 1.000	< 1.000	< 1.000	< 1.000
Oil-Hexane (as %)	1.200	1.200	0.660	1.100
BBP	6.700	6.700	0.340	0.550

ND = Not determined due to presence of interfering chemicals.

Table 15

PBB Concentrations (ug/kg dry weight) in Pine River Sediments,
1974, 1976, and 1977 (Rice et al. 1980; see Figure 15)

Station	Year		
	1974	1976	1977
Downstream from Alma reservoir	<100	<100	-
M-46 1/4 mile upstream from Michigan Chemical Corporation	<100	<100	350
St. Louis reservoir immediately downstream from Velsicol Chemical Corporation	4800	1100	7100
Immediately downstream from St. Louis reservoir	6200	1200	500
Miles below St. Louis Dam - 2	1600	200	400
- 4	480	<100 (trace)	260
- 9	270	<100	180
- 19	<100	<100	<100
- 25	100	<100	150

Table 16a

PBB, DDT, and Chlordane Residue Concentrations in Pine River Sediment

Grab Samples, 1980-1981 (Rice et al. 1982; see Figure 16)

Station	PBB Conc. (ug/kg)	Total DDT Residue (ug/kg)	Percent Composition of DDT Residue			Total Chlordane (cis+trans) (ug/kg)
			% DDE	% DDD	% DDT	
1	23	39	26.65	71.69	1.65	3.2
4	248	69	40.50	20.13	39.37	5.6
5	173	160	4.94	82.88	12.19	8.6
7	496	179	18.88	78.91	2.22	<0.4
9	1,350	5,412	2.55	19.91	77.54	<0.3
11	8,064	1,530	.04	74.35	25.61	<0.2
12	4,586	8,935	.03	71.72	28.31	<0.4
15	1,341	3,746	4.43	84.93	10.64	<0.3
16	1,108	5,451	1.50	93.61	4.89	<0.6
18	41	1,103	1.28	83.43	15.30	<0.1
19	106	5,193	.63	26.90	72.47	0.0

Table 16b

PBB, DDT, and Chlordane Residue Concentrations in Pine River Sediment

Core Samples, 1980-1981 (Rice et al. 1982; see Figure 16)

Station	Core Depth (cm)	PBB Conc. (ug/kg)	Total DDT Residue (ug/kg)	Percent Composition of DDT Residue			Total Chlordane (cis+trans) (ug/kg)
				% DDE	% DDD	% DDT	
3	20.00	353	126	6.66	84.09	9.25	12.6
3	30.00	367	313	29.08	36.66	34.26	11.6
3	47.00	0.0	546	27.75	50.84	21.41	21.2
8	10.00	126	359	8.72	24.89	66.39	<0.4
8	21.00	437	337	34.73	41.35	23.92	2.0
8	39.50	72	396	59.07	25.06	15.87	7.2
8	56.50	17	845	25.39	10.36	64.25	<0.1
8	59.50	2	310	73.70	12.96	13.34	20.3
8	70.50	2	861	29.51	6.65	63.84	<0.6
8	78.00	<0.1	209,316	1.89	73.28	24.84	1,513.2
10	15.00	233	4,608	18.42	39.06	42.52	0.0
10	32.00	277	89,005	8.59	32.70	58.71	2,757.6
10	50.00	30	99,119	5.28	30.50	64.21	1,946.0
10	68.00	58	3,570,109	0.37	0.35	99.28	2,813.0
14	23.50	2,265	4,696	11.57	81.76	6.67	120.3
14	45.50	96	107,343	99	83.96	15.05	<0.2

Table 17a

PCB, Dibenzofuran, and Dibenzodioxin Concentrations in Saginaw
River Sediments, 1978, 1980, and 1983 (USFWS 1983)

Station	1978 Total PCB (mg/kg)	1980 Total PCB (mg/kg)	1983 PCB		1983 2,3, 7,8-TCDF (ng/kg)
			1016, 1221 1232, 1242 1248 ² ; 1254 1260; (mg/kg)		
SR-1	0.9	<0.015	ND ³		<85
SR-2	1.2	-	ND		-
SR-3	2.2	1.1	2.0 (1248)		-
SR-3A	2.2	2.8 ⁵	ND		-
SR-4	22.9	0.11 ⁵	0.46 (1248)		-
SR-5	12.8	0.745	2.1 (1242)		<35
SR-6	5.5	-	7.6 (1242)		-
			1.7 (1254)		
SR-7	12.3	4.565	6.9 (1248)		-
SR-7A	1.8	<0.02	0.35 (1248)		-
SR-8	1.5	-	1.4 (1248)		-
SR-9	4.5	0.12	0.12 (1248)		-
SR-10	1.0	1.1	1.0 (1248)		-
SR-11	1.3	-	0.47 (1248)		-
SR-12	0.1	1.42	0.63 (1248)		-
SR-13	0.2	0.605	0.94 (1248)		-
SR-14	<0.1	1.2	0.93 (1248)		-
SR-14A	-	0.46	-		-
SR-15	2.0	0.11	ND		<390
SR-16	1.3	-	0.27 (1248)		-
SR-16A	-	1.28 ⁵	-		-
SR-17	1.9	1.9	0.22 (1248)		-
SR-18	4.8	<0.1	0.62 (1248)		-
SR-19	7.6	2.75	1.2 (1248)		-
SR-20	5.7	7.6	2.1 (1248)		-
SR-21	7.9	9.9	2.1 (1248)		-
SR-22	4.0	-	4.1 (1248)		-
SR-23	4.0	-	4.0 (1248)		<95
SR-24	4.1	0.42	4.9 (1248)		-
SR-25	3.5	6.3	22 (1248)		-
SR-26	11.8	2.0	27 (1248)		<15
SR-27	6.5	0.315	0.84 (1248)		-
SR-28	3.2	5.8	12 (1248)		-
SR-29	2.5	0.46	1.5 (1248)		-
SR-30	2.0	2.0	1.1 (1248)		-
SR-31	1.2	-	0.53 (1242)		-
SR-32	5.4	-	1.2 (1248)		-
SR-33	3.3	-	13 (1248)		<220
SR-34	2.1	-	2.5 (1248)		-
SR-35	1.9	-	0.62 (1242)		-

Table 17b
Saginaw River Navigation Channel Sediment Concentrations
(mg/kg) of Selected Metal Parameters, 1983
(USACE 1983; see Figures 17a and 17b)

Station	As	Cd	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Zn
1	6.7	0.8	23	39	9,900	-	250	12	21	100
2	3.4	0.9	13	12	6,100	-	100	5	10	65
3	18	2.2	90	99	26,000	0.2	520	36	65	250
3A	9	<0.8	29	10	21,000	-	1,000	23	4	64
4	9.1	1.2	28	30	14,000	0.2	370	18	34	220
5	8.9	0.8	32	35	17,000	0.2	670	17	13	110
6	12	2.2	96	82	26,000	0.3	620	36	55	260
7	20	2.7	110	130	21,000	0.2	520	38	71	340
7A	8.1	1.2	44	37	16,000	-	420	22	45	310
8	12	1.5	53	61	15,000	0.1	410	27	48	260
9	5.7	1.0	22	16	11,000	0.2	310	14	26	340
10	20	1.8	67	71	21,000	0.3	490	32	54	330
11	6.9	1.2	54	22	8,600	-	190	15	20	150
12	12	2.0	56	60	22,000	0.1	550	33	64	520
13	9.1	1.7	56	45	15,000	-	350	25	33	270
14	7.7	-	41	52	13,000	0.1	310	23	29	140
15	9.4	-	16	11	15,000	-	420	18	11	150
16	5.4	-	15	15	8,100	-	180	14	11	110
17	4.4	-	12	8	7,700	-	150	12	12	130
18	5.0	-	18	-	9,300	-	210	14	16	170
19	8.5	-	30	-	14,000	-	350	25	32	280
20	5.0	-	37	-	8,600	0.2	200	18	21	150
21	4.2	-	29	19	9,900	-	200	22	23	180
22	7.5	-	10	9	12,000	-	310	18	8	74
23	8.4	-	35	28	14,000	-	310	26	33	260
24	10	-	54	44	20,000	-	470	35	72	380
25	12	-	110	75	20,000	0.2	460	52	61	310
26	17	3.5	180	150	34,000	0.2	680	87	96	500
27	9.7	-	30	32	16,000	-	380	29	33	230
28	9.6	1.7	75	66	12,000	-	310	40	44	260
29	12	2	76	64	17,000	-	540	45	72	550
30	14	1.2	57	49	20,000	-	500	31	58	490
31	18	1.2	60	56	24,000	-	730	40	63	560
32	20	1.8	67	71	21,000	0.3	490	32	54	330
33	6.9	1.2	54	22	8,600	-	190	15	20	150
34	12	2.0	56	60	22,000	0.1	550	33	64	520
35	9.1	1.7	56	45	15,000	-	350	25	33	270
36	7.7	-	41	52	13,000	0.1	310	23	29	140

Table 17c

Saginaw River Navigation Channel Sediment Concentrations
(mg/kg) of Selected Conventional and Organic Parameters,
1983 (USACE 1983; see Figures 17a and 17b)

Station	Total P	TKN	Phenols
1	410	1,500	-
2	190	1,000	0.32
3	690	1,900	0.21
3A	330	2,400	-
4	540	980	-
5	710	2,800	-
6	790	970	-
7	1,500	2,600	-
7A	580	1,200	-
8	570	1,100	-
9	360	120	-
10	610	1,800	-
11	460	1,000	-
12	600	5,800	-
13	410	4,100	-
14	590	3,400	1
15	240	4,800	-
16	280	4,400	-
17	220	3,200	-
18	280	3,400	-
19	590	4,500	-
20	380	1,200	-
21	350	760	-
22	530	1,600	-
23	530	820	-
24	1,000	2,200	-
25	1,400	3,000	-
26	760	1,600	-
27	810	3,300	-
28	960	3,700	-
29	940	5,100	-
30	1,200	4,600	-
31	910	4,800	-
32	610	1,800	-
33	460	1,000	-
34	600	5,800	-
35	410	4,100	-
36	590	3,400	1

Table 18a
Saginaw River Project On-Site Data and Sample Descriptions
May 2-3, 1988 (USACE, Detroit 1988)

STATION NO. 19 (Southside of Channel)

Date: 05/02/88

Measured Water Depth: 13.4'

Water Depth Minus L.W.D.: 11.2'

Depth of Sample Collected: 2.2'

Sample Description - A 50-50 mixture of gray sandy silts with a few pieces of gray, septic odor, no oil observed.

STATION NO. 17 (East Edge of Channel)

Date: 05/02/88

Measured Water Depth: 22.6'

Water Depth Minus L.W.D.: 20.4'

Depth of Sample Collected: 1.9'

Sample Description - Sample consisted primarily of gray sand with detrital material on the surface. Very little silts, no oil was observed and the sample had a strong septic odor.

Continued)

(Sheet 1 of 9)

Table 18a. (Continued)

STATION NO. 15 (East Edge of Channel)

Date: 05/02/88

Measured Water Depth: 19.0'

Water Depth Minus L.W.D.: 16.8'

Depth of Sample : 1.9'

Sample Description - Approximately 90% gray sand with 10% silts. The sample has a light septic odor with no oil.

STATION NO. 13 (Northwest Edge of Channel)

Date: 05/02/88

Measured Water Depth: 19.0'

Water Depth Minus L.W.D.: 16.8'

Depth of Sample Collected: 1.4'

Sample Description - The entire sample consisted of medium coarse gray sand, light septic odor, no oil observed.

STATION NO. 11 (West Edge of Channel)

Date: 05/02/88

Measured Water Depth: 20.7'

Water Depth Minum L.W.D.: 18.5'

Depth of Sample Collected: 2.0'

Sample Description - Gray sand with detrital material intermixed, <5% silts. Sample had a light hydrocarbon odor, no oil observed.

STATION NO. 9 (North Edge of Channel)

Date: 05/02/88

Measured Water Depth: 20.7'

Water Depth Minus L.W.D. : 18.5'

Depth of Sample Collected: 2.0'

Sample Description - Primarily gray smooth silts with approximately 10% fine sand. Approximately 4" of brown clay on the bottom of the clam shell. Sample had a light hydrocarbon odor, no oil.

(Continued)

(Sheet 2 of 9)

Table 18a. (Continued)

STATION NO. 7 (West Edge of Channel)

Date: 05/02/88

Measured Water Depth: 19.0'

Water Depth Minus L.W.D.: 16.8'

Depth of Sample Collected: 3.0'

Sample Description - Primarily dark gray silts with approximately 20% very fine sand. Moderate amount of oil was observed and the sample had a strong hydrocarbon odor. Texture was smooth to light gritty.

STATION NO. 5 (West Edge of Channel)

Date: 05/02/88

Measured Water Depth: 19.68'

Water Depth Minus L.W.D.: 17.48'

Depth of Sample Collected: 1.20'

Sample Description - Primarily gray fine coarse sand with <5% silts. A light amount of oil was observed and the sample had a faint hydrocarbon odor.

STATION NO. 3 (West Edge of Channel)

Date: 05/02/88

Measured Water Depth: 19.7'

Water Depth Minus L.W.D.: 17.5'

Depth of Sample Collected: 1.30'

Sample Description - Primarily gray-brown medium coarse sand with very little silts (<5%) intermixed. No oil was observed and the sample had a faint septic odor.

(Continued)

(Sheet 3 of 9)

Table 18a. (Continued)

STATION NO. 1 (North Edge of Channel)

Date: 05/02/88

Measured Water Depth: 19.7'

Water Depth Minus L.W.D.: 17.5

Depth of Sample Collected: 1.90'

Sample Description - Blackish gray sand with approximately 10% loose gray silts intermixed. Gritty texture, no oil and the sample had a light septic odor.

STATION NO. 2

Date: 05/02/88

Measured Water Depth: 17.7'

Water Depth Minus L.W.D.: 15.5'

Depth of Sample Collected: 2.20'

Sample Description - Sample was identical to Station 1.

STATION NO. 4 (West Edge of Channel)

Date: 05/02/88

Measured Water Depth: 20.6'

Water Depth Minus L.W.D.: 18.5'

Depth of Sample Collected: 2.0'

Sample Description - Approximately 3" of gray loose silts over medium coarse brown sand. No oil was observed and the odor was light septic.

STATION NO. 16 (West Edge of Channel)

Date: 05/02/88

Measured Water Depth: 20.6'

Water Depth Minus L.W.D.: 18.2'

Depth of Sample Collected: 2.9'

Sample Description - The sample consisted primarily of gray stiff silts with a very small percentage of fine sand. The texture was smooth to lightly gritty, mild hydrocarbon odor and no oil was observed.

(Continued)

Table 18a. (Continued)

STATION NO. 6 (West Edge of Channel)

Date: 05/02/88

Measured Water Depth: 21.0'

Water Depth Minus L.W.D.: 18.8'

Depth of Sample Collected: 2.7'

Sample Description - Gray to dark black stiff silts with some fine sand intermixed, the texture is primarily smooth. The sample had a strong hydrocarbon odor with a moderate amount of oil observed.

STATION NO. 8 (East Edge of Channel)

Date: 05/02/88

Measured Water Depth: 21.0'

Water Depth Minus L.W.D.: 18.8'

Depth of Sample Collected: 1.4'

Sample Description - Approximately 2" of brown loose silts over 5" of dense black oily silts over gray/brown oily sand. Oil was visible throughout the sample and there was a strong hydrocarbon odor.

STATION NO. 10 (Mid-Channel)

Date: 05/02/88

Measured Water Depth: 21.6'

Water Depth Minus L.W.D.: 19.4'

Depth of Sample Collected: 1.2'

Sample Description - Entire sample consisted of brown to dark gray fine to medium coarse sand with some wood chips intermixed. No oil was observed and the sample had a light septic odor.

(Continued)

(Sheet 5 of 9)

Table 18a. (Continued)

STATION NO. 12 (Northwest Edge of Channel)

Date: 05/02/88

Measured Water Depth: 21.6'

Water Depth Minus L.W.D.: 19.4'

Depth of Sample Collected: 1.3'

Sample Description - 3" of brown loose silts over medium coarse brown sand with wood chips throughout. Earthy odor with no oil.

STATION NO. 14 (East Edge of Channel)

Date: 05/02/88

Measured Water Depth: 20.3'

Water Depth Minus L.W.D.: 18.1'

Depth of Sample Collected: 1.2'

Sample Description - Primarily fine to medium coarse gray/brown sand with a very small amount of gray silts on the surface. The odor was earthy and no oil was observed.

STATION NO. 18 (East Edge of Channel)

Date: 05/02/88

Measured Water Depth: 20.0'

Water Depth Minus L.W.D.: 17.8'

Depth of Sample Collected: 1.5'

Sample Description - 4" of gray loose silts over medium to fine coarse gray sand, very light oil observed, earthy odor.

STATION NO. 20 (West Edge of Channel)

Date: 05/03/88

Measured Water Depth: 19.7'

Water Depth Minus L.W.D.: 17.5'

Depth of Sample Collected: 2.5'

Sample Description - The entire sample consists of gray to dark brown gelatinous silts with a very small percent of fine sand. No oil was observed and the odor is earthy.

(Continued)

Table 18a. (Continued)

STATION NO. 21 (Mid-Channel)

Date: 05/03/88

Measured Water Depth: 20.5'

Water Depth Minus L.W.D.: 18.3'

Depth of Sample Collected: 1.3'

Sample Description - Fine to medium coarse gray sand with detrital material and crushed shells. Earthy odor, no oil.

STATION NO. 22 (South Edge of Channel)

Date: 05/03/88

Measured Water Depth: 23.2

Water Depth Minus L.W.D.: 21.0

Depth of Sample Collected: 2.4'

Sample Description - 1.0 foot of gray gelatinous silts over brown medium coarse sand. No oil was observed and the odor is earthy.

STATION NO. 23 (South Edge of Channel)

Date: 05/03/88

Measured Water Depth: 22.6'

Water Depth Minus L.W.D.: 20.4

Depth of Sample Collected: 2.0'

Sample Description - Brown fine sand (6") over medium coarse brown sand. No silts, no oil and a earthy odor.

STATION NO. 24 (Northwest Edge of Channel)

Date: 05/03/88

Measured Water Depth: 23.3'

Water Depth Minus L.W.D.: 21.1'

Depth of Sample Collected: 2.6'

Sample Description - 1.5 feet of loose gray silts over medium brown coarse sand with some detrital material intermixed. Odor is earthy with no oil observed.

(Continued)

(Sheet 7 of 9)

Table 18a. (Continued)

STATION NO. 25 (West Edge of Channel)

Date: 05/03/88

Measured Water Depth: 23.2'

Water Depth Minus L.W.D.: 21.1'

Depth of Sample Collected: 2.6'

Sample Description - The entire sample consists of very consolidated gray to dark gray silts with very little fine sand. Light hydrocarbon odor, no oil observed.

STATION NO. 26 (West Edge of Channel)

Date: 05/03/88

Measured Water Depth: 22.6'

Water Depth Minus L.W.D.: 20.4'

Depth of Sample Collected: 2.7'

Sample Description - Grayish green very thick silts over 6" of coarse brown sand. Strong septic odor, no oil observed.

STATION NO. 27 (West Edge of Channel)

Date: 05/03/88

Measured Water Depth: 21.3'

Water Depth Minus L.W.D.: 19.1'

Depth of Sample Collected: 1.8'

Sample Description - 10" of grayish green gelatinous silts over medium coarse gray/brown sand. Strong septic odor, no oil.

STATION NO. 28 (West Edge of Channel)

Date: 05/03/88

Measured Water Depth: 21.9'

Water Depth Minus L.W.D.: 19.7'

Depth of Sample Collected: 2.6'

Sample Description - 1.0' of gray loose silts over blackish gray silty sand (50-50). No oil was observed, odor light septic.

(Continued)

(Sheet 8 of 9)

Table 18a. (Concluded)

STATION NO. 29 (West Edge of Channel)

Date: 05/03/88

Measured Water Depth: 22.3'

Water Depth Minus L.W.D.: 20.1'

Depth of Sample Collected: 2.5'

Sample Description - 1.0 foot of gray consolidated silts over gray medium coarse sand with detrital material throughout. Odor light septic, no oil observed.

STATION NO. 30 (West Edge of Channel)

Date: 05/03/88

Measured Water Depth: 23.3'

Water Depth Minus L.W.D.: 21.1'

Depth of Sample Collected: 2.6'

Sample Description - 1.5 feet of gray consolidated silts over brown coarse sand. The sample had an earthy odor with no oil.

Table 18b. Chemical Analysis of Sediment Samples (USACE, Detroit 1988)

Project: A8563

Report Date: 06/27/88

Results by Sample

Prepared for:		Client P.O. : DACW35-88-D-0007		Approved: <i>[Signature]</i>		Residual Samples Will Be Held	
U S ARMY ENGINEER DISTRICT - DETROIT,		Report #: 565		LINDA DUNLAP		**	
BOX 1027		Samples Rec'd: 05-04-88		Saginaw River		For Two Weeks	
DETROIT, MI 48231		DELIVERY ORDER #0001					
Attention: FRANK GMITZ							
Client ID	SR-1	SR-2	SR-3	SR-4	SR-5	SR-6	
Collected	05-03-88	05-03-88	05-03-88	05-03-88	05-03-88	05-03-88	
MA Sample Number	05/187953	05/187954	05/187955	05/187956	05/187957	05/187958	
Matrix	SOLID	SOLID	SOLID	SOLID	SOLID	SOLID	
Parameters:							
ARSENIC mg/Kg	4 6	<2 2	<2 8	5 1	3 3	10	
CADMIUM mg/Kg	2 3	1 1	0 56	2 4	1 2	4 6	
ORGANIC CARBON, TOTAL mg/Kg	5200	5300	2200 8	18000	9500	45000	
CHROMIUM mg/Kg	22	8 8	<0 38	26	12	62	
COPPER mg/Kg	7 2	2 5		15	14	72	
CHEMICAL OXYGEN DEMAND							
IN PLACE DENSITY g/cm ³	62,000	17,000	17,000	61,000	34000	130000	
IRON mg/Kg	9500	4500	3200 2	11000	5700	16000	
LEAD mg/Kg	34	16	<0 02	56	23	100	
MERCURY mg/Kg	11	4 8	19 4	13	6 1	29	
NICKEL mg/Kg	22	20		130	20	150	
NITROGEN mg/Kg							
KJELDAHL NITROGEN, TOTAL	540	220	76	1200	360	1700	
OIL AND GREASE mg/Kg	1200	720	<100	640	320	10000	
PARTICLE SIZE, COE (5 PT)							
PARTICLE SIZE > 2 0 mm %	1 1	0 2	0 2	0 4	2	0	
PARTICLE SIZE > 0 43 mm %	41 1	21 4	20 6	3 4	3 4	25 0	
PARTICLE SIZE > 0 17 mm %	32 8	63 2	68 4	41 2	70 2	15 4	
PARTICLE SIZE > 0 075 mm %	20 5	14 8	9 8	49 2	24 8	57 4	
PARTICLE SIZE < 0 075 mm %	370	160	150	600	280	930	
PHOSPHORUS mg/Kg	69	76	81	53	64	52	
SOLIDS, PERCENT %	1 9	0 69	0 57	3 5	1 5	4 9	
VOLATILE SOLIDS %	64	34	20	190	71	280	
ZINC mg/Kg							

(Continued)

Table 18b. (Continued)

Project: AB563

Report Date: 27 JUN 1988

Client ID Collected TMA Sample Number Matrix Parameter	SR-7 05-03-88 05/187939 SOLID	SR-8 05-03-88 05/187980 SOLID	SR-9 05-03-88 05/187961 SOLID	SR-10 05-03-88 05/187962 SOLID	SR-11 05-03-88 05/187963 SOLID	SR-12 05-03-88 05/187964 SOLID
ARSENIC mg/Kg	<7.8	14.6	13.2	<2.4	<2.7	4.9
CADMIUM mg/Kg	1.2	4.6	4.2	1.1	0.70	1.4
ORGANIC CARBON, TOTAL mg/Kg	32000	48000	58000	5800	11000	8400
CHROMIUM mg/Kg	12	140	34	7.7	8.4	18
COPPER mg/Kg	8.9	94	47	4.0	6.4	13
CHEMICAL OXYGEN DEMAND mg/Kg	75000	120000	89000	13000	25000	29000
IN PLACE DENSITY gm/cm3	4.6	1.6	1.6	2.0	2.1	1.7
IRON mg/Kg	4400	16000	17000	3300	3800	7700
LEAD mg/Kg	25	100	100	48	47	40
MERCURY mg/Kg	0.08	0.28	0.15	<0.02	<0.02	0.04
NICKEL mg/Kg	6.1	31	26	3.9	3.7	8.8
AMMONIA NITROGEN mg/Kg	69	28	140	5.9	5.7	11
KJELDAHL NITROGEN, TOTAL mg/Kg	870	1900	2200	120	38	600
OIL AND GREASE mg/Kg (5 PT)	1900	19000	2700	<100	<100	230
PARTICLE SIZING, CDE (5 PT)						
PARTICLE SIZE > 2.0 mm %	0.2	0.4	0.2	3.6	1.1	0
PARTICLE SIZE > 0.43 mm %	4.6	35.2	15.0	20.8	1.9	4.4
PARTICLE SIZE > 0.17 mm %	13.2	50.0	13.2	69.8	84.4	65.8
PARTICLE SIZE > 0.074 mm %	40.0	52.0	66.6	90.0	93.8	43.2
PARTICLE SIZE < 0.074 mm %	0.14	0.12	0.35	0.20	<0.10	22.6
PHENOLS mg/Kg	780	1900	1200	190	260	370
PHOSPHORUS, TOTAL mg/Kg	58	58	47	77	73	63
SOLIDS, PERCENT %	3.0	4.8	1.1	0.21	1.1	0
VOLATILE SOLIDS %	130	430	460	44	80	180
ZINC mg/Kg						

Page 2 See last page for explanation of symbols

(Continued)

(Sheet 2 of 7)

Table 18b. (Continued)

Project: AB563

Report Date: 27 JUN 1988

Client ID TMA Sample Number Matrix Parameter	SR-13 03-03-88 05/187965 SOLID	SR-14 03-03-88 05/187966 SOLID	SR-15 03-03-88 05/187967 SOLID	SR-16 03-03-88 05/187968 SOLID	SR-17 03-03-88 05/187969 SOLID	SR-18 03-03-88 05/187970 SOLID
ARSENIC mg/kg	< 2	< 2	4 7	9 6	4 8	5 1
CADMIUM mg/kg	1 1	0 94	1 6	3 6	1 7	1 1
ORGANIC CARBON, TOTAL mg/kg	11000	5400	9200	26,000	11,000	13,000
CHROMIUM mg/kg	10	10	16 4	42	19	13 5
COPPER mg/kg	18 1	6 1	19 4	35	12	8 5
CHEMICAL OXYGEN DEMAND						
IN PLACE DENSITY gm/cm ³	29000	11000	31000	100000	50000	40000
IRON mg/kg	4500	4300	1 8	1 4	1 7	1 1
LEAD mg/kg	22	19	6600	14000	8200	5800
MERCURY mg/kg	0 03	< 0 02	< 0 02	0 10	0 04	< 0 02
NICKEL mg/kg	5 6	3 5	37 4	23	11	7 4
AMMONIA NITROGEN mg/kg	15	31	37	190	37	36
KJELDAHL NITROGEN, TOTAL mg/kg	320	230	500	1900	730	520
OIL AND GREASE mg/kg	< 100	110	580	2100	3400	720
PARTICLE SIZING, COE (5 PT)						
PARTICLE SIZE > 2 0 mm %	0 8	1 2	0 8	0 2	0 8	1 0
PARTICLE SIZE > 0 43 mm %	0 4	13 8	10 4	1 0	3 4	4 2
PARTICLE SIZE > 0 17 mm %	70 4	70 0	64 4	21 4	64 4	76 0
PARTICLE SIZE > 0 074 mm %	18 8	2 4	10 4	6 4	5 6	13 6
PARTICLE SIZE < 0 074 mm %	0 11	12 4	14 0	71 0	25 6	15 2
PHENOLS mg/kg	360	410	380	1200	450	330
PHOSPHORUS, TOTAL mg/kg	67	73	68	52 7	69	66 0
SOLIDS, PERCENT %	93	1 8	1 9	3 7	2 9	150
VOLATILE SOLIDS %						
ZINC mg/kg		120	240	340	260	150

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(Continued)

(Sheet 3 of 7)

Table 18b. (Continued)

Project: AB963

Report Date: 27 JUN 1988

Client ID Collected TMA Sample Number Metals Parameter	SR-19 05-03-88 05/187971 SOLID	SR-20 05-03-88 05/187972 SOLID	SR-21 05-03-88 05/187973 SOLID	SR-22 05-03-88 05/187974 SOLID	SR-23 05-03-88 05/187975 SOLID	SR-24 05-03-88 05/187976 SOLID
ARSENIC mg/kg	< 3	14	< 6	< 6	< 3	6 8
CADMIUM mg/kg	1 9	3 6	0 90	2 4	2 0	3 1
ORGANIC CARBON, TOTAL mg/kg	12000	26000	68000	19000	16000	19000
CHLORINE mg/kg	17	38	3	21	19	34
COPPER mg/kg	10	37	4 2	14	11	26
CHEMICAL OXYGEN DEMAND						
IRON mg/kg	47000	78000	33000	30000	41000	75000
IN PLACE DENSITY gm/cm3	1 6	1 5	1 9	1 7	1 7	1 5
LEAD mg/kg	8000	13000	3400	9400	7200	11000
MERCURY mg/kg	40	63	22	56	33	64
NICKEL mg/kg	< 0 02	0 15	< 0 02	0 05	0 13	0 46
AMMONIA NITROGEN mg/kg	10	28	4 4	13	10	18
KJELDAHL NITROGEN, TOTAL	41	48	4 2	60	34	110
OIL AND GREASE mg/kg	970	1100	130	980	340	1200
PARTICLE SIZE, COC (5 PT)	910	2400	3600	1000	1000	1100
PARTICLE SIZE > 2 0 mm x	1 2	3 4	6 4	3	2 0	0 3
PARTICLE SIZE > 0 43 mm x	10 8	18 4	18 4	23 8	14 9	6 1
PARTICLE SIZE > 0 17 mm x	23 8	34 2	63 4	43 7	72 4	72 2
PARTICLE SIZE > 0 074 mm x	17 2	43 4	1 2	16 2	9 2	10 0
PARTICLE SIZE < 0 074 mm x	47 8	43 2	8 4	16 2	1 3	11 4
PHENOL mg/kg	< 0 10	< 0 10	< 0 10	0 25	0 17	0 14
PHOSPHORUS, TOTAL mg/kg	510	680	240	560	420	680
SOLIDS, PERCENT x	62 9	33 6	77 1	57 3	63 9	54 8
VOLATILE SOLIDS x	160	130	39	200	140	310
ZINC mg/kg						

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(Continued)

(Sheet 4 of 7)

Table 18b. (Continued)

Client ID Collected YMA Sample Number Matrix Parameter	SR-25 05-03-88 05/187977 SOLID	SR-26 05-03-88 05/187978 SOLID	SR-27 05-03-88 05/187979 SOLID	SR-28 05-03-88 05/187980 SOLID	SR-29 05-03-88 05/187981 SOLID	SR-30 05-03-88 05/187982 SOLID
ARSENIC mg/kg	<9.6	<9.0	<2.8	<9.4	8.5	<10
CADMIUM mg/kg	4.6	4.1	2.9	2.5	3.0	3.6
ORGANIC CARBON, TOTAL mg/kg	38000	33000	20000	28000	28000	40000
CHROMIUM mg/kg	48	40	28	32	30	38
COPPER mg/kg	37	32	16	27	20	31
CHEMICAL OXYGEN DEMAND						
IRON mg/kg	120000	87000	78000	100000	83000	110000
IN PLACE DENSITY gm/cm ³	1.4	1.4	1.6	1.6	1.5	1.3
LEAD mg/kg	17000	16000	11000	11000	11000	13000
NICKEL mg/kg	100	92	63	64	66	73
AMMONIA NITROGEN mg/kg	25	23	15	18	17	21
KJELDAHL NITROGEN, TOTAL mg/kg	75	38	110	22	180	490
OIL AND GREASE mg/kg	1200	1000	1300	1000	1200	2100
PARTICLE SIZING, COE (5 PT)	2200	2300	960	970	1000	900
PARTICLE SIZE > 2.0 mm %	0	0	0	0	0	0
PARTICLE SIZE > 0.43 mm %	0	0	3	3	3	4
PARTICLE SIZE > 0.17 mm %	1	12	25	13	13	17
PARTICLE SIZE > 0.075 mm %	3	11	36	49	37	12
PARTICLE SIZE < 0.075 mm %	85	75	32	37	48	64
PHENOLS mg/kg	0	0	0	0	0	0
PHOSPHORUS, TOTAL mg/kg	960	780	690	730	680	850
SOLIDS, PERCENT %	51	51	53	51	53	44
VOLATILE SOLIDS %	8.2	7.5	4.7	5	5.2	5
ZINC mg/kg	560	410	200	290	300	310

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Project Comments:

Comments about sample 05/187933
 OIL AND GREASE - AVERAGE OF DUPLICATE RUNS
 PHENOLS - AVERAGE OF DUPLICATE RUNS
 TOTAL PHOSPHORUS - AVERAGE OF DUPLICATE RUNS
 TOTAL KJELDAHL NITROGEN - AVERAGE OF DUPLICATE RUNS
 PARTICLE SIZING, COE (5 PT) - AVERAGE OF DUPLICATE RUNS
 MERCURY - AVERAGE OF DUPLICATE RUNS
 Comments about sample 05/187935
 TOTAL ORGANIC CARBON - AVERAGE OF DUPLICATE RUNS
 AMMONIA NITROGEN - AVERAGE OF DUPLICATE RUNS
 Comments about sample 05/187936
 IRON - AVERAGE OF DUPLICATE RUNS
 CADMIUM - AVERAGE OF DUPLICATE RUNS
 COPPER - AVERAGE OF DUPLICATE RUNS
 CHROMIUM - AVERAGE OF DUPLICATE RUNS
 NICKEL - AVERAGE OF DUPLICATE RUNS
 LEAD - AVERAGE OF DUPLICATE RUNS
 ZINC - AVERAGE OF DUPLICATE RUNS
 Comments about sample 05/187937
 ARSENIC - AVERAGE OF DUPLICATE RUNS
 Comments about sample 05/187938
 TOTAL KJELDAHL NITROGEN - AVERAGE OF DUPLICATE RUNS

(Continued)

Table 18b. (Continued)

Comments about sample 03/187959
IN PLACE DENSITY - AVERAGE OF DUPLICATE RUNS
CHEMICAL OXYGEN DEMAND - AVERAGE OF DUPLICATE RUNS
Comments about sample 03/187960
IRON - AVERAGE OF DUPLICATE RUNS
CADMIUM - AVERAGE OF DUPLICATE RUNS
COPPER - AVERAGE OF DUPLICATE RUNS
CHROMIUM - AVERAGE OF DUPLICATE RUNS
NICKEL - AVERAGE OF DUPLICATE RUNS
LEAD - AVERAGE OF DUPLICATE RUNS
ZINC - AVERAGE OF DUPLICATE RUNS
Comments about sample 03/187961
TOTAL KUJELDAHL NITROGEN - AVERAGE OF DUPLICATE RUNS
Comments about sample 03/187962
OIL AND GREASE - AVERAGE OF DUPLICATE RUNS
TOTAL PHOSPHORUS - AVERAGE OF DUPLICATE RUNS
Comments about sample 03/187963
SOLIDS, PERCENT - AVERAGE OF DUPLICATE RUNS
PARTICLE SIZING, COE (5 PT) - AVERAGE OF DUPLICATE RUNS
MERCURY - AVERAGE OF DUPLICATE RUNS
Comments about sample 03/187965
IN PLACE DENSITY - AVERAGE OF DUPLICATE RUNS
TOTAL ORGANIC CARBON - AVERAGE OF DUPLICATE RUNS
AMMONIA NITROGEN - AVERAGE OF DUPLICATE RUNS
Comments about sample 03/187967
IN PLACE DENSITY - AVERAGE OF DUPLICATE RUNS
ARSENIC - AVERAGE OF DUPLICATE RUNS
Comments about sample 03/187968
OIL AND GREASE - AVERAGE OF DUPLICATE RUNS
Comments about sample 03/187971
TOTAL PHOSPHORUS - AVERAGE OF DUPLICATE RUNS
TOTAL KUJELDAHL NITROGEN - AVERAGE OF DUPLICATE RUNS
IRON - AVERAGE OF DUPLICATE RUNS
CADMIUM - AVERAGE OF DUPLICATE RUNS
COPPER - AVERAGE OF DUPLICATE RUNS
CHROMIUM - AVERAGE OF DUPLICATE RUNS
NICKEL - AVERAGE OF DUPLICATE RUNS
LEAD - AVERAGE OF DUPLICATE RUNS
ZINC - AVERAGE OF DUPLICATE RUNS
Comments about sample 03/187972
CHEMICAL OXYGEN DEMAND - AVERAGE OF DUPLICATE RUNS
Comments about sample 03/187973
VOLATILE SOLIDS - AVERAGE OF DUPLICATE RUNS
MERCURY - AVERAGE OF DUPLICATE RUNS
Comments about sample 03/187975
PHENOLS - AVERAGE OF DUPLICATE RUNS
AMMONIA NITROGEN - AVERAGE OF DUPLICATE RUNS
Comments about sample 03/187977
IRON - AVERAGE OF DUPLICATE RUNS
CADMIUM - AVERAGE OF DUPLICATE RUNS
CHROMIUM - AVERAGE OF DUPLICATE RUNS
NICKEL - AVERAGE OF DUPLICATE RUNS
LEAD - AVERAGE OF DUPLICATE RUNS
ZINC - AVERAGE OF DUPLICATE RUNS
Comments about sample 03/187978
TOTAL ORGANIC CARBON - AVERAGE OF DUPLICATE RUNS
Comments about sample 03/187979
OIL AND GREASE - AVERAGE OF DUPLICATE RUNS
TOTAL KUJELDAHL NITROGEN - AVERAGE OF DUPLICATE RUNS
PARTICLE SIZING, COE (5 PT) - AVERAGE OF DUPLICATE RUNS
Comments about sample 03/187981
TOTAL KUJELDAHL NITROGEN - AVERAGE OF DUPLICATE RUNS

Table 18b. (Concluded)

Comments about sample 05/187982
 CHEMICAL OXYGEN DEMAND - AVERAGE OF DUPLICATE RUNS
 TOTAL KJELDAHL NITROGEN - AVERAGE OF DUPLICATE RUNS

Note - Results indicated by '0' are in mg/L instead of mg/Kg
 FR - See field report for result
 NA - Not applicable to test requested
 PID - Undetected, detection limit in ()
 SID - Sample damaged

SR - See attached report for result
 C - Positive result but at unquantifiable
 concentration below indicated level
 - Test not requested for this sample

Table 18c. (Continued)

Project: A8563 1

Report Date: 23 JUN 1988

Client ID Collected TMA Sample Number Matrix CAS#	BR-7 05-02-88 05/187989 SOLID	BR-8 05-02-88 05/187990 SOLID	BR-9 05-02-88 05/187991 SOLID	SR-10 05-02-88 05/187992 SOLID	BR-11 05-02-88 05/187993 SOLID	SR-12 05-02-88 05/187994 SOLID
P. PEST AND PCB'S (CDE LIST)						
ALDRIN $\mu\text{g}/\text{kg}$	<0.010	<0.10	<0.010	<0.010	<0.010	<0.010
D-DT $\mu\text{g}/\text{kg}$	<0.010	<0.10	<0.010	<0.010	<0.010	<0.010
9-BHC $\mu\text{g}/\text{kg}$	<0.010	<0.10	<0.010	<0.010	<0.010	<0.010
9-BHC $\mu\text{g}/\text{kg}$	<0.010	<0.10	<0.010	<0.010	<0.010	<0.010
9-BHC $\mu\text{g}/\text{kg}$	<0.010	<0.10	<0.010	<0.010	<0.010	<0.010
CHLORDANE $\mu\text{g}/\text{kg}$	<0.010	<0.10	<0.010	<0.010	<0.010	<0.010
4,4'-DDT $\mu\text{g}/\text{kg}$	<0.010	<0.10	<0.010	<0.010	<0.010	<0.010
4,4'-DDE $\mu\text{g}/\text{kg}$	<0.010	<0.10	<0.010	<0.010	<0.010	<0.010
4,4'-DDT $\mu\text{g}/\text{kg}$	<0.010	<0.10	<0.010	<0.010	<0.010	<0.010
DIELDRIN $\mu\text{g}/\text{kg}$	<0.010	<0.10	<0.010	<0.010	<0.010	<0.010
ENDOSULFAN I $\mu\text{g}/\text{kg}$	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
ENDOSULFAN II $\mu\text{g}/\text{kg}$	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
ENDOSULFAN SULFATE $\mu\text{g}/\text{kg}$	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
ENDIN $\mu\text{g}/\text{kg}$	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
ENDIN ALDERYDE $\mu\text{g}/\text{kg}$	<0.010	<0.10	<0.010	<0.010	<0.010	<0.010
HEPTACHLOR $\mu\text{g}/\text{kg}$	<0.010	<0.10	<0.010	<0.010	<0.010	<0.010
HEPTACHLOR EPOXIDE $\mu\text{g}/\text{kg}$	<0.010	<0.10	<0.010	<0.010	<0.010	<0.010
TOXAPHENE $\mu\text{g}/\text{kg}$	<0.010	<0.10	<0.010	<0.010	<0.010	<0.010
PCB 1016 $\mu\text{g}/\text{kg}$	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
PCB 1221 $\mu\text{g}/\text{kg}$	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
PCB 1234 $\mu\text{g}/\text{kg}$	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
PCB 1248 $\mu\text{g}/\text{kg}$	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
PCB 1254 $\mu\text{g}/\text{kg}$	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
PCB 1260 $\mu\text{g}/\text{kg}$	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
MIREX $\mu\text{g}/\text{kg}$	<0.010	<0.10	<0.010	<0.010	<0.010	<0.010
METHOXYCHLOR $\mu\text{g}/\text{kg}$	<0.010	<0.10	<0.010	<0.010	<0.010	<0.010
HEXACHLOROBENZENE $\mu\text{g}/\text{kg}$	<0.010	<0.10	<0.010	<0.010	<0.010	<0.010

Page 2 See last page for explanation of symbols

(Continued)

(Sheet 2 of 5)

Table 18c. (Continued)

Project: AB563 I

Report Date: 23 JUN 1988

Client ID Collected TMA Sample Number Natri, Parameter	SR-13 05-02-88 05/187993 SOLID	SR-14 05-02-88 05/187996 SOLID	SR-15 05-02-88 05/187997 SOLID	SR-16 05-02-88 05/187998 SOLID	SR-17 05-02-88 05/187999 SOLID	SR-18 05-02-88 05/188000 SOLID
P. POLL PEST. AND PCB'S (CODE LIST)						
a-BHC mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
b-BHC mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
g-BHC mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
h-BHC mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
CHLORDANE mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
4,4'-DDD mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
4,4'-DDE mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
4,4'-DDT mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
DIELDRIN mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
ENDOSULFAN I mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
ENDOSULFAN II mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
ENDOSULFAN SULFATE mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
ENDRIN mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
HEPTACHLOR mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
HEPTACHLOR EPOXIDE mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
TOXAPHENE mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
PCB 101 mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
PCB 1231 mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
PCB 1232 mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
PCB 1242 mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
PCB 1248 mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
PCB 1253 mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
PCB 1260 mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
MIREX mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
METHOXYCHLOR mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
HEPTACHLOROBENZENE mg/Kg	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010

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(Continued)

(Sheet 3 of 5)

Table 18c. (Concluded)

Report Date 23 JUN 1988

Client ID Collected TMA Sample Number Matrix Parameter	SR-25 05-02-88 05/188007 SOLID	SR-26 05-02-88 05/188008 SOLID	SR-27 05-02-88 05/188009 SOLID	SR-28 05-02-88 05/188010 SOLID	SR-29 05-02-88 05/188011 SOLID	SR-30 05-02-88 05/188012 SOLID
P. POLYEST AND PCB'S (COE LIST)						
ALDRIN mg/Kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.050
γ-BHC mg/Kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.050
β-BHC mg/Kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.050
δ-BHC mg/Kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.050
CHLORDANE mg/Kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.050
4,4'-DDD mg/Kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.050
4,4'-DDE mg/Kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.050
4,4'-DDT mg/Kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.050
DIELDRIN mg/Kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.050
ENDOSULFAN I mg/Kg	<0.050	<0.050	<0.050	<0.050	<0.050	<0.010
ENDOSULFAN II mg/Kg	<0.050	<0.050	<0.050	<0.050	<0.050	<0.010
ENDOSULFAN SULFATE mg/Kg	<0.050	<0.050	<0.050	<0.050	<0.050	<0.010
ENDRIN mg/Kg	<0.050	<0.050	<0.050	<0.050	<0.050	<0.010
HEPTACHLOR mg/Kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.050
HEPTACHLOR EPOXIDE mg/Kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.050
TOXAPHENE mg/Kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.10
PCB 1016 mg/Kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.10
PCB 1221 mg/Kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.10
PCB 1232 mg/Kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.10
PCB 1242 mg/Kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.10
PCB 1248 mg/Kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.10
PCB 1254 mg/Kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.10
PCB 1260 mg/Kg	<0.20	<0.20	<0.20	<0.20	<0.20	<0.10
MIREX mg/Kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.050
METHOXYCHLOR mg/Kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.050
HEXACHLOROBENZENE mg/Kg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.050

Note: Results indicated by 'g' are in mg/L instead of mg/Kg
 FR = See field report for result
 NA = Not applicable to test requested
 ND = Nondetected, detection limit in ()
 SD = Sample damaged

SR = See attached report for result

< = Positive result but at unquantifiable

concentration below indicated level

- = Test not requested for this sample

Table 19a
Secchi Depth (m) by Season for Inner Saginaw Bay, 1974-1980
(Bierman et al. 1983)

Year	Season	
	Spring	Fall
1974	1.09	0.95
1975	1.30	1.12
1976	0.78	0.84
1977	1.39	0.78
1978	0.98	0.93
1979	1.09	0.95
1980	1.16	1.16

Table 19b
Mean Secchi Disc Depth (m) by Segment in Saginaw Bay, 1974 and 1975
(Smith et al. 1977; see Figure 49)

Segment	Year	
	1974	1975
1	0.87	0.9
2	1.3	1.5
3	1.0	1.4
4	3.4	3.6
5	2.7	3.0

Table 19c
Average Total Phosphorus Concentrations (ug/l) in Water for
Inner Saginaw Bay, During Spring and Fall, 1974-1980
(Bierman et al. 1984)

Year	Season	
	Spring	Fall
1974	30.5	29.3
1975	35.4	27.3
1976	41.2	40.9
1977	-	-
1978	47.3	34.8
1979	37.3	27.7
1980	26.8	24.8

Table 19d
Mean Concentrations (ng/l) and Percent Residues of Several
Organic Contaminants Found in Saginaw Bay Water Samples,
1967-1979 (Kreis and Rice 1985)

Category	Year						1979
	1967	1968	1974	1976	1976	1977	
Source	1	1	2	3	4	5	6
Nearshore or River	R	R	N	N	R	N	N
No. of samples	1	1		8			118
PCB							
Total			0-23			25.0	24.4
%1260			44.0				51.1
%1254			13.0				
%1242			44.0				48.7
DDT							
DDT-R	ND	ND	<3.0				
%p,p'DDD	ND	ND	33.3				
%p,p'DDE	ND	ND	33.3				
%p,p'DDT	ND	ND	33.3				
Dieldrin	T	ND	0.6				
Aldrin	ND	ND					
Chlordane	ND	ND					
Lindane	ND	ND					
Alpha BHC	7.0	ND					
"Apparent" Toxaphene	ND	ND					
DEHP			1300	2250	1000		
DBP			1000				

T = Trace
ND = Not Detected

Table 19e
Mean Concentrations of PCB (ug/l) and Suspended Solids (mg/l)
in Saginaw Bay, 1979 (Richardson et al. 1983;
see Figure 19)

Parameter	Segment				
	1	2	3	4	5
Total PCB					
Total	43.1	26.4	25.6	18.1	16.2
Dissolved	27.0	14.8	15.7	14.1	13.7
Particulate	16.2	11.6	9.91	3.98	2.57
A-1242					
Total	23.0	13.4	12.7	7.66	6.87
Dissolved	15.67	8.09	8.13	5.95	5.83
Particulate	7.45	5.31	4.52	1.71	1.04
A-1260					
Total	20.1	13.0	12.8	10.4	9.36
Dissolved	11.4	6.68	7.45	8.13	7.83
Particulate	8.70	6.34	5.39	2.27	1.53
Suspended Solids	15.2	9.68	12.2	3.03	2.65

Table 19f

Concentrations (ug/l) of Metals on Suspended Particulate Size
Fractions, Saginaw Bay, 1978 (Rygwelski et al. 1984)

Metal	Particulate Size (um)		
	10-74	74-210	210-1000
Copper			
N	95	101	97
Mean	410	70	95
Median	300	22	31
Minimum	3.7	4.8	3.5
Maximum	1300	610	430
Lead			
N	100	101	85
Mean	240	46	100
Median	50	32	53
Minimum	23.0	20.0	4.6
Maximum	3300	210	540
Zinc			
N	98	101	102
Mean	390	170	220
Median	330	130	160
Minimum	6.3	95	20
Maximum	870	430	650

Table 19g
Water Sampling Sites on Saginaw Bay Basin Tributaries

Tributary	Location	Description
Saginaw River	Mouth	Downstream of Bay City
Saginaw River	Midland Street	Approx. RM 5.0 in Bay City
Saginaw River	Center Street	Approx. RM 20.0 upstream of Saginaw
Tittabawassee River	Gordonville Rd.	Downstream of Midland
Shiawassee River	Fergus Road	Near Mouth
Flint River	Elms Road	Downstream of Flint
Cass River	Dixie Highway	Near Mouth
Tawas River	U.S. 23	Near Mouth
Whitney Drain	U.S. 23	Near Mouth
Au Gres River	U.S. 23	Near Mouth
Rifle River	State Road	Near Mouth
Pine River	State Road	Near Mouth
Pinconning River	Mouth	Mouth
Kawkawlin River	Mouth	Mouth
Sebewaing River	C&O RR Bridge	Near Mouth
Pigeon River	Kinde Road	Near Mouth
Pinnebog River	M-25	Near Mouth
Taft Drain	M-25	Near Mouth

Table 19h
Fecal Coliform and Fecal Streptococci Values in Surface
Waters of the Saginaw Bay Watershed Measured by USGS
in 1983, 1984, and 1985 (USGS 1983, 1984, and 1985)

River	Water Year			
	1983	1984	1985	
Saginaw ^a				
fecal coliform	min	410	110	220
	max	920	470	760
fecal streptococci	min	220	180	210
	max	320	570	580
Pigeon ^b				
fecal coliform	min	200	360	440*
	max	2200	4500	-
fecal streptococci	min	200	320	4300*
	max	9400	2800	-
Rifle ^c				
fecal coliform	min	410*	-	250
	max	-	760*	690
fecal streptococci	min	760	190	11
	max	9500	370	1600

^aRM 20.3 (Rust Ave.)

^bRM 3.1 (Kinde Rd.)

^cRM 20.0 (Old M-70)

* not all four samples represented

Table 20
Morphometric Data for Saginaw Bay^a

Measurement	Saginaw Bay		
	Inner Bay	Outer Bay	Total
Surface Area (km ²)	1,480 ^b	1,480 ^b	2,960 ^b
Average Depth (m)	4.6 ^b	14.6 ^c	9.6 ^b
Maximum Depth (m)	14.0 ^b	40.5 ^b	40.5 ^b
Volume (km ³)	6.8	21.6	28.4
Flushing Time	110 ^d	---	52 ^d
Surface Area/Volume	218	64	104
Shoreline Length (km)	---	---	240
Drainage Basin Area (km ²)			22,557 ^e
Mean Tributary Input (m ³)			153.7 ^c

^aChart datum for Lake Huron is 175.8 m (576.8 feet). As of June 1988, Lake Huron water levels were 176.4 m (578.8 feet).

^bBeeton, et al, 1967.

^cSmith, et al, 1977.

^dDolan, 1975. Flushing time determinations based on assumed volume of 25.3 cubic miles for total bay and 8.05 cubic miles for inner bay. Flushing times for volumes presented above would be 58 days for the whole bay and 93 days for the inner bay.

^eFrom Table II-2.

Table 21
Water Discharge Records for Rivers in the
Saginaw Bay Drainage Basin

Drainage Unit and Location	Drainage Area (km ²)	Period of Record	Average/Maximum/ Minimum Discharge (cms)			USGS Gauging Station #
-Pigeon R. near Owendale	137	1952-82	0.9	72.2	0.0	1585
-State Dr. near Sebewaing	161	1940-54	1.0	N.A.	0.0	1575
-Columbia Dr. near Sebewaing	98	1940-54	0.6	N.A.	0.0	1580
-N. Br. Kawkawlin R. near Kawkawlin	262	1951-82	1.6	45.6	0.0	1435
-Rifle R. at Selkirk	303	1950-81	4.0	78.2	1.5	1405
-Rifle R. near Sterling	829	1936-86	8.8	151.2	2.1	1420
-AuGres R. near National City	438	1950-81	2.7	77.0	0.2	1385
-E. Br. AuGres R. at McIvor	218	1950-73	1.8	37.1	0.3	1380
-Saginaw R. at Saginaw	15,695	1942-86	114.5 ⁺	1,925.6	NA	1570
-S. Br. Cass R. at Cass City	616	1948-80	3.5	181.2	0.0	1500
-Cass R. at Cass City	930	1947-86	6.1	354.0*	0.0	1505
-Cass R. at Wahjamega	1,671	1968-86	12.6	583.3*	0.6	1508
-Cass R. at Frankenmuth	2,178	1939-86	14.2	640.0*	NA	1515
-S. Br. Flint R. at Columbiaville	572	1980-86	5.4	87.5	0.4	1460
-Flint R. near Otisville	1,373	1952-86	8.9	174.1	0.1	1475
-Kearsley Cr. near Davison	256	1965-86	2.0	42.5	0.1	1481
-Swartz Cr. at Flint	298	1970-83	2.2	89.5	0.0	1483
-Flint R. near Flint	2,476	1932-86	17.0	421.9	0.3	1485
-Flint R. near Fosters	3,077	1939-84	21.0	538.0	0.8	1490
-Shiawassee R. at Linden	210	1967-86	1.7	13.5	0.0	1439
-Shiawassee R. at Byron	953	1947-83	7.1	109.9	0.5	1440

(Continued)

Table 21. (Concluded)

Drainage Unit and Location	Drainage Area (km ²)	Period of Record	Average/Maximum/ Minimum Discharge (cms)			USGS Gauging Station #
-Shiawassee R. at Owosso	1,393	1931-86	9.5	176.7	0.0	1445
-Shiawassee R. near Fergus	1,650	1939-74	11.9	212.4	0.8	1450
-Salt R. near North Bradley	357	1934-67	2.2	232.2	0.0	1535
-Chippewa R. near Mt. Pleasant	1,077	1932-86	8.8	186.9*	0.3	1540
-Chippewa R. near Midland	1,546	1947-72	12.0	241.0*	0.0	1545
-Pine R. at Alma	746	1930-86	6.1	147.8*	0.0	1550
-Pine R. near Midland	1,010	1948-86	8.5	265.0*	N.A.	1555
-Tittabawassee R. at Midland	6,216	1936-86	48.2	1,189.3*	1.1	1560

Source: Miller, et al. Water Resources Data - Michigan, Water Year 1985 (and others). U.S.G.S., June, 1986.

⁺ Average Saginaw River discharge based on the correlation:

$$QS = 1.82 QSh + 1.17 QF + 1.05 QC + 1.09 QT$$

where: QS = Saginaw River upstream flow
 QSh = Shiawassee River flow at gauge #1450
 QF = Flint River flow at gauge #1490
 QC = Cass River flow at gauge #1515
 QT = Tittabawassee River flow at gauge #1560

(Limno-Tech. Inc., July, 1977)

* Preliminary September 1986 Flood Data courtesy of John Miller, USGS, Lansing.

Table 22
Average Total Flow of Treated Wastewater, Phosphorus
and Suspended Solids Loads to the Saginaw River
and Its Tributaries from Major Municipal
Dischargers, 1986

Facility	Total Phosphorus (mt/yr)	Total Suspended Solids (mt/yr)	Average Daily Flow (MGD)
Alma	2.1	27	2.4
Bay City	6.6	266	8.7
Bridgeport	2.7	34	1.7
Buena Vista	1.8	50	1.7
Flint	45.0	430	42.5
Flushing	1.0	29	1.7
Frankenmuth	1.2	48	1.5
Genesee Co. Ragnone	20.4	884	25.2
Genesee Co. No. 3	1.9	105	9.41 ^a
Howell	1.0	18	1.3
Lapeer	2.1	11	1.8
Midland	2.5	72	7.3
Mount Pleasant	3.4	36	3.7
Owosso	1.7	73	4.4
Saginaw	22.7	261	30.2
Saginaw Twp.	48.6	410	4.5
West Bay Co. Reg.	2.6	67	4.0
Zilwaukee-Carrollton- Saginaw Twp.	1.9	87	3.5
TOTAL	169.2	2.908	155.5

Table 23

Phosphorus Loads from Municipal Wastewater Treatment Plants
to Surface Waters in the Saginaw Bay Watershed, 1974,
1979-1981 (IJC 1983), and 1983-1986

Year	Load (metric tons/yr)
1974	800
1979	211
1980	220
1981	232
1983	141 ^a
1984	125 ^a
1985	114 ^b
1986	169 ^c

^aData not available for Saginaw Twp. WWTP or Mt. Pleasant WWTP.

^bIncludes phosphorus load from Mt. Pleasant WWTP (3 mt); data not available for Saginaw Twp. WWTP.

^cIncludes phosphorus loads from Mt. Pleasant WWTP (3 mt) and Saginaw Twp. WWTP (49 mt).

Table 24
Estimated Total 1987 Loads (kg) of Phosphorus and Total
Suspended Solids (TSS) to the Saginaw River from
Selected Point Source Dischargers

NPDES #	Facility	Parameter	
		Phosphorus	TSS (mt/yr)
INDUSTRIAL			
1121	General Motors C-P-C Group	-	56
1139	General Motors Central Foundry	-	144
2224	Michigan Sugar- Carrollton Plant	647 ^a	64
1091	Monitor Sugar- Bay City Plant	334 ^b	25 ^b
MUNICIPAL			
22284	Bay City WWTP	10141	268
22918	Essexville WWTP	304	22
22497	Buena Vista WWTP	1392	32
25577	City of Saginaw WWTP	20184	178
42439	West Bay County Regional WWTP	2750	49
23981	Zilwaukee-Carrollton- Saginaw Twp. WWTP	1762	79

^a Average for eight months discharge.

^b Total for five months discharge.

Table 25
Estimated Total 1987 Loads (kg) of Selected Organics to
Surface Waters in the Saginaw Bay Watershed from
Major Point Source Dischargers with NPDES
Permit Requirements for Those Parameters

NPDES Number	Facility	CN*	Total Phenolics	PCBs
INDUSTRIAL				
1121	General Motors C-P-C Group			2.4
1139	General Motors Central Foundry	842	13693	2.0
27812	Hitachi Magnetics Corp.	**		
1066	Total Petroleum Inc.			
MUNICIPAL				
20265	City of Alma WWTP	**		
22926	City of Flint WWTP	934		***
25577	City of Saginaw WWTP	600	955	

* Amenable

** Monitoring data consistently less than detection.

*** Too few data points to estimate loading.

Table 26

Estimated 1987 Loads (kg) of Selected Metals to Surface Waters
in the Saginaw Bay Watershed from Major Point Source
Dischargers with NPDES Permit Requirements for Those
Parameters (Data from MDNR DMR Summaries)^a

NPDES Permit Number	Facility	Metal							
		Ag	Cd	Cr	Cu	Hg	Ni	Pb	Zn
INDUSTRIAL									
868	General Motors Central Foundry				5200 ^b			7300 ^b	203000 ^b
25194	General Motors Fisher Guide				1.7 ^e		9.9 ^e		1.2 ^e
27812	Hitachi Magnetics Corp.				6.6	0.3	5.3		14.2
3484	Johnson Controls Inc.							0.4	
MUNICIPAL									
20265	City of Alma WWTP	19.8	22.5						
22284	Bay City WWTP				932			287	
22926	City of Flint WWTP	383	141		4584	27.1			
23655	Mt. Pleasant WWTP	7.4 ^c							
25577	City of Saginaw WWTP			1273	724		1810		2633
23981	Zilwaukee- Carrollton- Saginaw Twp WWTP	d			d				d
22918	Essexville WWTP					0.7 ^c			

^aWhen loads were estimated, a data point of less than a level of detection was factored into the loading equation as one-half the level of detection.

^bThese loadings are based on only two data points. GM-Central Foundry began sampling for these parameters in November, 1987. These estimates may not be representative of actual annual loadings.

^cThese loadings are based on only six data points.

^dMonitoring had not begun until 1988.

^eThese loadings represent discharge from January through June, 1987. Subsequent discharges were routed to the municipal WWTP.

Table 27
Summary of Municipalities Suspected of Generating
Intermittent Point Sources (The Chester
Engineers 1976)

MDNR Facility Number	Municipality	Reason for suspecting the existence of intermittent point sources (I/I: infiltration and inflow)
290014	Alma	Storm sewer and I/I problems
090028	Auburn	Suspected I/I problems
060022	Au Gres	Suspected I/I problems
320048	Bad Axe	Suspected I/I problems
090029	Bay City	Predominantly combined sewers
290046	Breckenridge	Storm sewers
730032	Bridgeport Twp.	Suspected I/I problems; storm sewers
760028	Brown City	Possible I/I problems
730029	Buena Vista Twp.	Suspected I/I problems; storm sewers
790006	Caro	Suspected I/I problems; storm sewers
730030	Carrollton Twp.	Combined sewer overflow
790007	Cass City	Suspected I/I problems; storm sewers
730019	Chesaning	Possible I/I problems; storm sewers
180009	Clare	Possible I/I problems; storm sewers
760029	Croswell	Combined system
760074	Deckerville	Storm sewers
350026	East Tawas	Suspected I/I problems; combined system
320069	Elkton	Possible I/I problems; storm sewers
090030	Essexville	Suspected I/I problems; combined system
730020	Frankenmuth	Storm sewers
260007	Gladwin	Possible I/I problems; partially combined
290017	Fulton Twp.	Storm sewers
320049	Harbor Beach	Possible I/I problems
290015	Ithaca	Suspected I/I problems; combined system
790066	Kingston	Storm sewer
760030	Lexington	Possible I/I problems; storm sewers
760031	Marlette	Suspected I/I problems; combined system
790023	Mayville	Combined system
730159	Merrill	Storm sewers
560009	Midland	Possible I/I problems; combined sewers
790022	Millington	Suspected I/I problems; cross connections
370011	Mount Pleasant	Suspected I/I problems; storm sewers
320087	Port Austin	Combined system
720088	Roscommon	Possible I/I problems; combined sewers
370052	Rose City	Possible I/I problems
730026	Saginaw	Combined system
730028	Saginaw Twp.	Partially combined sewers
730043	St. Charles	Suspected I/I problems; storm sewers
290019	St. Louis	Possible I/I problems; partially combined
760033	Sandusky	Possible I/I problems; partially combined
370010	Shepherd	Combined system
060018	Standish	Possible I/I problems; storm sewers
350028	Tawas City	Suspected I/I problems

(Continued)

Table 27. (Continued)

MDNR Facility Number	Municipality	Reason for suspecting the existence of intermittent point sources (I/I: infiltration and inflow)
320134	Uby	Combined system
790010	Vassar	Possible I/I problems; storm sewers
650003	West Branch	Possible I/I problems; partially combined
730031	Zilwaukee	Possible I/I problems; combined system

Table 28

Average Erosion Rates (metric tons/acre) and Estimated Annual Sheet,
Rill and Wind Erosion (metric tons/year) on Cropland for Selected
Counties in the Saginaw Bay Drainage Basin in 1982
(USDA-SCS et al. 1987)

County	Average Rate of Erosion	Wind Erosion	Sheet & Rill Erosion	Total Erosion
Arenac	4.3	230,900	68,700	299,600
Bay	3.6	437,300	208,700	646,000
Clare	3.7	46,700	88,800	135,500
Genesee	2.0	108,800	229,500	338,300
Gladwin	3.4	69,300	56,100	125,400
Gratiot	3.1	573,500	236,400	809,900
Huron	3.0	944,900	312,600	1,257,500
Isabella	4.6	537,300	194,200	731,500
Lapeer	3.1	194,600	316,900	511,500
Livingston	2.6	51,600	251,100	302,700
Midland	2.9	179,000	62,400	241,400
Saginaw	4.5	1,003,900	437,100	1,441,000
Sanilac	1.6	415,700	237,300	653,000
Shiawassee	1.8	177,800	291,800	369,600
Tuscola	4.6	522,300	333,900	856,200
Total for Saginaw Bay Drainage Basin		5,493,600	3,325,500	8,719,100

Table 29
Median Phosphorus Soil Test Levels (pounds per acre) for
Counties in the Saginaw Bay Drainage Basin, 1972-1986
(MDNR 1985; Warncke 1987)

County	Year								
	1962	1967	1972	1976- 1977	1979- 1980	1982- 1983	1984	1985	1986
Arenac	19	21	46	88	130	102	119	108	90
Bay	27	51	74	88	130	147	194	182	222
Clare	--	--	--	41	66	76	66	61	60
Genesee	17	27	33	54	107	98	98	80	62
Gladwin	17	18	17	41	45	61	40	67	67
Gratiot	19	31	52	66	98	107	124	131	100
Huron	28	25	23	17	68	104	95	109	90
Iosco	--	31	27	38	77	67	85	57	78
Isabella	18	32	48	62	126	106	109	94	92
Lapeer	22	19	35	38	60	62	80	68	72
Livingston	44	32	36	62	98	96	98	114	80
Midland	26	30	45	51	111	128	165	130	99
Ogemaw	--	83	27	45	66	74	56	49	60
Shiawassee	16	25	36	41	82	97	90	100	63
Tuscola	18	29	38	56	82	93	112	97	117
Average	23	32	38	53	90	95	102	96	90

Table 30
Amount of Animal Waste Predicted to be Delivered to the
Saginaw Bay Watershed (MDNR 1985)

Source	Amount of Waste (metric tons)	Delivery Percent to Water Course	Animal Waste Delivered to Water Course (metric tons)
Feeding/Loafing	33,315	40%	13,326
Spreading			
Winter	359,780	35%	125,924
Summer	239,855	10%	23,985
Manure Storage	33,325	35%	11,630
TOTAL	666,275	26%	174,865

Table 31a
Preliminary List of NPS and Integrated Watershed Models
Selected for Review (Report to the Great Lakes Water
Quality Board, 1987)

MODELS REFERENCE	NAME	SOURCE	
<u>Loading/Screening Procedure</u>			
Hydrosience	Hydrosience Simplified Model	Hydroqual/EPA	EPA 1976
EPA Screening Procedures	EPA Water Quality Screening Procedures	EPA	McElroy <u>et al.</u> 1976; Mills <u>et al.</u> 1982
WLFNPS	Watershed Loading Functions for Non-Point Sources	Cornell University	Haith and Tubbs 1981
WREMS	Water Resources Evaluation of Non-Point Silvicultural Sources	U. S. Forest Service 1980	U.S. Forest Service
SWMM - Level I	SWMM - Level I	EPA	Heaney <u>et al.</u> 1976
<u>NPS Runoff Models</u>			
HSPF/PERLND & IMPLND	Hydrological Simulation Program - FORTRAN (land simulation modules)	EPA	Johanson <u>et al.</u> 1984
ARM	Agricultural Runoff Management Model	EPA	Donigian <u>et al.</u> 1977
NPS	Nonpoint Source Model	EPA	Donigian and Crawford 1977
CREAMS/CREAMS 2	Chemicals, Runoff, and Erosion From Agricultural Management Systems	USDA	USDA 1980
ANSWERS	Areal, Nonpoint Source Watershed Environment Response, Simulation Model	Purdue University	Beasley <u>et al.</u> 1980 Beasley and Huggins 1981
ACTMO	An Agricultural Chemical Transport Model	USDA/ARS	Frere <u>et al.</u> 1975
SWMM	Stormwater Management Model (land simulation modules)	EPA	Huber <u>et al.</u> 1975
STORM	Storage, Treatment, Overflow Runoff Model	COE	HEC 1977
MUNP	Management of Urban Nonpoint Pollution Model	Univ. of Maryland	Sutherland and McCuen 1978
ILLUDAS/DRAINQUAL	Illinois Urban Drainage Area Simulator	Illinois State Water Survey	Teratriep and Stall 1974
DRJM	Distributed Routing Rainfall-Runoff Model	USGS	Alley and Smith 1982a, 1982b
PRMS	Precipitation-Runoff Modeling System	USGS	Leavesley <u>et al.</u> 1983
Simplified SWMM	Simplified SWMM	EPA/MBE	Lager <u>et al.</u> 1976
<u>Integrated Watershed Models</u>			
HSPF	Hydrological Simulation Program - FORTRAN	EPA	Johanson <u>et al.</u> 1984
SWMM	Stormwater Management Model	EPA	Huber <u>et al.</u> 1975
PRS	Pesticide Runoff Simulator	EPA/CSC	CSC 1980
UTM-TOX	Unified Transport Model for Toxics	Oak Ridge/EPA	Patterson <u>et al.</u> 1983
SWAM	Small Watershed Model	USDA/ARS	DeCoursey 1982

Table 31b

Characteristics and Capabilities of Selected NPS Runoff Procedures and Models
(Report to the Great Lakes Water Quality Board, 1987)

	LAND USE/LOAD SOURCES					HYDROLOGY					WATER QUALITY					TIME SCALE					DATA NEEDS					SPACE SCALE		
	Urban	Agriculture	Forest/Natural	Mining	Precipitation	Chemical Application	Surface Runoff	Subsurface Flow	Snowmelt	Sediments	Nutrients	Pesticides/Toxics	Annual Loads	Event Loads	Continuous Simulation	Detailed	Moderate	Minimal	Segmented/Multiple Catchments	Lumped Catchments	Single Catchment	Use Documentation/Support						
LOADING/SCREENING PROCEDURES																												
Hydrosolence	●																											
EPA Screening Procedures	●	●			●		●			●	●	●	●	●														
WGENS		●								●	●	●	●	●														
WLFNPS		●								●	●	●	●	●														
SWMM - Level I	●																											
RUNOFF MODELS																												
Simplified SWMM	●																											
ARM		●					●		●	●	●	●	●	●														
HPS	●	●																										
IISSP/PERLND & IIAPLID	●	●					●																					
CREAMS/CREAMS 2	●	●																										
AIISWERS	●	●																										
ACTMO	●	●																										
SWMM	●																											
STORM	●																											
MUNI	●																											
ILLUC AS/DRAINHOVAL	●																											
DR3M	●																											
PRMS	●	●																										

Notes: ● - Capability Included in model

○ - Capability not explicitly included but can be user-defined

Use/Documentation/Support

E - Extensive

A - Adequate

M - Minimal

Table 31c

Characteristics and Capabilities of Integrated Watershed Models
 (Report to the Great Lakes Water Quality Board, 1987)

	WATERBODY & FLOW CONDITIONS					WATER QUALITY										TIME SCALE		DATA NEEDS		SPACE SCALE			Use/Documentation/Support		
	Rivers/Streams	Lakes/Impoundments	Estuaries	Confined Flow	Dr. Lago/Control Structures	Point Source Discharges	Temperature	D.O./BOD/NBOD	Suspended Sediment Transport	Sediment Deposition	Sediment Scour	Contaminant Interaction	Nutrient Kinetics	Pesticides/Toxics	Biologic Simulation	Dynamic	Steady-State	Detailed	Moderate	Multi Land Use Calculations	Single Land Use Calculations	Delta/Management			
INTEGRATED WATERSHED MODELS																									
IIISPF	●	●		○	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	E	E
SWMM (RECEIV)	●	●	●	●	●	○	●	●				●	●	○	●	●	●	●	●	●	●			E	A
PR3	●	●		●	●	●								●	●	●	●	●	●	●	●			M	M/A
UTM-TOX	●	●	●		●	●	○	●	●	●				●	●	●	●	●	●	●	●				
SWAM	●	●																							

Notes: ● - Capability Included in Model

○ - Capability not explicitly included but can be user defined

Use/Documentation/Support

E - Extensive

A - Adequate

M - Minimal

Table 32

Total Deposition of Airborne Trace Organics to Lake Huron
in Metric Tons per Year (Eisenreich et al. 1981)

Compound	Mass
Total PCB	7.2
Total DDT	0.43
alpha-BHC	2.4
gamma-BHC	11.6
Dieldrin	0.55
HCB	1.2
p,p'-Methoxychlor	6.1
alpha-Endosulfan	5.8
beta-Endosulfan	5.8
Total PAH	118.0
Anthracene	3.5
Phenanthrene	3.5
Pyrene	6.1
Benz (a) anthracene	3.0
Perylene	3.4
Benzo (a) pyrene	5.8
DBP	12.0
DEHP	12.0
Total organic carbon	1.5×10^5

Table 33a

Wet Precipitation, Dry Deposition and Bulk Atmospheric Loading of PCBs
(gm/km²/yr), Measured at Selected Sample Sites Along the Saginaw Bay
Shoreline (Murphy et al. 1981; Murphy et al. 1982)

Year/ Station	Wet Precipitation _b		Dry Depo- sition	Bulk Loading
	Avg ^a	Range ^b		
1977-1978				
Whitestone Pt.	11.5	0-24		
Pinconning	39.0 ^b	26-68	27.0 ^b 6.6 ^a	21
Tawas Point	14.5	6-24	16.0 ^b 6.6 ^a	9
Sebewaing			24.0 ^b 6.2 ^a	11
Saginaw Bay				18
1977 ^b				
Whitestone Pt.			3.24	
Pinconning				29.64
1978 ^b				
Pinconning			8.16	19.92
Tawas Point			10.2	3.6
Sebewaing			5.76	8.4
1979 ^b				
Pinconning			16.2	30.24
Tawas Point	16.8			10.20
Sebewaing			6.0	12.00
1980 ^b				
Tawas Point	8.4			3.60

^aMurphy et al., 1981

^bMurphy et al., 1982

Table 33b
Atmospheric Deposition Rates (kg/km²/yr) of Nutrients and Chlorides at
Bay City, Port Austin and Tawas Point Sample Stations, 1982-1984
(Data from GLAD Sampling Network Database)

Year/ Station	Parameter			
	Nitrate	TKN	Total Phosphorus	Chloride
1982				
Bay City	322	302	4.9	327
Port Austin	341	599	13.0	289
Tawas Point	275	454	19.9	262
Saginaw Bay Total (metric tons/yr)*	925	1336	37.0	866
1983				
Bay City	289	260	2.8	215
Port Austin	331	335	7.6	188
Tawas Point	351	406	20.6	160
Saginaw Bay Total (metric tons/yr)*	958	987	31.0	555
1984				
Bay City	358	356	3.5	284
Port Austin	488	577	13.0	177
Tawas Point	340	473	7.8	169
Saginaw Bay Total (metric tons/yr)*	1170	1387	24.0	621

* Station values summed, averaged, and multiplied by bay surface area

Table 34

Atmospheric Deposition Rates ($\text{gm}/\text{km}^2/\text{yr}$) of Heavy Metals at Bay City, Port Austin and Tawas
Point Sample Stations, 1982-1984 (Data from GLAD Sampling Network Database)

Year/ Station	Metal							
	Hg	Cd	Cu	Pb	Ni	As	Cr	Zn
1982								
Bay City	69		2982	31204	6241	172	5923	13279
Port Austin			4262	34290		191	5158	10634
Tawas Point		1422		1280	6096	251	9809	11199
Saginaw Bay Total (metric tons/year)*	0.2	4.2	10.7	65.9	18.3	0.6	20.6	34.63
1983								
Bay City	146	104		2822	347	248		5932
Port Austin	242	185	1273	3361	4046	224	6096	6926
Tawas Point	119	142	2987	3413	841	307	711	4991
Saginaw Bay Total (metric tons/year)*	0.4	0.42	6.3	9.5	5.2	0.8	10.1	17.6
1984								
Bay City	139	122	2420	2859	831	168	643	12792
Port Austin	8	150	3642	3286	609	219		20351
Tawas Point	71	112	3430	2339	498	316	711	18150
Saginaw Bay Total (metric tons/year)*	0.2	0.4	9.4	8.4	1.9	0.7	2.0	50.6

* Station values summed, averaged and multiplied by bay surface area.

Table 35

Mean and Range of pH Values in Precipitation Samples at Bay City, Port Austin
and Tawas Point, 1981-1985 (Deguire 1986a)

Year	Bay City			Port Austin			Tawas Point			Summary		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
1981	4.4	4.0	5.4	4.4	3.9	6.7	4.1	3.7	4.7	4.3	3.7	6.7
1982	4.4	4.0	5.1	4.5	4.0	5.5	4.2	3.7	6.4	4.4	3.7	6.4
1983	4.3	4.0	5.1	4.2	3.7	5.7	4.1	3.7	4.5	4.2	3.7	5.7
1984	4.3	4.0	4.8	4.1	3.1	6.8	4.0	3.5	6.9	4.1	3.1	6.9
1985	4.5	4.1	7.0	4.2	3.8	7.6	3.9	3.5	4.6	4.1	3.5	7.6
Avg	4.4			4.3			4.1			4.2		

Table 36

Average Monthly and Annual Precipitation Amounts (Inches) at Reporting Stations

Within the Saginaw Bay Drainage Basin

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Alma ¹	1.47	1.20	2.06	2.98	2.79	2.98	2.62	3.66	3.04	2.47	2.31	1.99	29.56
Bad Axe ¹	1.79	1.56	2.20	2.66	2.58	2.88	2.93	3.01	2.67	2.49	2.38	2.18	29.35
Bay City ¹	1.48	1.22	2.16	2.59	2.66	2.88	2.53	3.00	2.78	2.52	2.28	1.78	27.97
Caro ¹	1.48	1.18	2.10	2.51	2.55	3.09	2.92	2.96	2.98	2.30	2.27	1.88	28.21
East Tawas ²	1.61	1.28	2.06	2.61	2.85	3.21	2.94	3.05	2.98	2.30	2.41	2.22	29.52
Flint ¹	1.59	1.46	2.13	3.05	2.78	3.23	2.81	3.38	2.35	2.13	2.29	2.00	29.20
Gladwin ²	1.79	1.48	2.10	2.93	3.04	3.55	3.39	3.30	3.14	2.61	2.56	2.41	32.30
Harrison ²	1.64	1.37	1.91	2.84	2.82	3.17	3.47	3.24	2.99	2.63	2.41	1.95	30.44
Lapeer ¹	1.44	1.24	1.84	2.92	2.75	3.34	2.46	3.34	2.34	2.25	2.15	1.83	27.90
Midland ²	1.64	1.51	2.14	2.83	2.64	3.00	2.67	3.07	2.82	2.47	2.27	2.21	29.28
Millington ¹	1.40	1.26	2.05	2.52	2.89	3.11	2.70	3.07	2.85	2.25	2.22	1.84	28.16
Mt. Pleasant ¹	1.37	1.12	1.99	3.19	2.84	3.20	3.22	3.57	2.95	2.60	2.33	1.86	30.24
Owosso ¹	1.68	1.40	2.04	2.83	2.58	3.32	2.70	3.21	2.68	2.02	2.27	2.06	28.78
Saginaw ¹	1.47	1.22	1.95	2.76	2.70	3.32	2.72	3.13	2.82	2.39	2.38	1.98	28.95
St. Charles ²	1.62	1.34	2.13	2.43	2.49	3.09	2.83	3.29	2.76	2.24	2.17	1.91	28.30
Sebewaing ²	1.27	1.10	1.72	2.22	2.47	2.71	2.94	2.76	2.81	2.31	2.07	1.64	26.02
Standish ²	1.30	1.15	1.85	2.50	2.69	3.15	2.92	2.89	2.99	2.53	2.11	1.73	27.81
West Branch ¹	1.43	1.32	1.88	2.44	2.78	2.80	3.25	3.10	3.15	2.48	2.45	1.90	28.84
Basin Averages	1.53	1.30	2.02	2.71	2.72	3.11	2.89	3.17	2.84	2.39	2.30	1.96	28.93

Sources: ¹Fred Nurnberger, Climatology Division, Michigan Dept. of Agriculture. Averages compiled from data collected over 25-30 year period representing mid 1940's or early 1950's to mid 1970's or early 1980's.

²National Climatic Center, NOAA, Climate Normals for the U.S., 1951-80. Gale Research, Detroit, 1983.

Table 37

Act 307 Sites Affecting Surface Water in the Saginaw Bay Watershed (MDNR 1988)

SAS Score	County Date Scored	Common Site Name Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
GROUP 1							
885	Saginaw 02/06/87	Saginaw River/Bay Saginaw to East Tawas Saginaw	Multiple Sources	Unknown	PCB, TCDD, TCDF	Surface Water, Sediment, Fauna	IR (F), EP
823	Grafton 07/14/87	Alma Iron Metal Smith Prop 29-12N-02W-30CB Bethany	Scrap Metal Yard	Aboveground Tank Barrel, Surface Discharge	Chromium, Nickel, Lead, PCB, PBB	Surface Water Sediment, Soil, Wetland	RA
770	Livingston 02/01/84	Shiawassee River 47-03N-04E-22 Howell	Forging Stamping	Surface Discharge	PCB	Surface Water, Sediment	E (S.F)
723	Bay 09/23/87	GM CPC Plant 09-14N-05E-16DC Bay City, City of	Auto Mfg	Pile Lagoon	PCB	Soil Groundwater Surface Water	IR (P) E (P)
718	Midland 10/04/84	Tittabawassee River 56-14N-02E Midland	Chem Product Mfg	Unknown	Dichlorobenzene, PCBs, DDT, Chlordane, Halogenated Biphen	Surface Water, Sediment, Fauna	EP
661	Midland 01/22/87	Porter Field 56-13N-01W-7-23 Porter	Oil Drilling	Geologic Form	Brine, Crude	Surface Water, Groundwater, Wetland, Flora	EP
600	Genesee 09/26/86	Buckeye Pipeline Co. 25-09N-06E-23NC Vienna	Pipeline	Pipeline	Naphthalene, Xylene, Toluene, Benzene, Trimethylbenzene	Surface Water Groundwater	EP

(Continued)

(Sheet 1 of 7)

Table 37. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
466	Montcalm 01/16/87	Hitachi Magnetics Corp 59-12N-06W-27NB Ilione	Metal Processing	Lagoon	Mercury	Sediment, Ground- water, Surface Water, Residential Well	IR (P) RA
417	Saginaw 09/26/86	Hall Barrel Co 73-12N-04E-27AA Kochville	Barrel Reclaiming	Lagoon	Light Industrial, Heavy Mfg. Chem Prod Mfg	Surface Water, Soil	E (P) FR (P)
289	Tuscola 11/05/84	Olivera LF 79-10N-07E-031DA	Landfill	Landfill	Ammonia, Organics, Zinc	Surface Water, Groundwater	RA
211	Arenac 09/27/84	Shidony Disposal 06-20N-04E-26DB Clayton	Landfill	Landfill	Domestic Comm, Light Industrial	Surface Water, Soil	RA
GROUP 2							
9	Bay 08/11/87	Union Oil Bay City 09-14N-05E-11C Bangor	Oil Storage	Pipeline	Benzene, Toluene, Xylene, Acetone Ethylbenzene	Surface Water, Groundwater, Soil	EP
8	Bay 09/24/86	C & O Railroad Bay City 09-14N-05E-16DC Bangor	Railroad	Barrel	Light Industrial	Surface Water	IR (P) EP
8	Bay 08/11/87	Prestolite 09-14N-05E-22CB Bay City, City of	Motor Vehicle Part Mfg.	Surface Discharge	Organics, Heavy Metals	Surface Water Groundwater, Soil	IR (P) E (P)

(Continued)

(Sheet 2 of 7)

Table 37. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
8	Lapeer 09/26/86	Thumb Radiator Service 44-07N-20E-04 Lapeer	Auto Repair	Surface	Lead, Ethylene Glycol	Surface Water, Soil, Wetland, Fauna	IR (P) E (P)
8	Lapeer 09/29/87	CMS Motor Lapeer 44-07N-10E-08W Lapeer, City of	Gas Station	Underground Tank	Gasoline	Surface Water Soil	E (P) FR (P)
8	Livingston 11/01/84	Brighton Cameron 47-02N-06E-30W Brighton	Metal Conting	Surface Discharge	Zinc, Lead, Chromium	Surface Water, Soil	RA
8	Livingston 08/14/87	Thompson Lake Sediments 47-03N-04E-25D/36A Howell, Oceola	Unknown	Unknown	PCB	Sediment, Surface Water, Fauna	RA
8	Oakland 08/19/85	Oakland Co Rd Comm Dixie 63-04N-08E-03W Springfield	Salt Storage	Pile	Sodium, Chloride	Surface Water, Groundwater, Residential Well	IR (P) EP
8	Sanilac 08/06/87	Mid Thumb Sanitary LF 76-13N-13E-21D Argyle	Landfill	Landfill	Ammonia, Phenol, Cadmium	Surface Water, Groundwater	E (P) FR (P)
8	Shiawassee 01/20/85	Gd Trunk Western Railroad 78-06N-04E-16W Vernon	Railroad	Surface Discharge	Benzene, Xylene	Surface Water, Sediment, Soil	EP
8	Shiawassee 10/01/84	RJ Marshall 78-06N-04E-15DC Vernon	Chem Prod Mfg	Waste Pile	Boric Acid, Sulfuric Acid	Surface Water, Air, Soil	IR (P) EP

(Continued)

(Sheet 3 of 7)

Table 37. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
7	Arenac 10/10/84	Amoco Oil Co 06-18N-04E-05CD Lincoln	Oil Storage	Pipeline	Benzene, Xylene Toluene	Surface Water, Groundwater	EP
7	Bay 08/13/85	Bangor Twp Dump 09-15N-05E-30CH Bangor	Landfill	Landfill	Domestic Comm, Light Industrial, Phenol	Surface Water, Wetland	EP
7	Bay 08/11/87	Monitor Sugar 09-14N-05E-31AD Monitor	Food Processing	Lagoon Pile	Light Industrial Lime, HCl	Air, Surface Water, Ground- water	IR (P) E (P)
7	Genesee 10/15/85	McKinley & M57 Dump Site NE 25-09N-05E-27BH Montrouee	Dump	Dump	Chromium, Lead, Phenol	Surface Water	RA
7	Gladwin 10/07/85	Gladwin City of LF Closed 26-18N-02W-12AA Groul	Landfill	Landfill	Domestic Comm, Light Industrial, Arsenic	Surface Water, Groundwater, Soil	IR (P) EP RA
7	Huron 09/18/87	Englehart Oil Seepage 32-15N-09E-08DB Sebewaing, City of	Gas Station	Underground Tank	Gasoline	Surface Water, Groundwater, Soil	E (P)
7	Isabella 10/12/84	Total Petroleum Inc Roosevelt 37-14N-04W-10AD Union	Petro Refining	Lagoon	Chem Prod Hfg	Surface Water, Groundwater	IR (P) RA
7	Lapeer 09/29/87	Star Oil Co. Lapeer 44-07N-10E-05DB Lapeer, City of	Gas Station	Underground Tank	Gasoline	Surface Water	EP

(Continued)

(Sheet 4 of 7)

Table 37. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
7	Midland 09/25/84	Tridge Area 56-14N-02E-20AA Midland	Landfill	Landfill	Domestic Comm	Surface Water, Soil	RA
7	Oakland 08/09/86	Holly Area School Bus Garage 63-05N-07E-34AB Holly	Municipal Facility	Underground Tank	Petroleum Product	Surface Water, Groundwater, Soil	IR (P) EP RA
7	Shiawassee 09/27/87	Johnson Control Globe Union 78-07N-03E-20CC Caledonia	Battery Mfg	Lagoon	Heavy Mfg.	Surface Water, Sediment	RA
7	Shiawassee 9/26/84	Ann Arbor Railroad Yard 78-07N-03E-19BC Caledonia	Railroad	Underground Tank	Benzene, Xylene, Other Constituents of Fuel Oil	Surface Water Soil	EP
6	Midland 08/22/86	D & C Laundromat 56-15N-01W-11AC Jerome	Laundry Dry Cleaner	Lagoon, Under- ground Tank	PCE, Dichloroethane Bromodichlorometha	Surface Water	E (P)
6	Midland 08/21/86	Warren Township Dump 56-16N-02W-22A Warren	Landfill	Landfill	Domestic Comm	Surface Water	FR (S)
6	Ogemaw 09/27/84	Oscoda Refining Co 65-22N-02E-32DC West Branch	Petro Refining	Lagoons	Phenols, Lead, PCB	Surface Water, Soil	IR (P) EP RA
5	Bay 08/23/85	Bay City Middlegrounds 09-14N-05E-32CA Bay City	Landfill	Landfill	Domestic Comm, Light Industrial	Surface Water, Groundwater	IR (P,S) E (S)

(Continued)

(Sheet 5 of 7)

Table 37. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
5	Bay 08/15/87	Coal Mine Disc. to Culver Cr. Coal Mining 09-14N-04E-16CD Monitor	Coal Mining	Geologic Form	Brine, Iron	Sediment, Sur- face Water, Fauna, Flora	EP
5	Saginaw 09/18/87	Dykhous Pickles 73-11N-06E-27 Frankenmuth, City of	Food Processing	Lagoon, Surface Discharge	Brine	Surface Water, Soil, Wetland	EP
4	Clare 10/02/84	Clare I.F. Closed City of 18-17N-07W-35CC Grant	Landfill	Landfill	Domestic Comm	Surface Water, Groundwater	RA
4	Huron 09/18/87	Carmet Manufacturers 32-16N-13E-19DC Bail Ave, City of	Motor Vehicle Parts	Surface Discharge	Phosphorus Softening Agent	Surface Water Wetland, Fauna Flora	EP
3	Bay 09/22/86	Bayview Food Products No 1 09-15N-04E-02DC Kaukawlin	Food Processing	Lagoon, Container	Brine, Raw Sewage, ROD	Groundwater, Surface Water, Sediment, Soil	E (P)
3	Iosco 09/22/86	Sherman Twp Dump 35-21N-06E-16CC Sherman	Landfill	Landfill	Domestic Comm	Groundwater, Surface Water	EP
3	Midland 08/31/83	Oil Field Area Anderson Res 56-14N-01W-18NC Lee	Oil Drilling	Lagoon	Chlorides	Surface Water, Groundwater	RA
2	Arenac 10/10/84	Au Grea Twp Dump Closed 06-19N-06E-15AA Au Grea	Landfill	Landfill	Domestic Comm	Surface Water, Soil	EP

(Continued)

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Table 37. (Concluded)

SAS Score	County Date Scored	Common Site Name ^a Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status ^{aa}
2	Bay 08/01/85	Rayview Food Products No 3 09-16N-14E-12CB Kawkawlin	Food Processing	Lagoon Container	Urine, Raw Sewage, BOD	Groundwater, Surface Water, Sediment, Soil	IR (P) EP
2	Cladwin 09/22/86	Tobacco Twp Refuse Closed 26-17N-01W-13BA Tobacco	Dump	Dump	Domestic Comms	Surface Water	IR (P) EP

^a The common site name is for identification only and is not necessarily a party responsible for contamination.

^{aa} IR-Interim Response; E-Evaluation; FR-Final Response; RA-Regulatory Action; EP-Evaluation Pending; P-Privately Funded Actions; F-Federally Funded Actions.

Table 38

Act 307 Sites Affecting Groundwater in the Saginaw Bay Watershed (MDNR 1988)

SAS Score	County Date Scored	Common Site Name ^a Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status ^a
GROUP 1							
933	Genesee 08/21/85	Forest Waste Products 25-09N-08E-08DB Furcut	Landfill	Lagoon, Landfill	Dieldrin, Lead, Cyanide, PCB, Oil	Groundwater	IR (S,F) E (S,F)
921	Lapeer 10/04/84	Metamora Sanitary LF 44-06N-10E-10DB Metamora	Landfill	Barrel, Landfill	Dichlorobenzene, Hexachlorobenzene, Methyl Chloroform	Groundwater	IR (S,F) E (S,F)
906	Saginaw 08/11/87	GM Saginaw Malleable Iron Plant 73-12N-04E-35 Saginaw	Iron, Steel Foundry	Barrel, Landfill	Nickel, Manganese, Soil Zinc, Chromium, PCB, Benzene, Toluene	Groundwater, Soil	IR (P) E (P)
812	Oakland 10/4/84	Hillford Rd Highland Areas 63-03N-07E-02DB Highland	Unknown	Unknown	Ethyl Benzene, Trichloroethane, Perchloroethylene	Groundwater, Soil	E (P)
797	Livingston 01/29/86	Reamassena Dump 47-01N-06E-30AA Green Oak	Landfill	Landfill, Barrel	Volatile Organics, Dioxins, PCB, Lead Arsenic, Copper	Groundwater, Soil	IR (S,F) E (S,F)
772	Oakland 08/19/85	Ray Frick Fuel Storage 63-05N-07E-34BC Holly	Oil Storage	Aboveground/ Underground Tanks	Benzene, Toluene, Xylene, Ethyl- benzene	Groundwater, Soil	E (P)
758	Ogemaw 10/05/87	Henderson Lk. Rd. Mills Twp. 65-21N-03E-25AD Mills	Unknown	Unknown	TCE, DCE, PCE, DCA, Groundwater Trichloroethane, Soil, Residential Chlorobenzene Wells	Groundwater	IR (S) E (P) RA

(Continued)

(Sheet 1 of 17)

Table 38. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
741	Genesee 08/26/86	Berlin and Farro 25-06N-05E-23DA Gaines	Haz Waste Facility	Lagoon Landfill	Toluene, Ethylbenzene, Bromoform	Groundwater, Soil	IR (P,S,F) E (P,S,F) FR (P,S,F)
731	Livingston 10/05/87	Spiegelburg LP 47-01N-06E-31AB Green Oak	Dump	Heap Barrels	Liquid Paints, Zinc, Arsenic Thallium	Groundwater, Soil	IR (S) E (S,F)
707	Clare 01/07/87	Clare Municipal Wells, City of 18-17N-04W-34B Grant	Auto Component Mfg	Lagoon, Surface Discharge	Dichloroethane, Trichloroethene	Groundwater, Municipal Well	E (F)
704	Genesee 09/29/87	Action Auto No 2 25-07N-07E-15BC Burton	Gas Station	Underground Tank	Xylene, Benzene, Naphthalene, Toluene, Hexane, Cyclohexane	Groundwater	RA
683	Midland 01/20/87	Poseyville LP 56-14N-02E-29AB Greendale	Landfill	Landfill	Pentachlorophenol, Dichlorophenol, Benzene, Toluene	Groundwater	IR (P) E (P) FR (P)
652	Livingston 08/13/87	Livingston Co. Rd. Comm. Howell Garage 47-03N-04E-36DA Howell	Road Commission	Underground Tank	Gasoline	Groundwater, Soil	E (P)
650	Livingston 08/25/86	Lucy Rd Gr Riv Contam Area 47-03N-04E-36DB Howell	Unknown	Unknown	Tetrahydrofuran	Groundwater, Residential Well	IR (S) EP

(Continued)

(Sheet 2 of 17)

Table 38. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
639	Bay 10/01/87	Amoco Oil Terminal-Bay City 09-14N-05E-148B Bay City, City of	Oil Storage	Pipeline	Oil, Jet Fuel	Groundwater, Soil	IR (P) E (P)
628	Bay 10/04/84	Dow Chem Benzene Pipeline 19-14N-03E-24 Auburn	Chem Product Mfg	Pipeline	Benzene	Groundwater, Soil	IR (P) E (P) FR (P)
590	Genesee 09/29/87	A.C. Spark Plug 25-07N-07E-09BA Burton	Engine Component Mfg	Underground Tank	Xylene, Benzene, Naphthalene, Toluene, Hexane, Cyclohexane	Groundwater	E (P) RA
585	Saginaw 09/18/87	GMC Modular Iron Foundry- Saginaw 23-12N-05E-08A Saginaw, City of	Iron, Steel Foundry	Landfill, Pile	Cyanide, Phenol	Groundwater, Air	EP
580	Midland 10/04/87	Res Contam W. Isabella Rd. 56-14N-01W-09CD Lee	Unknown	Unknown	Benzene, Toluene, Xylene, Ethyl- benzene	Groundwater, Soil Residential Well	EP
552	Iosco 08/20/85	Res Welle Becker 35-22N-04E-01NC Grant	Unknown	Unknown	Benzene, Ethyl- benzene, Dichloro- ethylbenzene, Dichloropropane	Groundwater	IR (S) RA
550	Livingston 07/23/87	Drake Gasoline 47-03N-04E-36BH Novell	Gas Station	Underground Tank	Fuel Oil	Groundwater, Soil	EP
547	Genesee 10/02/87	Linden Road I.F 25-07N-06E-17AD Flint	Auto Mfg	Landfill	Phenol, Sulfide, Oil, Iron, Zinc Dichloroethene	Groundwater	RA

(Continued)

(Sheet 3 of 17)

Table 38. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
540	Livingston 07/23/87	Total Gas Pinckney 47-01N-04E-220D Putnam	Gas Station	Underground Tank	Benzene, Toluene, Chlorobenzene Ethylbenzene	Groundwater, Residential Well	IR (P) RA
533	Livingston 07/23/87	Bergin Rd Old US 23 Area 47-13N-06E-28CD Hartland	Gas Station	Underground Tank	Gasoline	Groundwater, Soil, Residential Well	EP
522	Iosco 01/23/87	Oacode Top Municipal Well 35-23N-09E-04BD Oscoda	Unknown	Unknown	Perchloroethylene	Groundwater	IR (P) RA
511	Iosco 10/01/87	Helubum Industries 35-23N-09E-04DC Au Sable	Forging, Stamping	Surface Discharge	Trichloroethylene	Groundwater Residential Well	IR (P,S) E (F)
506	Genesee 10/11/84	Sunshine Food Store 25-08N-08E-32BB Richfield	Gas Station	Unknown	Benzene, Xylene, Toluene	Groundwater	RA
496	Midland 10/07/87	Mooney Oil Company 56-16N-02E-1900 Coleman, City of	Gas Station	Underground Tank	Gasoline	Groundwater, Soil	EP
430	Livingston 08/13/87	MSI Station Hartland 47-03N-06E-21CC Hartland	Gas Station	Underground Tank	Gasoline	Groundwater, Soil	RA
410	Isabella 07/23/86-	Blanchard Area CW Contam 37-13N-06W-33DA Rolland	Unknown	Unknown	Methylene Chloride, Ethylene Dibromide 1,2-Dichloroethane	Groundwater, Residential Wells	IR (S) RA

(Continued)

(Sheet 4 of 17)

Table 38. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
380	Midland 01/14/86	Res Well Nine Mile Rd 56-15N-01W-33DA Jerome	Unknown	Unknown	Toluene, Ethylbenzene Xylene	Groundwater	IR (S) EP
370	Tuscola 10/04/84	Walbro Corp 790-14N-11E-33AC Elkland	Engine Component Mfg	Lagoon	Toluene, Xylene, Mineral Spirits, Styrene, TCE	Groundwater, Soil	IR (P) E (P)
364	Livingston 07/23/87	Green Oak Fire Station 47-01N-06E-17DB Brighton	Gasoline Storage	Underground Tank	Xylene, Toluene, Benzene, Ethyl- benzene	Groundwater, Residential Well	EP
327	Bay 09/24/86	Magline Inc 09-17N-04E-27DD Pinconning	Forging, Stamping	Pile	Magnesium, Oxide, Phenol, Lead, Boron	Groundwater, Residential Well, Fauna, Flora	E (P)
324	Saginaw 08/15/87	Thomson Products 73-10N-03E-32CB Swan Creek	Forging, Stumping	Surface Discharge	Trichloroethylene, Zinc Chloroethane Hydraulic Oil	Groundwater, Soil, Flora	E (P)
308	Isabella 10/30/84	Res Well Schutt 37-14N-04W-02AD Union	Unknown	Unknown	Xylene, Toluene, Isopentane, Ethylbenzene	Groundwater, Residential Well	EP
306	Saginaw 09/24/86	Thomas Twp LF 73-12N-03E-07DD Thomas	Landfill	Landfill	Domestic Comm, Ammonia, Lead, Total Organic Carbon	Groundwater	IR (P)
252	Livingston 10/01/87	G and C Paint Developers 47-02N-05E-04CC Genoa	Paint Products	Pile, Surface Discharge, Container	Benzene, Toluene Xylene, Ethyl- benzene	Groundwater, Soil, Residential Well	IR (P)

(Continued)

(Sheet 5 of 17)

Table 38. (Continued)

SAS Score	County Date Scored	Common Site Name Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
185	Midland 09/20/86	Shepard Rd 56-13N-02W-100C Jasper	Landfill	Unknown	Ethylbenzene, Xylene	Groundwater, Residential Well	EP RA
178	Oakland 10/11/84	III Mill Manufacturing 63-03N-07E-23AB Highland	Valves Pipe Hfg	Lagoon	Heavy Hfg	Groundwater, Soil	IR (P)
GROUP 2							
11	Ogemaw 08/10/87	Horseshoe Lk Rd W. Branch 62-23N-01E-11CA Foster	Unknown	Unknown	Ethylbenzene, Benzene, Toluene, Xylene	Groundwater, Soil	EP
10	Isabella 08/10/87	Winn Groundwater Contam. 37-13N-05W-100D Fremont	Unknown	Unknown	Dichloroethane, Benzene	Groundwater, Residential Well	IR (S) EP
10	Midland 09/18/87	Hostly Motors 56-14N-02E-18DD Midland, City of	Auto Repair	Surface Dis- charge	Toluene, Methylene Chloride	Groundwater, Soil	EP
8	Bay 09/18/87	Consumers Power Wendock Plant 09-15N-05E-02CD Hampton	Gas/Electric Utility	Underground Tank	Fuel Oil	Groundwater, Soil	E (P)
8	Bay 08/11/87	Enterprise Petroleum Corp. 09-15N-04E-03AC Frasier	Gas Station	Underground Tank	Gasoline	Groundwater, Soil	IR (P) E (P) IR (P)

(Continued)

(Sheet 6 of 17)

Table 38. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
8	Clare 07/25/86	Clare Sanitary LP City of 18-18N-04W-34AA Hutton	Landfill	Landfill	Chloroform, Cis 1,2-Trichloro Trichloroethylene	Groundwater, Residential Well	RA
8	Genesee 08/13/87	GM Fisher Guide Flint 25-07N-06E-13C Flint	Gasoline Storage	Underground Tank	Benzene, Toluene, Ethylbenzene, Xylene	Groundwater, Soil	RA
8	Genesee 08/13/87	Kimes Corp. Plant Site 25-08N-07E-31A Flint	Chem. Prod. Htg.	Unknown	Benzene, Dichloro- ethylene, Chlorobenzene	Groundwater, Soil	RA
8	Genesee 08/13/87	Kimes Corp. Warehouse Site 25-07N-07E-07BA Flint	Oil Storage	Unknown	Benzene, Toluene, Dichloroethane Naphthalene	Groundwater, Soil	RA
8	Genesee 08/07/85	Nevilles Waste Collection 25-06N-08E-04CB Atlas	Landfill	Landfill	Cadmium, Chromium, Iron	Groundwater	RA
8	Gladwin 10/08/84	Elliot Gas & Oil Co 26-18N-01W-31CC Buckeye	Oil Storage	Aboveground Tank	Chem Prod Mfg	Groundwater	IR (P) RA
8	Gladwin 08/19/86	Gladwin Bulk Oil Plant State Street 26-18N-01W-06B Buckeye	Gasoline Storage	Underground Tank	Benzene, Toluene, Ethylbenzene, Xylenes	Groundwater, Soil	IR (P) RA
8	Gladwin 08/14/87	Gladwin City Public Works Garage 26-18N-01W-08B Buckeye	Municipal Facility	Surface Spill	Gasoline	Soil, Groundwater	IR (P) RA

(Continued)

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Table 38. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
8	Gladwin 08/14/87	Simpson Industries Gladwin 26-11N-02W-06N Buckeye	Mfac. Machinery Mfg.	Surface Discharge	Benzene, Toluene, Xylene, Ethyl- benzene	Groundwater, Soil	IR (P)
8	Gratiot 10/08/85	Alma Products 29-12N-03W-35A Pine River	Engine Components Mfg	Lagoon	Trichloroethylene, Cyanide, Dichloro- ethylene	Groundwater	EP
8	Gratiot 08/20/84	Total Petroleum Almu 29-11N-03W-02A Arcade	Petro Refining	Lagoon	Phenols, Chlorides	Groundwater	RA
8	Livingston 08/13/85	Chem Trend Inc 47-02N-05E-05BC Genoa	Oil, Grease Prod	Surface Discharge	Dichloroethane, Trichloroethene	Groundwater, Soil	E (P)
8	Livingston 09/07/84	R & B Manufacturing 47-01N-05E-24ABC Hamburg	Rubber, Plastic Production	Surface Discharge	Dichloroethene, Trichloroethane, Methylene Chloride	Groundwater	E (P)
8	Midland 08/15/85	Gordonville Road 56-14N-01W-27CD Lee	Scrap Metal Yard	Pile, Barrel	PNAS, Oil	Soil, Groundwater	RA
8	Midland 08/15/87	Res. Well Bradford Road 56-13N-01W-06AB Porter	Brine Use, Disposal	Surface Discharge	Brine	Groundwater, Reef- dential Well, Soil	E (P)
8	Okland 10/02/87	Pontiac Steel 36-04N-08E-14WD Springfield	Metal Processing	Dry Well	Heavy Mfg	Groundwater	IR (P) RA

(Continued)

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Table 38. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
8	Saginaw 09/18/87	Amoco Gas Genesee & Holland 73-12N-05E-30BD Saginaw, City of	Gas Station	Underground Tank	Gasoline	Groundwater, Soil	EP
8	Saginaw 09/18/87	Grand Trunk RR Genesee St. 73-12N-04E-24CA Saginaw, City of	Rail Transport	Surface Discharge	Fuel Oil	Groundwater, Soil	IR (P) E (P)
8	Saginaw 08/06/87	Rebel Car Wash 73-12N-04E-11C Saginaw, City of	Gas Station	Underground Tank	Gasoline	Groundwater, Soil	IR (P) EP
8	Saginaw 08/22/86	Shields Manufinc. Paints 73-12N-04E-32AD Saginaw, City of	Metal Conting	Surface Discharge	Benzene, Toluene, Oil	Groundwater Soil	IR (P)
8	Shiawassee 08/14/85	Drake Gasoline Durand 78-06N-04E-16AA Vernon	Gas Station	Underground Tank	Gasoline	Groundwater, Soil	IR (P) EP
7	Bay 09/04/84	Peterm Mfg 09-15N-04E-14 Kaukaulin	Metal Hardware Mfg	Surface Discharge	Heavy Mfg	Groundwater, Flora	RA
7	Clare 09/16/85	Clare CU MUOT Bulk Storage Site 18-17N-04W-34D Grant	Gasoline Storage	Aboveground Tank	Benzene, Xylene, Ethylbenzene, Toluene	Groundwater, Soil	E (S,F) RA
7	Genesee 09/21/84	Boron Gas Station 25-09N-06E-23NB Vienna	Gas Station	Underground Tank	Naphthalene, Xylene, Toluene, Ethylbenzene	Groundwater	EP

(Continued)

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Table 38. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
7	Genesee 09/24/84	GMC Fisher Guide Coldwater Rd 25-08N-07E-18AB Genesee	Plating, Polishing	Waste, Pile Lagoon	Lead, Chromium, Nickel, Chlorides, Sulfate	Groundwater, Soil	RA
7	Genesee 07/30/86	Kish LF 25-09N-05E-09DA Grant	Landfill	Landfill	Chlorides, Lead	Groundwater	RA
7	Genesee 08/21/85	Union 76 Station Flint 25-08N-07E-22DA Genesee	Gas Station	Underground Tank	Benzene, Toluene, Xylene	Groundwater, Soil	
7	Gratiot 09/24/84	Alma, City of 29-12N-03W-34DA Arcade	Petro Refining	Lagoon	Phenol	Groundwater, Soil	EP
7	Gratiot 09/25/84	Gratiot Farmers Supply 29-12N-03W-33AA Pine River	Gas Station	Underground Tank	Naphthalene, Xylene, Toluene, Bucene, Ethyl- benzene	Groundwater	EP
7	Isabella 10/07/84	Stanley Oil Co 37-13N-03W-08DU Coe	Gas Station	Underground Tank	Benzene, Toluene, Xylene	Groundwater	IR (P) RA
7	Isabella 10/07/84	Wicks Agriculture 37-13N-06W-18BA Rolland	Grain Elevator	Aboveground Tank	Ammonium Nitrate, Urea	Groundwater, Residential Well, Ogemaw	RA
7	Livingston 10/02/84	MI Dept. of Transportation 47-02N-06E-32DB Brighton	Salt Storage	Waste, Pile	Salt	Groundwater, Residential Well	E (P)

(Continued)

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Table 38. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
7	Livingston 08/12/85	Wellman Property Disposal 47-02N-04E-25CC Marion	Municipal Facility	Pit	2,4-D, 2,4,5-T	Groundwater, Soil	IR (P) EP
7	Livingston 01/07/86	Wintere Quick Clean 47-01N-05E-26BB Hamburg	Laundry Dry Cleaner	Lagoon	Perchloroethylene	Groundwater	RA
7	Midland 08/05/85	Dow Chem Brine Pipeline Spills 09-56-73 Midland	Brine Use, Disposal	Pipeline	Brine	Groundwater, Soil, Flora	E (P) FR (P)
7	Midland 09/18/87	Dow Corning 56-14N-02E-26CC Midland, City of	Plastic Rubber Mfg.	Aboveground Tank	Toluene	Groundwater, Soil	IR (P)
7	Midland 07/30/87	Forward Car Wash 56-14N-02E-09BB Midland, City of	Gas Station	Underground Tank	Gasoline	Groundwater, Soil	EP
7	Saginaw 09/27/87	Amoco Gas Stn Center & State 73-12N-04E-20AA Saginaw, City of	Gas Station	Underground Tank	Gasoline	Groundwater, Soil	EP
7	Saginaw 09/29/87	Rea Well Lone Road 73-12N-03E-6AA Thomas	Farming	Surface Discharge	Atrazine	Groundwater, Reel- dential Well	EP
6	Arenac 10/08/84	Rea Wells Sterling River 06-19N-04E-20C Deep River	Ag Chem Products	Unknown	Nitrates	Groundwater, Residential Wells	RA

(Continued)

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Table 38. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
6	Bay 09/18/87	Dore Fletcher Gas Station 09-13N-04E-01DB Franklin	Gas Station	Underground Tank	Gasoline	Groundwater, Soil	EP
6	Bay 09/18/87	Forward Corp. Essexville 09-14N-05E-23CB Essexville, City of	Gas Station	Underground Tank	Gasoline	Groundwater, Soil	IR (P)
6	Bay 09/23/86	Aerospace America Inc 09-14N-05E-09DC Bangor	Misc Metal Prod	Barrel	Xylene, Toluene, Naphthal, Acetone, Chromic Acid	Groundwater	RA
6	Clare 09/25/87	Harrison LF, City of 1R-19N-04W-29AC Hines	Dump	Dump	Domestic Comm	Groundwater	RA
6	Clare 09/24/84	Ken Wells Lake George 1R-18N-05W-08DC Lincoln	Unknown	Unknown	Gasoline	Groundwater	IR (S) EP
6	Clare 09/21/87	Tuculo/Saginaw Bay RR Dernil 1R-17N-05W-26AA Surrey	Rail Transport	Surface Discharge	Fuel Oil	Groundwater	IR (P) RA
6	Gladwin 10/08/84	Buckeye Oil Field 26-28N-01W-11 Buckeye	Oil Drilling	Geologic Form	Brine	Groundwater, Residential Well	IR (P)
6	Gladwin 05/20/87	Ruby Dr. Res Leaking Pipe- line 26-20N-02W-17DB Sherman	Private residence	Aboveground Tank	Fuel Oil	Groundwater	IR (P) RA

(Continued)

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Table 38. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
6	Huron 09/18/87	Brighton Metals Caseville 32-18N-10E-35AC Caseville, City of	Metal Coating	Surface Discharge	Chromium, Paint Primers	Groundwater, Soil	E (P) FR (P)
6	Iosco 09/19/85	Straits Aggregate 35-22N-08E-30 Baldwin	Wood Preserving		Arsenic, Selenium, Chromium	Groundwater, Soil	IR (P) EP RA
6	Isabella 10/15/84	Michigan Ohio Pipeline Co 37-15N-04W-33CA Union	Pipeline	Pipeline	Chem Prod Mfg	Groundwater	IR (P) RA
6	Lapeer 09/18/87	U.S. Post Office, Lapeer 44-07N-10E-05DC Lapeer, City of	U.S. Postal Svc.	Underground Tank	Gasoline	Groundwater, Soil	E (F)
6	Livingston 09/15/86	Livingston Co LF 47-03N-04D-13AD Howell	Landfill	Landfill	Domestic Comm, Heavy Mfg	Groundwater	FA
6	Macosta 08/10/87	Fargo, Inc. 54-14N-07W-16DD Wheatland	Gas Station	Underground Tank	Benzene, Toluene Xylene, Ethyl- benzene	Groundwater, Soil	IR (A) RA
6	Midland 10/08/84	Central Michigan Petroleum 56-14N-02E-16 Midland	Gas Station Underground Tank		Benzene, Toluene, Xylene, Isopentane	Groundwater	EP
6	Monroe 09/24/84	Res Wells Vestaburg 59-12N-05W-27CA Richland	Salt Storage	Waste, Pile	Salt, Urine	Residential Well, Groundwater	IR (P) RA

(Continued)

(Sheet 13 of 17)

Table 38. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
6	Ogemaw 09/27/86	Ree Well Main St Lupton 65-24N-03E-36RC Rose	Unknown	Unknown	Ethylene, Dibromide	Groundwater, Soil	IP RA
6	Roscommon 08/22/86	Artesia Beach Fuel Oil Spill 72-23N-01W-30CA Richfield	Private Residence	Aboveground Tank	Benzene, Styrene, Xylene, Toluene, Ethylbenzene	Groundwater, Flora, Soil	IR (P) E (P)
6	Saginaw 08/20/86	Wickes Engineering 73-12N-05E-30CA Buena Vista	Carbon Graphite Production	Pile, Surface Discharge	Trichloroethene, 1,1,1-Trichloro- ethane, 1,1,1-Di- chloroethane	Groundwater, Soil	IR (P) E (P)
6	Shiawassee 08/13/85	Numatics 78-07N-03E-30AA Caledonia	Valves Pipe Mfg	Surface Discharge	Chromium	Groundwater, Soil	IR (P) FR (P)
5	Clare 09/06/84	American Dry Cleaners 18-17N-04W-34DA Grant	Laundry Drycleaners	Xylene, Carbon, tetrachloro- ethene	Soil	Groundwater, Soil	IP
5	Clare 03/30/87	Ree Well Farwell 18-17N-04W-19CC Grant	Unknown	Unknown	Nitrates	Groundwater	IP
5	Gratiot 09/25/84	Fowler Farm & City Supply 29-11N-03W-34CC Arcada	Gas Station	Underground tank	Naphthalene, Xylene Toluene, Benzene, Ethylbenzene	Groundwater	IP
5	Ipsbelle 10/07/84	Mt. Pleasant City of 37-14N-04W-15 Union	Unknown	Unknown	Hydrocarbons	Groundwater	E

(Continued)

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Table 38. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
5	Ianbelle 08/12/87	Mt. Pleasant Twp Plt 37-14N-04W-10NC Union	Coal Unrefinement	Surface Discharge	Chem Prod Mfg. Cyanide, Benzene Phenol, Xylene, PM10	Groundwater Soil	RA
5	Ianbelle 10/07/84	Res Well Lonsdale 37-16N-03W-10D Wise	Unknown	Unknown	Benzene, Toluene Xylene	Groundwater	EP
5	Ianbelle 08/21/85	Res Well N Ottawa Twp 37-15N-05W-30D N Ottawa	Private Residence	Underground Tank	Gasoline	Groundwater	RA
5	Montcalm 08/13/85	Res Well Wyman 59-12N-06W-04CB Home	Petro Refining	Unknown	Benzene, Ethyl Benzene, Xylene	Groundwater, Residential Well	RA
5	Saginaw 08/24/84	Tri City Refine 73-12N-03E-08 Buena Vista	Landfill	Landfill	Zinc	Groundwater, Soil	EP
5	Saginaw 09/18/87	SCA Saginaw Twp LF 73-12N-04E-32DD Saginaw	Landfill	Landfill	Domestic Comm	Groundwater	IR (S) E (S)
5	Shiawassee 08/16/85	Aiken Rd Homes 78-07N-03E-19DD Caledonia	Unknown	Unknown	Iron, Zinc	Groundwater, Residential Well	RA
4	Clare 08/13/86	GW Contamination Meredith 18-20N-03W-13DA Franklin	Unknown	Unknown	Tetrachloro- ethylene, Toluene	Groundwater	IR (S) EP

(Continued)

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Table 38. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
4	Clatsop 10/19/84	Valcast Inc 18-17N-04W-35-34 Grant	Metal Container Hfg	Surface Discharge	Salt	Groundwater	RA
4	Isabella 10/05/84	HI Wisconsin Pipeline Co 37-16N-06W-28CA Coldwater	Pipeline	Pipeline	Hydrocarbons	Groundwater	RA
4	Lapeer 10/19/84	Lapeer Co Rd Comm Mayfield 44-08N-10E-12CB North Branch	Road Commission	Salt Pile	Salt	Groundwater	EF
4	Livingston 10/08/84	US 23-196 Interchange Area 47-02N-06E-32AC Brighton	Salt Storage	Surface Discharge	Salt	Groundwater	EF
4	Hecosta 10/03/84	Farm and Res Well 54-14N-08W-25HC Horton	Farming	Container	Eptam Herbicide	Groundwater	RA
4	Hecosta 10/03/84	Hecosta Co Rd Comm Remus 54-14N-07W-16BH Whetland	Unknown	Salt Pile	Salt	Groundwater	RA
3	Clatsop 08/13/86	Clatsop Co Rd Comm Pinnawilding Road 18-18N-04W-15AA Hayes	Road Commission	Cont Storage	Salt	Groundwater	RA
3	Clatsop 10/02/84	Dodge Lake Dump 18-19N-03W-30AB Hayes	Landfill	Landfill	Domestic Comm	Groundwater	RA

(Continued)

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Table 38. (Concluded)

SAS Score	County Date Scored	Common Site Name ^a Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status ^{aa}
3	Clare 10/11/84	Harrison Lagoon System City of 18-19N-04W-29DC Hayes	Landfill	Ingoon	Ammonia Nitrate	Groundwater	RA
3	Inabella 10/12/84	Fusman Race Track 37-14N-04W-11A Union	Unknown	Surface Discharge	Brine	Groundwater	LA
3	Mecosta 10/25/84	Mecosta Co I.F. 54-15N-09W-23CD Colfax	Landfill	Landfill	Domestic Comm	Groundwater	RA
3	Tuscola 10/09/84	Bailey & DeShaw Stewart 79-10N-07E-32CB Arbela	Oil Drilling	Geologic Form	Chlorides	Groundwater	EP
2	Gladwin 10/08/84	Long Harry Tope No 3 26-17N-02W-36NB Beaverton	Pipeline	Pipeline	Brine	Groundwater, Flora	EP
2	Ogemaw 01/24/85	Ree Well Uran 65-22N-02E-28CC West Branch	Unknown	Unknown	Chloride	Groundwater	IR (P) EP
1	Gladwin 10/08/84	Buckeye Top Dump Closed 26-18N-01W-15CC Buckeye	Dump	Dump	Domestic Comm	Groundwater	IR (P) RA

^a The common site name is for identification only and is not necessarily a party responsible for contamination.

^{aa} IR = Interim Response; E = Evaluation; FR = Final Response; RA = Regulatory Action; EP = Evaluation Pending; P = Privately Funded Actions;
F = Federally Funded Actions

Table 39a

Act 307 Sites Affecting Resources Other Than Surface Water or Groundwater in the Saginaw Bay Watershed

(MDNR 1988)

SAS Score	County Date Scored	Common Site Name ^A Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
GROUP 1							
808	Gratiot 09/22/86	Pine R Downstream St. Louis 29-12N-02W Bathany	Chem Product Mfg	Unknown	Chem Prod Mfg	Sediment	EP
746	Livingston 10/07/87	Roto Corp 47-03N-04E-28DC Howell	Soap, Cleaners Mfg	Aboveground Tank, Barrel Surface Discharge	Heavy Mfg	Soil Air	RA
734	Saginaw 08/12/87	Saginaw Paint Saginaw Coatings 73-12N-04E-24RA Saginaw, City of	Paint Products	Container Barrel	Xylene, MEK, Naptha, Diethylene- amine, Glycol Ether	Soil	IR (S,F) EP
631	Genesee 08/13/87	Container Specialties 23-07N-06E-10BD Flint	Laundry, Dry Cleaner	Underground Tank	Perchloroethylene, Soil Trichloroethylene	Soil	IR (P) RA
519	Oakland 10/09/85	Old Marlowe LP 63-04N-07E-36BC Rose	Landfill	Landfill	Heavy Metals, PCBs, Organics	Sediment, Soil	RA
482	Livingston 10/01/87	Grossman Ideal Steel 47-01N-05E-25CB Hamburg	Unknown	Barrel	Heavy Mfg	Soil	IR (P) RA
477	Bay 09/23/87	Hirschfelds Salvage Yard 09-14N-05E-21AB Bangor	Scrap Metal Yard	Pile	PCB, Oil	Soil	E (P)

(Continued)

(Sheet 1 of 12)

Table 39a. (Continued)

SAS Score	County Date Scored	Common Site Name ^a Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status ^{a,b}
305	Livingston 10/01/87	Cotter Electric 47-03N-04E-36W Howell	Electronic Component Manufacturing	Container, Barrel	PCBs	Soil	IR (P)
343	Tuacola 08/13/87	Vassar Fibercoating Metalizing 79-11N-08E-27W Vassar	Plating, Polishing	Pile, Container, Barrel	Heavy Metals	Soil	E (P)
340	Livingston 09/26/86	Internat. Paper Disposal 47-02N-05E-06W Genoa	Paper Products	Surface	Phenols, PCB, Chromium, Copper		RA
302	Shiawassee 10/01/87	Flint Industrial Plating 78-07N-02E-14W Owosso	Plating, Polishing	Surface Discharge	Chromium, Cyanide	Soil	IR (P) RA
266	Lapeer 01/09/85	Thornville Rd Dump 44-06N-10E-13D Metamora	Landfill	Waste Pile	PCBs	Soil	IR (P) E (P) FR (P)
225	Midland 11/28/84	Dow Chemical Midland Plant 56-14N-02E Midland	Chem Product Mfg	Unknown	Dioxins	Soil	E (P)(S) FR (P)
163	Arenac 09/27/86	Sims Whitney Twp Disposal 06-20N-07E-35W Whitney	Landfill	Landfill	Domestic Com	Fauna	EP RA

(Continued)

(Sheet 2 of 12)

Table 39a. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
GROUP 2							
8	Clare 09/28/84	Hoover Univ. Funnel Prop. 18-17N-05W-35AC Surrey	Unknown	Container, Landfill	Heavy Mfg	Soil,	EP
8	Genesee 08/07/85	Auto Write Collisions Inc 25-07N-07E-29AA Burton	Auto Repair	Surface Discharge	Chem Prod Mfg	Soil	RA
8	Genesee 08/10/87	Phil Flint Oil Co. 25-07N-07E-08BC Flint	Oil Storage	Aboveground Tank	Fuel Oil	Soil	RA
8	Isabella 10/07/84	Total Pet. Inc Mt Pleasant 37-14N-04W-14CB Union	Gas Station	Unknown	Benzene, Toluene, Xylene		IR (P) RA
8	Midland 09/18/87	Ree Contam Curtis Rd. 56-16N-01W-02BC Edenville	Private Residence	Underground Tank	Gasoline	Soil	EP
8	Oakland 12/19/85	Booker Property 63-14N-R7E-28B Rosa	Scrap Metal Yrzd	Pile	Phenol, PCB, Lead, Chromium, Cadmium, Nickel, Zinc	Air, Soil	EP
8	Oakland 08/16/85	Delta Tube & Fabrica. Corp 63-05N-07E-27BD Holly	Metal Processing	Barrel	Heavy Mfg	Soil	IR (P) EP RA
8	Oakland 09/26/86	Holly Containers Inc 63-05N-07E Holly	Barrel Reclaiming	Surface Discharge	Oil, Grease	Soil	EP RA

(Continued)

(Sheet 3 of 12)

Table 39a. (Continued)

SAS Score	County Date Scored	Common Site Name ^a Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status ^{aa}
8	Saginaw 09/28/87	Down Route Dixie Hwy 73-11N-05E-16NA Bridgeport	Gas Station	Underground Tank	Gasoline	Soil	EP
8	Saginaw 09/18/87	Res Contam Ledynrd St. 73-12N-05E-30NA Saginaw, City of	Private Residence	Aboveground Tank	Heating Oil	Soil	EP
8	Saginaw 09/18/87	Saginaw Steering Gear Throop/Ham 73-12N-04E-2CA Saginaw, City of	Auto Mfg.	File Surface Discharge	PCB	Soil	EP
8	Saginaw 08/23/86	Severance Tool Indus. Inc 73-11N-05E-06BN Bridgeport	Tool and Die	Underground Tank	Cyanide, Barium, Chromium, Lead TCE	Soil	E (P) RA
8	Saginaw 08/05/87	Shields Ziehnert 73-12N-03E-25CA Thomas	Auto Repair	Underground Tank	Mineral Spirits	Soil	E (P) FR (P)
8	Shiawassee 08/13/87	Partz Corp. 78-07N-02E-14ND Owosso	Plating, Polishing	Container Surface Discharge	Chromium Nickel		RA
7	Bay 11/05/84	Labadie Oldsmobile 09-14N-05E-20B Bay City	Car Dealer	Unknown	Light Industrial		RA
7	Bay 09/18/87	Scrath/Bay City Scrap Yard 09-14N-05E-21CC Bay City, City of	Scrap Metal Yard	File Barrel	Domestic/Comm Light Industrial	Soil	EP

(Continued)

(Sheet 4 of 12)

Table 39a. (Continued)

SAS Score	County Date Scored	Common Site Name ^a Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status ^{aa}
7	Clare 09/24/84	Renosol Plant 18-17N-05W-26AA Surtey	Rubber Plastic Products	Surface Discharge	Ethylhexylphalate	Soil	EP
7	Genesee 11/02/84	Als Junk 25-07N-07E-09DA Burton	Unknown	Surface Discharge	PCB	Soil	RA
7	Genesee 07/30/86	Richfield Hamblett LF 25-08N-08E-02A Richfield	Landfill	Landfill	Domestic Comm. Heavy Mfg		RA
7	Genesee 11/05/84	Thrall Oil Site Former 25-07N-07E-17CC Burton	Oil, Solvent Recycle	Surface Discharge	Chem Prod Mfg	Soil	EP
7	Gratiot 08/10/87	Gratiot Metal Property 29-10N-03W-01BA Newark	Scrap Metal Yard	Surface Discharge	Heavy Mfg.		EP
7	Huron 09/18/87	Wiederhold Dump 32-16N-11E-23BB Olliver	Dump	Lagoon, Landfill Surface Discharge	Paint Cutting Oil Refuse, Cars	Soil	EP
7	Lapeer 01/22/87	Albar Industries 44-07N-10E-05CB Lapeer	Rubber Plastic Products	Barrel	Xylene, Toluene, MEK	Soil	E (P)
7	Livingston 09/26/86	Bullock Farm 47-03N-06E-15C Hartland	Sanitary Services	Surface Discharge	Dichlorobenzene	Soil	RA

(Continued)

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Table 39a. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
7	Midland 08/11/87	Anderson Service Station 56-14N-02E-1500 Midland, City of	Gas Station	Underground Tank	Gasoline	Soil	E (P)
7	Saginaw 08/22/86	AgriLand 73-12N-05E-2800 Buena Vista	Fertilizer Mfg	Surface Discharge Aboveground Tank Container	PCB, Phosphoric Acid	Soil	E (P) FR (P)
7	Saginaw 09/24/86	Entech Inc Saginaw 73-12N-05E-29AC Buena Vista	AG Chem Products	Pit	Cadmium, Nickel, Chromium, Lead, Copper, Zinc, pH	Soil	EP
7	Saginaw 09/23/86	Frutchey Henn Co 73-09N-03E-1600 Oakley	Grain Elevator	Aboveground Tank	Gasoline, Fuel, Oil	Soil	IR (P) E (P)
7	Saginaw 09/23/86	Johnson Cathide 73-12N-05E-29AC Buena Vista	Metal, Hardware	Aboveground/ Underground Tanks, Barrel	Solvents, L.L., Trichloroethylene, Cutting Oil	Soil, Flora	FR (P)
7	Saginaw 09/18/87	Lero Iron Salvage Yard 73-12N-05E-1500 Buena Vista	Auto Junkyard	Surface Discharge	Light Industrial	Soil	EP
7	Saginaw 09/18/87	Sargent Docks & Terminal Co. 73-13N-05E-3200 Kochville	Coal Gasification	Surface Discharge	Polynuclear Aromatics	Soil	EP
7	Saginaw 09/18/87	Stroebel & S. River Rd. Dump 73-12N-04E-3100 Saginaw	Dump	Dump	Domestic Contam Heavy Mfg	Soil	EP

(Continued)

(Sheet 6 of 12)

Table 39a. (Continued)

SAS Score	County Date Scored	Common Site Name ^a Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status ^{aa}
7	Saginaw 09/18/87	Zilwaukee City Garage 73-12N-05E-06DA Zilwaukee, City of	Municipal Facility	Underground Tank	Gasoline, Brine	Soil	EP
6	Clare 10/01/84	Surrey Twp LF 18-17N-05W-12CN Surrey	Landfill	Landfill	Chem Prod Mfg		RA
6	Genesee 10/01/87	Dye Rd Dump 25-07N-06E-17AC Flint	Dump	Barrel	Domestic Comm, Heavy Mfg.	Soil	RA
6	Genesee 08/13/87	Genesee Co. Jail Project 25-07N-07E-18CA Flint	Municipal Facility	Unknown	Gasoline, Oil	Soil	IR (P) RA
6	Huron 10/19/84	Davis Wash King 32-16N-12E-24BD Colfax	Laundry Dry Cleaner	Lagoon	PCE	Soil	EP
6	Huron 09/18/87	Port Austin State Bank 32-19N-13E-31DC Port Austin	Dump	Pile, Barrel Surface Discharge	Light Industrial	Soil	EP
6	Huron 09/18/87	Sebewaing Industries 32-15N-09E-08DN Sebewaing, City of	Dump	Pile, Barrel Surface Discharge	Light Industrial	Soil	EP
6	Lapeer 09/18/87	Lapeer Foundry & Mach., Inc. 44-07N-10E-05BA Lapeer, City of	Iron Steel Foundry	Pile, Barrel	Heavy Mfg.	Soil	EP

(Continued)

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Table 39a. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
6	Livingston 08/18/86	Old Howell LF Lucy Rd Park 47-02N-05E-06BC Genoa	Landfill	Landfill	Domestic Comm, Light Industrial		RA
6	Saginaw 09/18/87	Atline Auto 73-11N-04E-13CC Spaulding	Auto Repair	Pile	Oil, Gasoline, Antifreeze	Soil	EP
6	Saginaw 09/18/87	Boron Stn Tittibawassee & Bay Gas Station 73-13N-04E-34DD Kochville	Gas Station	Underground Tank	Gasoline	Soil	E (P)
6	Saginaw 08/28/87	Farm Bureau Saginaw 73-11N-05E-06CB Saginaw, City of	Gas Station	Aboveground Tank	Gasoline	Soil	EP
6	Saginaw 09/18/87	Peto Met Salvage Yard 73-12N-05E-18DD Saginaw, City of	Scrap Metal Yard	Surface Discharge	PCB, Oil	Soil	EP
6	Saginaw 09/18/87	Rea Contam Reed Street 73-12N-04E-14AA Saginaw, City of	Unknown	Unknown	Oil	Soil	EP
6	Shiawassee 08/20/85	Lee Woodard Sons Inc 78-07N-02E-24BA Owosso	Forging, Stamping	Unknown	Zinc, Cadmium, Copper, Lead	Soil	EP
6	Shiawassee 08/13/85	Old Laundry Lagoon 78-07N-03E-20AB Caledonia	Laundry Dry Cleaner	Lagoon	Copper, Chromium, Cadmium, Nickel, Lead, Zinc		IR (P) RA

(Continued)

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Table 39a. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
6	Tuscola 09/18/87	Astech Industries 79-11N-08E-208B Vassar	Iron Steel Foundry	Pile	Foundry Sands	Soil	E (P)
6	Tuscola 10/09/84	Eaton Grede Vassar 79-11N-08E-07CD Vassar	Iron, Steel Foundry	Ingoons, Piles	Light Industrial		E (P)
6	Tuscola 09/28/87	Fairgrove Gas Stn 79-13N-08E-16CC Fairgrove	Gas Station	Surface Discharge	Gasoline	Soil	EP
5	Isabella 10/07/84	Dana Corp 37-14N-04W-118C Union	Misc Machinery Mfg	Underground Tank	PCE, TCE, Methylene Chloride		RA
5	Isabella 09/26/86	Shepherd School Gas Spill 37-13N-03W-17AD Coe	Gasoline Storage	Underground Tank	Gasoline	Soil	RA
5	Livingston 09/28/84	Brighton Twp Dump 47-02N-06E-15DA Brighton	Landfill	Landfill	Domestic Comm		EP
5	Midland 09/18/87	Midland Iron Works 56-14N-01W-24AA Lee	Iron Steel Foundry	Pile	Heavy Mfg.	Soil	EP
5	Ogemaw 09/27/84	Caracallena Store Area 65-22N-03E-09DB Churchill	Gas Station	Underground Tank	Benzene, Toluene, Xylene	Soil	EP

(Continued)

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Table 39a. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
5	Saginaw 10/13/84	Agrico Chemical Co. 73-12N-06E-15C11 Hlumfield	Fertilizer Mfg	Barrel	Chem Prod Mfg		IR (P)
5	Saginaw 10/09/84	C & O Railroad 73-11N-06E-03AD Frankenmuth	Rail Transport	Underground Tank	Diesel Fuel, Salt		EP
5	Saginaw 08/06/87	Saginaw Products Corp. 73-12N-04E-34AB Saginaw, City of	Metal Hardware Mfg	Surface Discharge	PCB		EP
5	Saginaw 09/30/87	Shaefer Chemical 73-12N-04E-1200 Carrolton	Chem Product Mfg	Surface Discharge	Caustic Soda, De- tergent, Phos- phoric Acid	Soil	EP
5	Shiawassee 08/13/85	Midwest Abrasives 78-08N-02E-22RC Rush	Abrasives	Surface Discharge	Phenol		IR (P) EP
5	Tuscola 10/09/84	Dular Products Inc 79-11N-08E-07CA Vassar	Paint Products	Surface Discharge	Light Industrial	Soil	E (P)
4	Genesee 08/07/85	Old Plating Plant 25-09N-06E-22AA Vienna	Plating, Polishing	Barrel, Pit, Surface Discharge	Cyanide, Chromium	Soil	IR (P) EP
4	Huron 09/18/87	Port Austin Laundromat 32-19N-12E-30AA Port Austin, City of	Laundromat	Surface Discharge	Domestic Comm	Soil	EP

(Continued)

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Table 39a. (Continued)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
4	Iosco 10/08/84	Kaul Glove & Manufacturing 35-23N-09E-03D Wilber	Work Glove Mfg	Waste Pile	Vinyl Chloride, Polyvinyl Chloride, Diethyl Phthalate	Soil	IR (P) E (P) RA
4	Isabella 10/05/84	Isabella Co Sanitary LF 37-14N-05W-19CA Union	Landfill	Landfill	Domestic Comm, Light Industrial		RA
4	Isabella 10/19/84	Wise Top LF 37-16N-03W-30BB Wise	Landfill	Landfill	Domestic Comm		RA
4	Lepeor 09/26/86	Otter Lake Marathon Field 56-09N-09E-18AC Marathon	Oil Drilling	Geologic Form	Hydrogen, Sulfide	Air	EP
4	Saginaw 08/22/86	Herrill Dump 73-12N-01E-27BC Jonesfield	Landfill	Landfill	Domestic Comm		EP
3	Isabella 10/05/84	Gilmore Top Sanitary LF 37-16N-05W-28AA Gilmore	Landfill	Landfill	Domestic Comm		RA
2	Arenac 09/12/86	Mason Turner Tops Dump 06-20N-05E-15AD Mason	Landfill	Landfill	Domestic Comm	Soil	EP
2	Arenac 11/05/84	Standish Lincoln Dump Closed 06-18N-05E-07CD Standish	Landfill	Landfill	Domestic Comm	Wetland, Soil	EP

(Continued)

(Sheet 11 of 12)

Table 39a. (Concluded)

SAS Score	County Date Scored	Common Site Name* Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status**
2	Clare 10/02/84	Arthur Top Dump 18-18N-03W-15AD Arthur	Landfill	Land fill	Domestic Comm		RA
2	Shiawassee 10/14/85	G & G Disposal 78-05N-04E-19RA Burns	Landfill	Landfill	Iron	Soil	EP
1	Gladwin 11/05/84	D & B Disposal Closed 26-18N-01W-06CA Buckeye	Dump	Dump	Domestic Comm		IR (P) EP
1	Gladwin 02/01/85	Gladwin Co Rd Comm 26-18N-01W-06CA Buckeye	Unknown	Waste Pile	Salt		RA
1	Gladwin 10/08/84	Sage Top Dump Closed 26-19N-02W-22CC Sage	Dump	Dump	Domestic Comm		EP

*The common site name is for identification only and is not necessarily a party responsible for contamination.

** IR-Interim Response; E-Evaluation; FR-Final Response; RA-Regulatory Actions; EP-Evaluation Pending; P-Privately Funded Actions; F-Federally Funded Actions

Table 39b

Act 307 Priority List, Two Sites in the Saginaw Bay Watershed (MDNR 1988)

SAS Score	County Date Scored	Common Site Name ^a Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status ^{aa}
0757	Lapeer 01/20/87	Oregon Twp Dump 44-08N-09E-24AB Oregon	Landfill	Barrel Landfill	Toluene Xylene TCE Zinc Benzene PCBs Carbon Disulfide	Surface Water Groundwater Soil Wetland	E (S) FR (S)
0751	Oakland 02/09/87	Springfield Twp Dump Site 63-04N-08E-32CB Springfield	Dump	Barrel	PCB Benzene Toluene Xylene	Groundwater Soil	IR (S,F) E (S,F)
0725	Bay 01/17/86	Hartley and Hartley 09-15N-04E-25AD Kawkawlin	Landfill	Lagoon Barrel Landfill	PCB Xylene Dichloroethane Diethyl Phthalate	Groundwater Wetland	E (S)
0725	Oakland 02/09/87	Rose Twp Dump Site 63-04N-07E-28AC Rose	Dump	Pit Barrel	Lead Cadmium Phenol PCB Dichloroethylene	Surface Water Groundwater Soil	IR (S,F) E (S,F)
0696	Oakland 02-10-87	Rose Twp Cemetery Site 63-04N-07E-27AA Rose	Dump	Barrel	Phenol PCB Arsenic Lead Nickel Chromium		IR (S,F) E (S,F)

^a The common site name is for identification only and is not necessarily a party responsible for contamination.

^{aa} IR-Interim Response (alternate water, surface removal, site security, and other partial remedies; E-Evaluation (studies)); FR-Final Response (final cleanup); NA-Regulatory Action (agency actions to initiate site work, e.g., negotiations, preliminary investigation); EP-Evaluation Pending (sites currently with insufficient priority for publicly-funded response); P-Privately Funded Actions; S-State-funded actions; F-Federally Funded Actions

Table 40

Environmental Protection Agency Superfund Sites in the Saginaw Bay Watershed

Act 307 List Group	County Date Scored	Common Site Name ^a Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status ^a
1.1	Clare	Clare Municipal Wells 18-17N-04W-34D Grant	City of Auto Component Mfg	Lagoon Surface Discharge	Dichloroethane Trichloroethene	Groundwater Sediment Municipal well Surface Water	IR (P) E (P,S,F)
1.1	Genesee	Forest Waste Products 23-09N-08E-08DB Forest	Landfill	Lagoon Landfill	Dieldrin Lead Cyanide PCB Oil	Groundwater	IR (S,F) E (S,F)
1.1	Genesee	Berlin and Ferro 23-06N-05E-23DA Gaines	Haz waste facility	Lagoon Landfill	Toluene Ethylbenzene Bromofom	Groundwater Soil	IR (P,S,F) E (P,S,F) FR (P,S,F)
Unlisted	Gratiot	Gratiot Co. Landfill	Landfill	Landfill	Leachate, PBB		
Unlisted	Gratiot	Valeicol	Plant site	Discharge	PBB	Surface Water Sediments	
1.1	Iosco	Medblum Industries 33-23N-09E-04DC Au Sable	Forging stamping	Surface discharge	Trichloroethylene	Groundwater	IR (P,S) E (F)
1.1	Lapeer	Metamora Sanitary LP 44-06N-10E-10DB Metamora	Landfill	Barrel Landfill	Dichlorobenzene Hexachlorobenzene Methyl Chloroform	Groundwater	IR (S,F) E (S,F)
1.1	Livingston	Rasmussens Dump 47-01N-06E-30AA Green Oak	Dump	Dump Barrel	Volatile Organics Dioxins PCB Lead Arsenic Copper	Groundwater Soil	IR (S,F) E (S,F)

(Continued)

(Sheet 1 of 2)

Table 40. (Concluded)

Act 307 List Group	County Date Scored	Common Site Name ^a Location Code Township	Source of Contamination	Point of Release	Pollutant	Resource Affected	Status ^a
1.1	Livingston	Shinnersen River 47-03M-04E-22 Novell	Forging stamping	Surface discharge	PCB PCT	Surface Water Sediment	E (S,P)
1.1	Livingston	Spierelburg LP 47-01M-06E-31M Green Oak	Dump	Heap Barrel	Liquid Paints Zinc Arsenic Thallium	Groundwater Soil	IR (S) E (S,P)
2.	Oakland	Springfield Typ Dump Site 63-04M-08E-32CB Springfield	Dump	Barrel	PCB Benzene Toluene Xylene	Groundwater Soil	IR (S,P) E (S,P)
2.	Oakland	Rose Typ Dump Site 63-04M-07E-28AC Rose	Dump	Pit Barrel	Lead Cadmium Phenol PCB Dichloroethylene	Surface Water Groundwater Soil	IR (S,P) E (S,P)
2.	Oakland	Rose Typ Cemetery Site 63-04M-07E-27AA Rose	Dump	Barrel	Phenol PCB Arsenic Lead Nickel Chromium	Surface Water Groundwater Soil	IR (S,P) E (S,P)

^a The common site name is for identification only and is not necessarily a party responsible for contamination.

^a IR-Interim Response (alternate water, surface removal, site security, and other partial remedies; E-Evaluation (studies);
 PR-Final Response (final cleanups); RA-Regulatory Action (agency actions to initiate site work, e.g., negotiations, preliminary
 investigation); EP-Evaluation Pending (sites currently with insufficient priority for publicly-funded response); P-Privately Funded
 Actions; S-State-funded actions; F-Federally Funded Actions

Table 41

Crop Acreage Totals for Counties in the Saginaw Bay Drainage Basin

County	Total Cropland	2 CT Impl.	Seed & Feed Corn	Wheat	Oats	Soybeans	Dry Edible Beans	Sugar Beets	Vegets. Sweet Melons	2 of County in Basin
Arenac	68,355	24	13,424	4,041	3,305	6,918	12,825	2,193	1,693	100
Bay	161,143	19	45,976	6,757	2,060	18,879	48,969	16,134	3,478	100
Clare	50,215	28	6,826	2,286	3,453	356	-	-	43	54
Genesee	134,134	26	45,652	4,648	10,370	31,532	1,216	-	618	100
Gladwin	52,844	15	10,461	3,419	3,576	1,650	2,902	324	143	100
Gratiot	248,451	31	70,343	14,972	8,165	65,918	48,128	4,985	2,650	63
Huron	384,598	26	111,847	23,145	24,420	4,901	105,66	21,449	16	63
Iosco	35,022	16	6,971	1,244	2,370	434	968	-	31	66
Isabella	159,774	29	41,941	10,568	8,786	13,255	17,094	-	352	100
Lapeer	178,853	27	58,614	7,065	11,221	9,168	7,413	-	3,427	71
Livingston	103,952	34	38,519	6,784	4,758	4,351	299	-	-	43
Mecosta	93,022	35	17,943	4,469	3,352	180	2,928	-	724	24
Midland	72,404	7	22,886	3,259	1,676	17,164	14,130	2,254	375	100
Montcalm	183,585	41	55,428	20,374	8,511	6,340	20,415	-	1,142	13
Oakland	50,530	33	15,793	2,762	1,971	987	-	-	657	18

(Continued)

(Sheet 1 of 2)

Table 41. (Concluded)

County	Total Cropland	% CT Impl. ¹	Seed & Feed Corn	Wheat	Oats	Soybeans	Dry Edible Beans	Sugar Beets	Vegets. Sweet Melons	% of County in Basin
Ogemaw	46,970	8	5,268	1,360	3,555	-	-	-	11	79
Osceola	76,293	20	6,064	1,508	3,771	-	-	-	-	5
Roscommon	3,391	4	-	-	78	-	-	-	-	11
Saginaw	282,524	30	62,878	17,761	6,853	117,778	39,716	13,436	2,233	100
Sanilac	391,182	13	93,981	14,604	42,785	37,794	46,979	10,871	763	32
Shiawassee	203,254	32	49,343	13,526	19,321	66,900	2,553	135	93	57
Tuscola	301,425	19	96,423	20,816	12,409	22,162	72,865	23,490	1,998	100

¹CT Impl. is the percentage of total row crop, small grain, and forage crop acreage planted using conservation tillage methods in 1986.

Table 42

Livestock Populations and Acreage Totals for Hay and Pasture Within the
Saginaw Bay Drainage Basin (Bureau of the Census 1984)

County	Cattle	Milk Cows	Hogs	Sheep	Horses	Chickens	Hay Acreage	Pasture Acreage	County
Arenac	9,109	3,146	3,769	154	210	6,347	10,094	3,791	100
Bay	4,736	1,501	3,231	55	292	4,634	3,776	69	100
Clare	14,215	3,012	6,282	1,796	502	29	15,995	12,151	54
Genesee	18,478	4,464	12,139	1,513	1,336	12,821	15,918	4,981	100
Gladwin	10,568	1,805	3,543	1,410	378	3,774	13,876	9,244	100
Gratiot	28,096	8,774	17,880	1,046	443	162,570	14,036	4,887	63
Huron	77,272	19,514	34,078	292	280	1,406,243	38,144	10,912	63
Iosco	11,167	1,535	2,151	518	296	706	10,990	5,778	66
Isabella	35,429	11,077	15,125	438	608	-	32,720	10,034	100
Lapeer	36,040	10,795	13,132	3,344	2,104	11,608	38,264	12,713	71
Livingston	23,961	7,229	6,315	3,279	1,896	8,197	24,601	8,189	43
Mecosta	451	6,160	4,336	1,170	620	3,734	33,114	12,041	24
Midland	170	650	5,304	225	497	1,982	3,939	1,503	100
Montcalm	557	10,361	10,769	1,230	760	10,279	31,321	7,768	13
Oakland	6,371	1,111	2,246	1,147	2,408	3,130	12,981	8,056	18

(Continued)

(Sheet 1 of 2)

Table 42. (Concluded)

County	Cattle	Milk Cows	Hogs	Sheep	Horses	Chickens	Hay Acreage	Pasture Acreage	2 County
Ogemaw	14,498	4,246	1,026	456	222	1,311	18,926	9,608	79
Osceola	22,518	8,094	2,936	1,390	561	-	36,500	16,798	5
Roscommon	321	3	50	-	185	887	1,043	-	11
Saginaw	15,543	4,629	8,192	1,181	856	38,419	10,725	3,239	100
Sanilac	75,180	30,891	11,014	1,042	886	29,942	71,643	17,499	32
Shiawassee	24,463	8,325	13,039	1,841	1,019	35,861	23,317	7,806	57
Tuscola	23,838	7,455	18,487	1,166	823	477,759	21,753	8,743	100

Table 43
Fish Consumption Advisories for 1988 in the Saginaw Bay Watershed
 (MDNR 1988; MDPH 1988)

Location	Advisory		Contaminant of Concern
	Restrict*	Do Not Eat	
Saginaw Bay	Lake Trout Rainbow Trout Brown Trout	Carp or Catfish	PCB
Pine River Downstream of St. Louis		All species	PBB, DDT
Shiawassee River M-59 to Byron Rd. Byron Rd to Owosso		All species Carp	PCB
Tittabawassee River Downstream of Midland		Carp or Catfish	Dioxin
Saginaw River		Carp or Catfish	PCB
Cass River Downstream of Bridgeport	Carp	Catfish	PCB

*The MDPH advises restricting consumption to no more than one meal per week.

Table 45

Contaminant Concentrations (mg/kg) in Fish Samples from the Cass River, 1984-1985

(MDNR, unpublished data)

Species	Year	Parameter				
		PCB		Dieldrin	Toxaphene	DDD, DDE DDT
		A-1254	A-1260			
Carp n value	1984	9		9		9
		1.25		0.008		0.192
Smallmouth Bass n value	1984	17		17		17
		0.75		0.001		0.023
Bullhead n value	1984		4	4	4	2
			0.06	0.001	0.050	0.019
Channel Catfish n value	1985	4		4	4	4
		0.72		0.010	0.050	0.2

Table 46

Contaminant Concentrations in Fish Samples from the Tittabawassee River, at Smith's Crossing, 1984-1985
(MDNR, unpublished data; see Figure 13b)

Species	Year	2,3,7,8- TCDD (ng/kg) (Dow)	2,3,7,8- TCDD (ng/kg) (FDA)	PCB A-1254 (mg/kg)	Dieldrin (mg/kg)	Total Chlordane (mg/kg)	Toxaphene (mg/kg)	DDD,DDE DDT (mg/kg)
Carp n value	1984			9 2.66	8 0.01		9 0.01	9 2.66
Walleye n value	1984			9 0.37	9 0.012		9 0.100	9 0.077
Crappie n value	1985	3 ^a 3.9	1 5.4	3 ^a 0.13	3 ^a 0.002	1 ^a 0.019	3 ^a 0.023	3 ^a 0.088
Northern Pike n value	1985	3 ^a 9.5	1 ^a 16.5	3 ^a 0.382	3 ^a 0.003	1 ^a 0.055	3 ^a 0.068	3 ^a 0.386
Smallmouth Bass n value	1985	3 5.00	1 8.00	3 0.045	3 0.001	1 0.010	3 0.042	3 0.048
Walleye n value	1985	14 4.0	4 2.7	14 0.683	14 0.002	4 0.041	14 0.101	14 0.163
White Bass n value	1985	4 ^b 8.2	1 ^a 15.9	4 ^b 1.330	4 ^b 0.014	1 ^a 0.074	4 ^b 0.089	4 ^b 0.324

^a"n" is the number of composite samples of three fish each.

^bThree composites of three fish each and one composite of four fish.

Table 47

Contaminant Concentrations (mg/kg) in Fish Samples from the Chippewa River, 1984-1985

(MDNR, unpublished data)

Species Year	Parameter												
	PCB		Dieldrin	Toxa- phene	DDD,DDE DDT	Hg	As	Zn	Pb	Ni	Cu	Cr	Cd
	A-1254	A-1260											
Crappie 1984													
n	5	5			5								
value	0.064	0.001			0.296								
Sucker 1984													
n	8	8			8								
value	0.090	0.002			0.534								
Carp 1985													
n		8	8	8	8	8	8	8	8	8	8	8	8
value		0.126	0.002	0.050	0.240	0.4	0.5	14.4	1.1	1.8	13.2	1.0	0.4

Table 48

Contaminant Concentrations (mg/kg) in Fish Samples from the Pine River, 1984-1985

(MDNR, unpublished data)

Species Year	Parameter									
	Dieldrin	DDD, DDE DDT	Hg	As	Zn	Pb	Ni	Cu	Cr	Cd
Smallmouth Bass										
1984										
n	2	2								
value	0.002	4.391								
Sucker										
1984										
n	4	4								
value	0.001	2.229								
Carp										
1985										
n	10	10	10	10	10	10	10	10	10	10
value	0.004	10.033	0.2	<0.5	12.6	<0.1	1.0	1.8	<0.1	<0.4

Table 49

Contaminant Concentrations (mg/kg) in Fish Samples from the Saginaw River, 1986

(MDNR, unpublished data)

Species	Parameter									
	PCB A-1254	Dieldrin	Toxa- phene	DDE,DDD DDT	Hg	Pb	Ni	Cu	Cr	Cd
Carp	2	2	2	2	2	1	2	2	2	2
	n				ND*	0.11*	ND*	1.5*	ND*	0.03
	value	0.04	1.4	1.5						
	5	5	5	5	5	5	5	5	5	5
	n					ND**	ND**	0.36**	ND**	0.002
	value	0.10	1.77	1.5	0.04					
Walleye	2	2	2	2	2	2	2	2	2	2
	n				ND ^a	ND ^a	ND ^a	ND ^a	0.6 ^a	ND ^a
	value	0.028	0.053	0.605						
	3	3	3	3	9	3	3	3	3	5
	n				0.2	ND ^b	ND ^b	0.017 ^b	0.17 ^b	ND ^b
	value	0.004	0.12	0.077						

* composited whole samples of five fish

** skin off fillet

^a composited whole samples of three fish^b skin on fillet

Table 50

Concentrations (ng/kg) of 2,3,7,8-Tetrachlorodibenzo-p-dioxin in Fish Samples
from the Saginaw Bay Watershed (Devault 1984)

Location	Species	Sample Type	# Samples/ # Fish per Sample	2,3,7,8- TCDD	Total TCDD	Total PCDD	Source
Saginaw River							
Saginaw WWT	Carp	E	1/U	319	NA	NA	MSU 1979
Wickes' Park	Carp	E	1/1	62	NA	NA	USEPA 1978
	Yellow Perch	E	1/2	<11	NA	NA	USEPA 1978
Wickes Park	Carp	E	1/U	35	NA	NA	MSU 1979
Blocks Marina	Channel Catfish	E	1/1	105	NA	NA	USEPA 1978
	Channel Catfish	E	1/1	52	NA	NA	USEPA 1978
	Carp	E	1/1	28	NA	NA	USEPA 1978
Mouth	Channel Catfish	E	1/1	30	NA	NA	USEPA 1978
	Carp	E	1/1	153	NA	NA	USEPA 1978
	Yellow Perch	E	1/2	11	NA	NA	USEPA 1978
Mouth	Carp	E	1/U	288	NA	NA	MSU 1979
Consumers Power	Carp	E	1/U	301	NA	NA	MSU 1979
P'ant	Carp	E	1/U	129	NA	NA	MSU 1979
Below Saginaw	White Sucker	E	1/U	64	NA	NA	MSU 1979
WWT	Carp	E	1/U	126	NA	NA	MSU 1979
	Carp	E	1/U	135	NA	NA	MSU 1979
Chippewa River							
10 miles upstream	Carp	E	1/U	136	NA	NA	MSU 1979
of Dow							
Pine River							
Below St. Louis	Carp	E	1/U	322	NA	NA	MSU 1979
	White Sucker	E	1/U	85	NA	NA	MSU 1979
Alma	Carp	E	1/U	<10	NA	NA	USEPA 1983
Cass River							
Frankenmuth	Redhorse Sucker	E	1/U	<40	NA	NA	MSU 1979
	Carp	E	1/U	<9	NA	NA	MSU 1979

(Continued)

(Sheet 1 of 4)

Table 50. (Continued)

Location	Species	Sample Type	# Samples/ # Fish per Sample	2,3,7,8- TCDD	Total TCDD	Total PCDD	Source
Flint River Below Flint	Carp	E	1/U	<100	NA	NA	MSU 1979
	Carp	E	1/8	<10	NA	NA	USFDA 1983
Holloway Reservoir	White Sucker	E	1/U	<24	NA	NA	MSU 1979
Shiawassee River Cheasaning	Carp	E	1/8	<10	NA	NA	USFDA 1983
Tittabawassee River 5 Miles Upstream of Dow	White Sucker	E	1/U	287	NA	NA	MSU 1979
	Carp	E	1/U	20	NA	NA	MSU 1979
	White Sucker	E	1/U	<63	NA	NA	MSU 1979
Tittabawassee Rd.	Carp	E	1/1	52	NA	NA	USEPA 1978
	Yellow Perch	E	1/1	20	NA	NA	USEPA 1978
	Carp	E	1/1	93	NA	NA	USEPA 1978
	Carp	E	1/1	32	NA	NA	USEPA 1978
Freeland Rd.	Yellow Perch	E	1/1	10	NA	NA	USEPA 1978
	Carp	E	1/U	66	NA	NA	MSU 1979
Smith's Crossing Rd	Channel Catfish	E	1/1	273	NA	NA	USEPA 1978
	Carp	E	1/1	695	NA	NA	USEPA 1978
	Channel Catfish	E	1/1	49	NA	NA	USEPA 1978
	Carp	E	1/1	49	NA	NA	USEPA 1978
	Sucker	E	1/1	8	NA	NA	USEPA 1978
	Sucker	E	1/1	21	NA	NA	USEPA 1978
State Street	Yellow Perch	E	1/2	20	NA	NA	USEPA 1978
	Carp	E	1/1	93	NA	NA	USEPA 1978
Above Dow Dam	Channel Catfish	E	1/1	42	NA	NA	USEPA 1978
	Carp	E	1/1	<5	NA	NA	USEPA 1978
	Carp	E	1/1	<9	NA	NA	USEPA 1978
	Channel Catfish	E	1/1	28	NA	NA	USEPA 1978
	Yellow Perch	E	1/1	<4	NA	NA	USEPA 1978

(Continued)

(Sheet 2 of 4)

Table 50. (Continued)

Location	Species	Sample Type	# Fish Per Sample	2,3,7,8-TCDD	Total TCDD	Total PCDD	Source
Dublin Rd	Carp	E	1/1	<9	NA	NA	USEPA 1978
Below Dow	Carp	W	1/3-2	NA	81	233	USFWS 1979
	Carp	E	1/0	17	NA	NA	MSU 1979
	Carp	E	1/0	39	NA	NA	MSU 1979
	Carp	E	1/0	83	NA	NA	MSU 1979
	Carp	E	1/0	<54	NA	NA	MSU 1979
Saginaw Bay							
Sebewaing	Yellow Perch	E	1/1	<16	NA	NA	MSU 1979
Au Gres	Yellow Perch	E	1/1	<15	NA	NA	MSU 1979
Sand Point	Carp	E	1/0	<14	NA	NA	MSU 1979
	Carp	E	1/8	<10	NA	NA	WFDA 1983
Near Saginaw River	Carp	E	1/0	43	NA	NA	MSU 1979
Near Saginaw River	Carp	E	1/0	173	NA	NA	MSU 1979
Near Saginaw River	Carp	E	1/0	28	NA	NA	MSU 1979
Near Saginaw River	Carp	E	1/0	<50	NA	NA	MSU 1979
Bay City	Carp	W	1/1	NA	94	385	USFWS 1981
Grid 1509*	Yellow Perch	E	1/24	<10	NA	NA	USFWS 1981
Grid 1507	Yellow Perch	E	1/24	<10	NA	NA	USFWS 1981
	Bowfin	E	1/1	<10	NA	NA	USFWS 1981
	Walleye	E	1/1	<10	NA	NA	USFWS 1981
Grid 1509	Yellow Perch	E	1/24	<10	NA	NA	USFWS 1981
Grid 1509	Yellow Perch	E	1/5	<10	NA	NA	USFWS 1981
	Whitefish	E	1/1	<10	NA	NA	USFWS 1981
	Buffalo	E	1/1	<10	NA	NA	USFWS 1981
Grid 1506	Sucker	E	1/12	<10	NA	NA	USFWS 1981
Grid 1506	Sucker	E	1/13	<10	NA	NA	USFWS 1981
Grid 1506	Catfish	E	1/7	<10	NA	NA	USFWS 1981
Grid 1506	Catfish	E	1/14	14/15	NA	NA	USFWS 1981
Grid 1506	Carp	E	1/2	<10	NA	NA	USFWS 1981
Grid 1506	Carp	E	1/2	<10	NA	NA	USFWS 1981
Grid 1507	Sucker	E	1/10	<10	NA	NA	USFWS 1981
Grid 1507	Carp	E	1/7	<10	NA	NA	USFWS 1981

(Continued)

(Sheet 3 of 4)

Table 50. (Concluded)

Location	Species	Sample Type	# Samples/ # Fish Per Sample	2,3,7,8- TCDD	Total TCDD	Total PCDD	Source
Grid 1507	Carp	E	1/2	16/20	NA	NA	USFDA 1978
Grid 1507	Catfish	E	1/1	35/45	NA	NA	USFDA 1979
Grid 1507	Carp	E	1/1	17/45	NA	NA	USFDA 1979
Grid 1507	Carp	E	1/1	<10	NA	NA	USFDA 1979
Grid 1507	Sucker	E	1/2	<10	NA	NA	USFDA 1979
Grid 1507	Crappie	E	1/1	<10	NA	NA	USFDA 1979
Grid 1507	Rockbass	E	1/1	<10	NA	NA	USFDA 1979
Grid 1507	Bullhead	E	1/1	<10	NA	NA	USFDA 1979
Grid 1507	Bullhead	E	1/1	<10	NA	NA	USFDA 1979
Grid 1509	Sucker	E	1/12	<10	NA	NA	USFDA 1978
Grid 1509	Carp	E	1/1	<10	NA	NA	USFDA 1978
Grid 1509	Carp	W	1/3-5	NA	27	111	USFDA 1979
Grid 1509	Catfish	E	1/1	29/32	NA	NA	USFDA 1979
Grid 1509	Catfish	E	1/1	26/34	NA	NA	USFDA 1979
Grid 1509	Catfish	E	1/3	<10	NA	NA	USFDA 1979
Grid 1509	Carp	E	1/3	<10	NA	NA	USFDA 1979
Grid 1509	Sucker	E	1/2	<10	NA	NA	USFDA 1979
Grid 1509	Bullhead	E	1/1	<10	NA	NA	USFDA 1979
Grid 1509	Bullhead	E	1/1	<10	NA	NA	USFDA 1979
Grid 1509	Catfish	E	1/10	13/12	NA	NA	USFDA 1980
Grid 1509	Catfish	E	1/10	13/14	NA	NA	USFDA 1980
Grid 1509	Carp	E	1/3	68/62	NA	NA	USFDA 1981

NA Not Analyzed
 ND Not Detected
 U Unknown
 E Edible Portion
 W Whole Fish

Table 51
Concentrations (ng/kg) of TCDD in Commercial Fish Samples
from Saginaw Bay, 1979-1982 (Firestone and Nieman 1986)

Year	Species	Number of Samples	2,3,7,8- TCDD
1979	Sucker	9	ND
	Perch	8	ND
	Bullhead	2	ND
	Whitefish	1	ND
	Carp	6	ND
	Carp	1	21
	Carp	1	57
	Catfish	21	ND
	Catfish	1	60
	Catfish	1	19
	Catfish	1	52
	Catfish	1	43
	Catfish	1	34
1980	Carp	1	ND
	Carp	1	35
	Catfish	1	18
	Catfish	1	18
1981	Perch	1	ND
	Carp	1	ND
	Carp	1	28
	Carp	1	37
	Catfish	1	28
	Catfish	1	44
	Catfish	1	50
	Catfish	1	57
1982	Sucker	1	ND
	Walleye	1	ND
	Whitefish	1	14
	Whitefish	1	20
	Carp	3	ND
	Carp	1	15
	Carp	1	16
	Carp	1	18
	Carp	1	20
	Carp	1	30
	Catfish	4	ND
	Catfish	1	7
	Catfish	1	13

ND = Not quantified or confirmed; if 2,3,7,8-TCDD is present, it is present at a level below 10 ng/kg.

Values are corrected for reagent blank (ca 3 ng/kg and recovery).

Table 52
Contaminant Concentrations (mg/kg) in Carp, Catfish and Walleye Samples from
Saginaw Bay, 1982-1986 (MDA and FDA, unpublished data)

Species	Year	Location ^a	Parameter			
			PCB	DDT	Dieldrin	Chlordane
Carp	1984	Unknown				
		n	24	24	24	24
		value	2.52	0.76	0.03	0.17
		1506				
		n	1			
		value	1.25			
		1507				
		n	1			
		value	1.18			
		1509				
		n	1			
		value	ND			
		1607				
		n	1			
		value	6.78			
		1608				
		n	2			
		value	4.03			
	1985	1509				
		n	9		9	9
		value	1.92		0.01	0.01
		1607				
		n	9 ^b	9		
		value	1.28	0.26		
		Bayport				
		n	4 ^c			
		value	1.56			
Carp	1986	1506				
		n	4	4	4	4
		value	0.22	0.10	ND	0.04

(Continued)

(Sheet 1 of 3)

Table 52. (Continued)

Species	Year	Location ^a	Parameter			
			PCB	DDT	Dieldrin	Chlordane
Catfish		Unknown				
		n	3			
		value	2.97			
	1982	Bayport				
		n	2			
		value	1.84			
	1984	1507				
		n	6		4	
		value	3.42		0.02	
		1509				
Catfish		n	4		1	
		value	3.00		0.04	
		1608				
		n	1			
		value	2.09			
		Unknown				
		n	6	6	6	6
		value	1.55	0.36	0.05	0.08
	1985	1506				
		n	4			
Catfish		value	0.32			
		1509				
		n	9 ^b			
		value	1.92			
	1985	1607				
		n	9	9	9	
		value	1.70	0.28	0.03	
		Unknown				
		n	6			
		value	2.76			
		Bayport				
		n	9			
		value	1.92			

(Continued)

(Sheet 2 of 3)

Table 52. (Concluded)

Species	Year	Location ^a	Parameter			
			PCB	DDT	Dieldrin	Chlordane
	1986	1506				
		n	4	4	4	4
		value	0.32	0.16	0.01	0.09
		1609				
		n	1	1	1	
		value	7.30	0.99	0.03	
		Unknown				
		n	6			
		value	2.76			
		Caseville				
Walleye	1986	n	10	10	10	10
		value	1.61	0.28	0.02	0.03
		Caseville				
		n	10	10	10	10
		value	0.67	0.11	0.01	0.02

^aGrid location^bComposited skin-off fillets^cComposited samples of 6,6,5 and 2 fish

ND = Not detected

Table 53
Coho Salmon Collection Data - 1984 (DeVault et al. 1988)

Each sample represents a five-fish (skin on fillet) composite.

Collection Site and Date	Sample #	Age	Mean Weight (Range) kg	Mean Length (Range) mm	% Lipid
<i>Lake Superior</i>					
Sioux River	1	3	1.13 (0.54-1.65)	508 (381-566)	4.7
	2	3	1.83 (1.75-1.97)	583 (577-594)	4.4
	3	3	2.15 (1.89-2.98)	622 (607-666)	3.4
<i>Lake Huron</i>					
Tawas River	1	3	2.50 (2.20-2.90)	635 (612-658)	3.0
	2	3	3.15 (2.96-3.42)	663 (658-668)	3.4
	3	3	3.51 (2.20-2.90)	680 (671-711)	2.8
<i>Lake Michigan</i>					
Kellogg Creek	1	2-3	1.46 (0.70-1.10)	430 (420-455)	2.2
	2	2-3	1.71 (0.95-2.30)	548 (460-620)	1.6
	3	3	2.38 (2.20-2.60)	657 (630-685)	1.3
St. Joseph River	1	3	2.35 (0.52-3.34)	580 (368-683)	2.5
Thompson Creek	1	3	1.88 (1.50-2.08)	582 (569-589)	1.5
	2	3	2.23 (1.82-2.46)	625 (605-640)	1.5
	3	3	2.60 (2.34-2.78)	653 (640-678)	1.7
Platte River	1	3	2.46 (2.12-2.86)	620 (597-633)	1.6
	2	3	2.46 (2.26-2.58)	642 (640-678)	2.1
	3	3	2.82 (2.17-3.16)	660 (643-691)	2.2
Manistique River	1	3	5.54 (1.58-9.50)	711 (533-997)	0.8
Grand River	1	3	2.26 (2.10-2.46)	592 (572-610)	1.5
	2	3	2.26 (2.40-2.97)	632 (622-635)	1.8
	3	3	2.94 (2.58-3.42)	665 (648-699)	1.9
Trail Creek	1	3	2.19 (1.85-2.64)	595 (564-645)	1.2
	2	3	2.28 (2.04-3.01)	622 (615-660)	1.6
	3	3	2.65 (2.13-2.90)	655 (589-683)	1.2
Sheboygan River	1	3	2.43 (2.05-2.90)	620 (584-660)	1.5
	2	3	2.28 (2.09-2.48)	589 (559-610)	1.2
	3	3	2.78 (2.40-3.11)	625 (610-635)	1.9
<i>Lake Erie</i>					
Trout run	1	3	1.86 (1.59-2.04)	584 (580-610)	1.6
	2	3	2.23 (2.07-2.44)	611 (590-645)	0.8
	3	3	2.63 (2.30-3.00)	645 (620-670)	0.8
Chagrin River	1	3	1.42 (0.88-1.71)	512 (452-546)	3.0
	2	3	1.80 (1.38-2.25)	563 (550-552)	1.7
	3	3	2.55 (1.92-2.87)	623 (609-635)	2.9
Huron River	1	3	1.98 (1.6 -2.6)	590 (541-612)	0.6
	2	3	2.90 (2.6 -3.8)	638 (612-658)	1.4
	3	3	3.30 (3.0 -4.2)	685 (666-730)	2.0
<i>Lake Ontario</i>					
Salmon River	1	3	3.98 (3.40-4.61)	715 (710-722)	1.5
	2	3	4.18 (3.86-5.02)	737 (725-748)	1.6
	3	3	4.97 (4.12-5.38)	764 (740-775)	1.7

Table 55

PCBs and DDT in Saginaw Bay White Suckers (Kononen 1989)

<u>Sampling Period</u>	<u>Sex</u>	<u>Length (cm)</u>	<u>Weight (g)</u>	<u>PCBs (ppm)</u>	<u>DDT (ppm)</u>
FALL	I	27.5	200	0.03	<0.001
	I	32.3	550	0.08	0.001
	M	32.0	400	0.08	0.010
	M	36.3	535	0.01	0.003
	M	40.5	740	0.03	0.010
	M	41.5	660	0.02	0.017
	F	45.8	1145	0.18	0.010
	F	47.9	1220	0.04	0.043
	F	49.7	1150	0.05	0.007
	F	50.5	1115	0.05	0.020
SPRING	I	38.6	580	0.01	0.005
	I	39.6	590	0.06	0.002
	M	31.5	355	0.03	0.016
	M	33.4	350	0.03	0.004
	M	36.8	560	0.04	0.003
	M	40.9	755	0.03	0.033
	M	41.7	830	0.05	0.015
	M	45.2	985	0.03	0.044
	M	45.8	960	0.02	0.007
	M	46.5	940	0.03	0.040
	F	41.9	625	0.01	0.014
	F	44.0	925	0.05	0.012
	F	44.1	1075	0.05	0.007
	F	45.7	1100	0.17	0.030
	F	49.6	1225	0.01	0.010

Table 56
Results of Tier 7 Fish Great Lakes Region (Kuehl 1989)

EPA Region	State	Watershed	Location	Type of Fish	Cut of Sample	Value (mg/L)
<u>Contaminated Sites</u>						
	NY	Lake Ontario	Olcott	Predator	Whole	18.0 (1.4)
				Predator	Fillet	13.0 (1.0)
	NY	Lake Ontario	Rochester Embayment	Predator	Whole	13.0 (0.6)
	NY	Lake Ontario	Wilson	Predator	Fillet	9.0 (0.9)
	OH	Lake Erie	Black River	Bottom feeder	Whole	2.4 (1.0)
	MI	Lake Erie	Detroit River	Bottom feeder	Whole	14.0 (0.8)
	MI	Lake Huron	Rockport	Predator	Fillet	5.0 (1.1)
	MI	Lake Huron	Saginaw Bay	Bottom feeder	Whole	18.0 (0.5)
				Bottom feeder	Fillet	13.2 (0.4)
				Predator	Whole	6.8 (0.1)
				Predator	Fillet	0.7 (0.2)
	MI	Lake Michigan	Saugatuck	Predator	Fillet	4.0 (1.4)
	MI	Lake Ontario	Oswego	Predator	Fillet	41.0 (1.1)
	MI	Lake St. Clair	Michigan	Predator	Fillet	5.8 (0.9)
	WI	Lake Michigan	Menominee River	Bottom feeder	Whole	7.3 (0.7)
				Predator	Whole	1.4 (0.1)
	WI	Lake Michigan	Oconto River	Bottom feeder	Whole	3.6 (0.5)
				Predator	Whole	ND (1.5)
				Predator	Fillet	ND (0.2)
	WI	Lake Michigan	Pestigo River	Bottom feeder	Whole	8.5 (0.6)
				Predator	Whole	1.5 (0.3)
				Predator	Fillet	ND (0.2)
	WI	Lake Superior	Ashland	Bottom feeder	Whole	4.8 (0.4)
	WI	Menominee River Harbor	Marinette	Bottom feeder	Fillet	8.0 (0.1)
	WI	Superior Harbor	Superior	Bottom feeder	Fillet	5.2 (0.7)
				Predator	Whole	5.2 (0.4)
				Predator	Fillet	ND (1.2)
<u>Non-Contaminated Sites (not detected)</u>						
	NY	Lake Ontario	Cape Vincent	Bottom feeder	Whole	ND (1.4)
	PA	Lake Erie	Erie	Bottom feeder	Whole	ND (1.2)
	MI	Lake Superior	Apostle Island	Predator	Fillet	ND (3.1)
	MI	Lake Michigan	Manistique River	Bottom feeder	Whole	ND (0.9)
	OH	Lake Erie	Bass Island	Predator	Whole	ND (1.8)
	OH	Lake Erie	Maumee River	Bottom feeder	Whole	ND (1.5)

Table 57

Benthic Macroinvertebrate Taxa Collected from the Saginaw Bay Navigation
Approach Channel to the Saginaw River, July 1983 (USACE, 1984)

Taxon	Family	Species
Nematoda		
Oligochaeta	Tubificidae	<u>Ilyodrilus</u> <u>templentoni</u>
		<u>Isochaetides</u> <u>freyi</u>
		<u>Limnodrilus</u> <u>cervix</u>
		<u>Limnodrilus</u> <u>hoffmeisteri</u>
		<u>Limnodrilus</u> <u>maumeensis</u>
Diptera	Chironomidae	<u>Chironomus</u> sp.
		<u>Cryptochironomus</u> sp.
		<u>Paracladopelma</u> sp.
		<u>Procladius</u> sp.
		<u>Psectrotanypus</u> sp.
		<u>Tanytarsus</u> sp.
Cladocera	Ceratopogonidae	
Cladocera	Leptodoridae	<u>Leptodora</u> <u>kindti</u>
Coleoptera	Elmidae	<u>Dubiraphia</u> sp.
Pelecypoda	Sphaeriidae	<u>Pisidium</u> sp.

Table 58

Benthic Macroinvertebrates Collected in the Saginaw Bay Navigational Approach
Channel and Their Pollution Tolerance Classification
 (USACE 1984; see Figure 6)

Station	Taxa	Common Name	Count	Pollution Tolerance
SB-1	<u>Tanytarsus</u> sp.	midge	1	tolerant
	<u>Procladius</u> sp.	midge	6	tolerant
	<u>Chironomus</u> sp.	midge	3	tolerant
	<u>Ceratopogonidae</u>	biting midge	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	13	tolerant
	<u>Limnodrilus cervix</u>	worm	20	tolerant
	<u>Limnodrilus maumeensis</u>	worm	7	tolerant
	<u>Ilyodrilus templetoni</u>	worm	5	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	34	tolerant
SB-2	<u>Chironomus</u> sp.	midge	9	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	4	tolerant
	<u>Limnodrilus cervix</u>	worm	3	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	14	tolerant
	Immat. Tubificidae w/ cap. chaetae	worm	4	tolerant
SB-3	<u>Procladius</u> sp.	midge	8	tolerant
	<u>Chironomus</u> sp.	midge	12	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	7	tolerant
	<u>Limnodrilus cervix</u>	worm	2	tolerant
	<u>Limnodrilus maumeensis</u>	worm	1	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	11	tolerant
SB-4	<u>Leptodora kindti</u>	water flea	1	tolerant
	<u>Chironomus</u> sp.	midge	26	tolerant
	<u>Procladius</u> sp.	midge	10	tolerant
	<u>Limnodrilus udekemianus</u>	worm	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	10	tolerant
	<u>Limnodrilus cervix</u>	worm	2	tolerant
	<u>Limnodrilus maumeensis</u>	worm	2	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	9	tolerant
SB-5	Nematoda	roundworm	1	tolerant
	<u>Dubiraphia</u>	riffle beetle	1	tolerant
	<u>Chironomus</u> sp.	midge	79	tolerant
	<u>Procladius</u> sp.	midge	2	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	2	tolerant
	<u>Limnodrilus cervix</u>	worm	7	tolerant
	<u>Limnodrilus maumeensis</u>	worm	1	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	4	tolerant

(Continued)

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Table 58. (Continued)

Station	Taxa	Common Name	Count	Pollution Tolerance
SB-6	Nematoda	roundworm	2	tolerant
	<u>Leptodora kindtii</u>	water flea	2	tolerant
	<u>Paracladopelma</u> sp.	midge	2	tolerant
	<u>Cryptochironomus</u> sp.	midge	1	tolerant
	<u>Chironomus</u> sp.	midge	24	tolerant
	<u>Procladius</u> sp.	midge	1	tolerant
	<u>Tanytarsus</u> sp.	midge	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	4	tolerant
	<u>Isochaetides freyi</u>	worm	3	tolerant
	<u>Limnodrilus cervix</u>	worm	7	tolerant
	<u>Limnodrilus udekemianus</u>	worm	1	tolerant
	<u>Ilyodrilus templetoni</u>	worm	1	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	22	tolerant
SB-7	<u>Chironomus</u> sp.	midge	53	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	4	tolerant
	<u>Limnodrilus maumeensis</u>	worm	15	tolerant
	<u>Limnodrilus cervix</u>	worm	13	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	66	tolerant
	Immat. Tubificidae w/ cap. chaetae	worm	1	tolerant
SB-8	<u>Chironomus</u> sp.	midge	55	tolerant
	<u>Procladius</u> sp.	midge	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	3	tolerant
	<u>Limnodrilus maumeensis</u>	worm	5	tolerant
	<u>Limnodrilus cervix</u>	worm	6	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	65	tolerant
	Immat. Tubificidae w/ cap. chaetae	worm	1	tolerant
SB-9	Nematoda	roundworm	2	tolerant
	<u>Leptodora kindtii</u>	water flea	1	tolerant
	<u>Chironomus</u> sp.	midge	63	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	7	tolerant
	<u>Limnodrilus cervix</u>	worm	7	tolerant
	<u>Limnodrilus maumeensis</u>	worm	7	tolerant
	<u>Ilyodrilus templetoni</u>	worm	2	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	98	tolerant
	Immat. Tubificidae w/ cap. chaetae	worm	10	tolerant
SB-10	Nematoda	roundworm	3	tolerant
	<u>Pisidium</u> sp.	pill clam	2	tolerant
	<u>Chironomus</u> sp.	midge	108	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	4	tolerant
	<u>Limnodrilus cervix</u>	worm	10	tolerant
	<u>Limnodrilus maumeensis</u>	worm	5	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	161	tolerant
	Immat. Tubificidae w/ cap. chaetae	worm	30	tolerant

(Continued)

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Table 58. (Concluded)

Station	Taxa	Common Name	Count	Pollution Tolerance
SB-11	Nematoda	roundworm	3	tolerant
	<u>Leptodora kindti</u>	water flea	1	tolerant
	<u>Chironomus</u> sp.	midge	69	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	3	tolerant
	<u>Limnodrilus cervix</u>	worm	14	tolerant
	<u>Limnodrilus maumeensis</u>	worm	7	tolerant
	<u>Ilyodrilus templetoni</u>	worm	1	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	58	tolerant
	Immat. Tubificidae w/ cap. chaetae	worm	9	tolerant

Table 59

Benthic Macroinvertebrate Taxa Collected from Saginaw Bay in 1956
(Brinkhurst 1967) and 1978 (White et al. unpublished)

Order Family Species	Year	
	1956	1978
Oligochaeta		
Tubificidae		
<u>Aulodrilus americanus</u>	X	
<u>Aulodrilus limnobius</u>	X	
<u>Aulodrilus piqueti</u>	X	X
<u>Aulodrilus pluriseta</u>	X	X
<u>Ilyodrilus templetoni</u>	X	X
<u>Isochaetides freyi</u>	X	
<u>Limnodrilus angustipenis</u>	X	
<u>Limnodrilus cervix</u>	X	X
<u>Limnodrilus claparedeianus</u>	X	X
<u>Limnodrilus hoffmeisteri</u>	X	X
<u>Limnodrilus maumeensis</u>	X	X
<u>Limnodrilus udekemianus</u>	X	
<u>Potamothrrix bedoti</u>		X
<u>Potamothrrix moldaviensis</u>	X	X
<u>Potamothrrix vej dovski</u>	X	X
<u>Quistadrilus multisetosus longidentus</u>	X	X
<u>Quistadrilus multisetosus multisetosus</u>	X	X
<u>Spirosperma ferox</u>	X	
<u>Rhyacodrilus montana</u>	X	
<u>Tubifex tubifex</u>	X	X
Naididae		
<u>Amphichaeta leydigi</u>		X
<u>Arcteonais lomondi</u>	X	X
<u>Cheatogaster diaphanus</u>		X
<u>Cheatogaster setosus</u>		X
<u>Dero digitata</u>	X	X
<u>Nais communis</u>		X
<u>Nais elinquis</u>	X	
<u>Nais simplex</u>		X
<u>Ophidonais serpentina</u>	X	X
<u>Paranais litoralis</u>	X	
<u>Piguetiella mighiganensis</u>		X
<u>Specaria josinae</u>		X
<u>Stylaria lacustris</u>	X	
<u>Uncinaiis uncinata</u>	X	X
<u>Vejdovskyella intermedia</u>		X
Diptera		
Chironomidae		
<u>Chironomus anthracinus</u>		X
<u>Chironomus plumosus semireductus</u>		X
<u>Cryptochironomus fulvus</u>		X
<u>Procladius sp.</u>		X
<u>Psectrotanypus sp.</u>		X

Table 60

Benthic Macroinvertebrate Taxa Collected from the Saginaw River,
July 1983 (USACE 1984)

Taxon	Family	Species
Nematoda		
Oligochaeta	Tubificidae	<u>Aulodrilus piqueti</u>
		<u>Ilyodrilus templetoni</u>
		<u>Limnodrilus cervix</u>
		<u>Limnodrilus hoffmeisteri</u>
		<u>Limnodrilus maumeensis</u>
		<u>Limnodrilus udekemianus</u>
		<u>Ouistadrilus multisetosus</u>
		<u>Spirosperma ferox</u>
	Naidiae	<u>Arcteonais lomondi</u>
		<u>Dero digitata</u>
Diptera	Chironomidae	<u>Chironomus</u> sp.
		<u>Cricotopus</u> sp.
		<u>Cryptochironomus</u> sp.
		<u>Glyptotendipes</u> sp.
		<u>Procladius</u> sp.
	Chaoboridae	<u>Chaoborus</u> sp.
	Ceratopogonidae	
Cladocera	Leptodoridae	<u>Leptodor kindti</u>
Coleoptera	Elmidae	<u>Dubiraphia</u> sp.
Isopoda	Asellidae	<u>Asellus</u> sp.
Pelecypoda	Sphaeriidae	<u>Sphaeridium</u> sp.

Table 61
Benthic Macroinvertebrates Collected in the Saginaw River and Their
Pollution Tolerance Classification (USACE 1984; see
Figures 17a and 17b)

Station	Taxa	Common Name	Count	Pollution Tolerance
SR-1	<u>Procladius</u> sp.	midge	2	tolerant
	<u>Dero digitata</u>	worm	2	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	8	tolerant
	<u>Limnodrilus cervix</u>	worm	6	tolerant
	<u>Limnodrilus maumeensis</u>	worm	6	tolerant
	<u>Limnodrilus udekemianus</u>	worm	1	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	30	tolerant
	Immat. Tubificidae w cap. chaetae	worm	3	tolerant
SR-2	<u>Procladius</u> sp.	midge	1	tolerant
	<u>Dero digitata</u>	worm	2	tolerant
	<u>Quistadrilus multisetosus</u>	worm	1	tolerant
	<u>Limnodrilus maumeensis</u>	worm	8	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	6	tolerant
	<u>Limnodrilus cervix</u>	worm	16	tolerant
	<u>Ilyodrilus templetoni</u>	worm	4	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	17	tolerant
	Immat. Tubificidae w cap. chaetae	worm	1	tolerant
SR-3A	<u>Limnodrilus hoffmeisteri</u>	worm	3	tolerant
	<u>Limnodrilus cervix</u>	worm	6	tolerant
SR-3	<u>Procladius</u> sp.	midge	1	tolerant
	<u>Cricotopus</u> sp.	midge	1	tolerant
	<u>Chaoborus</u> sp.	phantom midge	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	12	tolerant
	<u>Limnodrilus maumeensis</u>	worm	9	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	7	tolerant
SR-4	<u>Limnodrilus hoffmeisteri</u>	worm	7	tolerant
	<u>Limnodrilus cervix</u>	worm	5	tolerant
	<u>Limnodrilus maumeensis</u>	worm	10	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	24	tolerant
	Immat. Tubificidae w cap. chaetae	worm	1	tolerant
SR-5	<u>Cricotopus</u> sp.	midge	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	9	tolerant
	<u>Limnodrilus cervix</u>	worm	6	tolerant
	<u>Limnodrilus maumeensis</u>	worm	5	tolerant
	<u>Ilyodrilus templetoni</u>	worm	3	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	21	tolerant

(Continued)

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Table 61. (Continued)

Station	Taxa	Common Name	Count	Pollution Tolerance
SR-6	<u>Glyptotendipes</u> sp.	midge	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	2	tolerant
	<u>Limnodrilus cervix</u>	worm	5	tolerant
	<u>Limnodrilus maumeensis</u>	worm	1	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	8	tolerant
	Immat. Tubificidae w cap. chaetae	worm	1	tolerant
SR-7A	<u>Limnodrilus hoffmeisteri</u>	worm	3	tolerant
	<u>Limnodrilus cervix</u>	worm	7	tolerant
	<u>Limnodrilus maumeensis</u>	worm	13	tolerant
	<u>Ilyodrilus templetoni</u>	worm	2	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	37	tolerant
SR-7	<u>Chaoborus</u> sp.	phantom midge	2	tolerant
	<u>Procladius</u> sp.	midge	1	tolerant
	<u>Quistadrilus multisetosus</u>	worm	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	4	tolerant
	<u>Limnodrilus cervix</u>	worm	3	tolerant
	<u>Limnodrilus maumeensis</u>	worm	2	tolerant
	<u>Ilyodrilus templetoni</u>	worm	1	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	15	tolerant
SR-8	<u>Dero digitata</u>	worm	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	5	tolerant
	<u>Limnodrilus cervix</u>	worm	1	tolerant
	<u>Limnodrilus maumeensis</u>	worm	3	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	6	tolerant
SR-9	<u>Limnodrilus hoffmeisteri</u>	worm	1	tolerant
	<u>Aulodrilus pigueti</u>	worm	1	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	6	tolerant
SR-10	<u>Procladius</u> sp.	midge	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	2	tolerant
	<u>Limnodrilus cervix</u>	worm	3	tolerant
	<u>Limnodrilus maumeensis</u>	worm	2	tolerant
	<u>Ilyodrilus templetoni</u>	worm	1	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	11	tolerant
SR-11	<u>Procladius</u> sp.	midge	4	tolerant
	<u>Chironomus</u> sp.	midge	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	1	tolerant
	<u>Limnodrilus cervix</u>	worm	2	tolerant
	<u>Limnodrilus maumeensis</u>	worm	3	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	14	tolerant

(Continued)

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Table 61. (Continued)

Station	Taxa	Common Name	Count	Pollution Tolerance
SR-12	<u>Procladius</u> sp.	midge	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	4	tolerant
	<u>Limnodrilus cervix</u>	worm	3	tolerant
	<u>Limnodrilus maumeensis</u>	worm	8	tolerant
	<u>Ilyodrilus templetoni</u>	worm	1	tolerant
	Immat. Tubificidae w/p cap. chaetae	worm	15	tolerant
SR-13	<u>Leptodora kindti</u>	water flea	1	tolerant
	Ceratopogonidae	biting midge	3	tolerant
	<u>Procladius</u> sp.	midge	2	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	3	tolerant
	<u>Limnodrilus cervix</u>	worm	4	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	20	tolerant
SR-14	<u>Procladius</u> sp.	midge	4	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	9	tolerant
	<u>Limnodrilus cervix</u>	worm	2	tolerant
	<u>Limnodrilus maumeensis</u>	worm	1	tolerant
	<u>Ilyodrilus templetoni</u>	worm	1	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	22	tolerant
SR-15	<u>Sphaerium</u> sp.	pill clam	1	tolerant
	<u>Leptodora kindti</u>	water flea	1	tolerant
	Ceratopogonidae	biting midge	1	tolerant
	<u>Procladius</u> sp.	midge	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	11	tolerant
	<u>Limnodrilus cervix</u>	worm	17	tolerant
	<u>Ilyodrilus templetoni</u>	worm	1	tolerant
	Immat. Tubificidae w/p cap. chaetae	worm	35	tolerant
SR-16	<u>Leptodora kindti</u>	water flea	1	tolerant
	<u>Procladius</u> sp.	midge	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	2	tolerant
	<u>Limnodrilus cervix</u>	worm	9	tolerant
	<u>Limnodrilus maumeensis</u>	worm	2	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	42	tolerant
SR-17	<u>Asellus</u> sp.	sow bug	1	tolerant
	<u>Procladius</u> sp.	midge	6	tolerant
	<u>Dero digitata</u>	worm	7	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	2	tolerant
	<u>Limnodrilus cervix</u>	worm	3	tolerant
	<u>Limnodrilus maumeensis</u>	worm	4	tolerant
	<u>Ilyodrilus templetoni</u>	worm	3	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	29	tolerant
	Immat. Tubificidae w cap. chaetae	worm	2	tolerant

(Continued)

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Table 61. (Continued)

Station	Taxa	Common Name	Count	Pollution Tolerance
SR-18	<u>Ceratopogonidae</u>	biting midge	1	tolerant
	<u>Procladius</u> sp.	midge	1	tolerant
	<u>Cricotopus</u> sp.	midge	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	1	tolerant
	<u>Limnodrilus cervix</u>	worm	11	tolerant
	<u>Limnodrilus maumeensis</u>	worm	6	tolerant
	<u>Limnodrilus udekemianus</u>	worm	1	tolerant
	<u>Ilyodrilus templetoni</u>	worm	1	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	64	tolerant
SR-19	Immat. Tubificidae w/ cap. chaetae	worm	1	tolerant
	<u>Asellus</u> sp.	sow bug	2	tolerant
	<u>Procladius</u> sp.	midge	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	2	tolerant
	<u>Limnodrilus cervix</u>	worm	18	tolerant
	<u>Limnodrilus maumeensis</u>	worm	7	tolerant
	<u>Limnodrilus udekemianus</u>	worm	1	tolerant
	<u>Ilyodrilus templetoni</u>	worm	2	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	63	tolerant
SR-20	Immat. Tubificidae w/ cap. chaetae	worm	1	tolerant
	<u>Procladius</u> sp.	midge	4	tolerant
	<u>Dero digitata</u>	worm	2	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	5	tolerant
	<u>Limnodrilus cervix</u>	worm	6	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	65	tolerant
SR-21	Immat. Tubificidae w/ cap. chaetae	worm	1	tolerant
	<u>Limnodrilus cervix</u>	worm	5	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	10	tolerant
SR-22	Immat. Tubificidae w/ cap. chaetae	worm	1	tolerant
	<u>Leptodora kindti</u>	water flea	1	tolerant
	<u>Procladius</u> sp.	midge	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	4	tolerant
	<u>Limnodrilus cervix</u>	worm	13	tolerant
	<u>Limnodrilus maumeensis</u>	worm	1	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	21	tolerant
	Immat. Tubificidae w/ cap. chaetae	worm	1	tolerant
SR-23	Nematoda	roundworm	1	tolerant
	<u>Procladius</u> sp.	midge	3	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	8	tolerant
	<u>Limnodrilus cervix</u>	worm	13	tolerant

(Continued)

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Table 61. (Continued)

Station	Taxa	Common Name	Count	Pollution Tolerance
SR-23	<u>Limnodrilus maumeensis</u>	worm	15	tolerant
Cont.	<u>Ilyodrilus templetoni</u>	worm	1	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	48	tolerant
	Immat. Tubificidae w/ cap. chaetae	worm	4	tolerant
SR-24	<u>Dero digitata</u>	worm	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	3	tolerant
	<u>Limnodrilus cervix</u>	worm	16	tolerant
	<u>Limnodrilus maumeensis</u>	worm	5	tolerant
	<u>Ilyodrilus templetoni</u>	worm	2	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	10	tolerant
	Immat. Tubificidae w/ cap. chaetae	worm	1	tolerant
SR-25	Ceratopogonidae	biting midge	1	tolerant
	Procladius sp.	midge	4	tolerant
	<u>Dero digitata</u>	worm	3	tolerant
	<u>Quistadrilus multisetosus</u>	worm	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	9	tolerant
	<u>Limnodrilus cervix</u>	worm	8	tolerant
	<u>Limnodrilus maumeensis</u>	worm	7	tolerant
	<u>Ilyodrilus templetoni</u>	worm	5	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	33	tolerant
	Immat. Tubificidae w/ cap. chaetae	worm	1	tolerant
SR-26	Nematoda	roundworm	1	tolerant
	Procladius sp.	midge	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	8	tolerant
	<u>Limnodrilus cervix</u>	worm	7	tolerant
	<u>Limnodrilus maumeensis</u>	worm	5	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	21	tolerant
	Immat. Tubificidae w/ cap. chaetae	worm	1	tolerant
SR-27	Procladius sp.	midge	7	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	11	tolerant
	<u>Limnodrilus cervix</u>	worm	12	tolerant
	<u>Ilyodrilus templetoni</u>	worm	1	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	30	tolerant
	Immat. Tubificidae w/cap. chaetae	worm	4	tolerant
SR-28	<u>Asellus sp.</u>	sow bug	1	tolerant
	<u>Dero digitata</u>	worm	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	10	tolerant
	<u>Limnodrilus cervix</u>	worm	45	tolerant
	<u>Limnodrilus maumeensis</u>	worm	4	tolerant
	<u>Ilyodrilus templetoni</u>	worm	3	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	29	tolerant
	Immat. Tubificidae w/ cap. chaetae	worm	2	tolerant

(Continued)

(Sheet 5 of 7)

Table 61. (Continued)

Station	Taxa	Common Name	Count	Pollution Tolerance
SR-29	<u>Asellus sp.</u>	sowbug	1	tolerant
	<u>Procladius sp.</u>	midge	2	tolerant
	<u>Dero digitata</u>	worm	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	6	tolerant
	<u>Limnodrilus cervix</u>	worm	13	tolerant
	<u>Limnodrilus maumeensis</u>	worm	4	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	68	tolerant
SR-30	<u>Dubiraphia sp.</u>	riffle beetle	2	tolerant
	<u>Procladius sp.</u>	midge	3	tolerant
	<u>Dero digitata</u>	worm	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	12	tolerant
	<u>Limnodrilus cervix</u>	worm	21	tolerant
	<u>Limnodrilus maumeensis</u>	worm	3	tolerant
	<u>Ilyodrilus templetoni</u>	worm	9	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	32	tolerant
SR-31	<u>Cryptochironomus sp.</u>	midge	1	tolerant
	<u>Procladius sp.</u>	midge	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	1	tolerant
	<u>Limnodrilus cervix</u>	worm	8	tolerant
	<u>Limnodrilus maumeensis</u>	worm	6	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	16	tolerant
SR-32	<u>Ceratopogonidae</u>	biting midge	2	tolerant
	<u>Procladius sp.</u>	midge	2	tolerant
	<u>Dero digitata</u>	worm	4	tolerant
	<u>Limnodrilus claparadianus</u>	worm	1	tolerant
	<u>Limnodrilus cervix</u>	worm	3	tolerant
	<u>Limnodrilus maumeensis</u>	worm	2	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	4	tolerant
	<u>Ilyodrilus templetoni</u>	worm	2	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	5	tolerant
	Immat. Tubificidae w cap. chaetae	worm	1	tolerant
SR-33	<u>Hyaella azteca</u>	scud	1	tolerant
	<u>Procladius sp.</u>	midge	3	tolerant
	<u>Quistadrilus multisetosus</u>	worm	2	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	6	tolerant
	<u>Limnodrilus cervix</u>	worm	15	tolerant
	<u>Limnodrilus maumeensis</u>	worm	4	tolerant
	<u>Ilyodrilus templetoni</u>	worm	4	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	31	tolerant
	Immat. Tubificidae w/ cap. chaetae	worm	1	tolerant

(Continued)

(Sheet 6 of 7)

Table 61. (Concluded)

Station	Taxa	Common Name	Count	Pollution Tolerance
SR-34	<u>Leptodora kindti</u>	water flea	1	tolerant
	<u>Ceratopogonidae</u>	biting midge	2	tolerant
	<u>Procladius</u> sp.	midge	2	tolerant
	<u>Chironomus</u> sp.	midge	1	tolerant
	<u>Spirosperma ferox</u>	worm	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	9	tolerant
	<u>Limnodrilus cervix</u>	worm	8	tolerant
	<u>Limnodrilus maumeensis</u>	worm	2	tolerant
	<u>Ilyodrilus templetoni</u>	worm	1	tolerant
	Immat. Tubificidae w/o cap. chaetae	worm	27	tolerant
SR-35	<u>Leptodora kindti</u>	water flea	5	tolerant
	<u>Procladius</u> sp.	midge	8	tolerant
	<u>Arcteonais lomondi</u>	worm	1	tolerant
	<u>Dero digitata</u>	worm	1	tolerant
	<u>Limnodrilus hoffmeisteri</u>	worm	11	tolerant
	<u>Limnodrilus cervix</u>	worm	17	tolerant
	<u>Limnodrilus udekemianus</u>	worm	2	tolerant
	<u>Ilyodrilus templetoni</u>	worm	1	tolerant
	Immat. Tubificidae w/o ca. chaetae	worm	98	tolerant
	Immat. Tubificidae w/ cap. chaetae	worm	2	tolerant

Table 62a

Seasonal Phytoplankton Concentrations (mg/l dry weight) in Saginaw Bay
Segment 2, and Number of Annual Odor Days and Maximum Odor Value,
1974-1976 and 1980 (Dolan et al. 1986)

Parameter	Year							
	1974		1975		1976		1980	
	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Peak Total Algal	8.0	2.47	9.87	4.42	19.6	3.32	0.630	1.39
Peak Diatom	7.62	0.921	9.64	3.66	19.1	1.97	0.541	1.30
Peak Total Bluegreen	0.217	1.29	0.387	0.863	0.066	0.59	0.043	0.027
Percent Bluegreen During Bluegreen Peak	15.0	63.4	25.4	27.9	0.49	19.2	8.04	5.46
Ratio of Bluegreen Peak to Total Algal Peak (%)	2.71	52.2	3.93	19.5	0.34	17.7	6.82	1.94
Number of Annual Odor Days (Odor >3)	56		22		9		0	

Table 62b

Abundance (Mean Number of Individuals/Liter) of Selected Rotifers and Mean Surface Values of Selected Physiochemical Variables in Groups of Stations Identified by Cluster Analysis, 1974 (Gannon 1981)

Topic	Groups			
	I	II	III	IV
Species				
<u>Brachionus</u> spp.*	140	20	<1	<1
<u>Keratella cochlearis</u> f. <u>tecta</u> *	170	13	1	<1
<u>Conochiloides dossuarius</u>	150	4	0	0
<u>Filinia longiseta</u> *	34	273	70	12
<u>Pompholyx sulcata</u> *	11	126	14	7
<u>Polyartra vulgaris</u>	294	528	132	51
<u>Keratella cochlearis</u>	193	154	102	51
<u>Conochilus unicornis</u>	<1	19	17	27
<u>Kellicottia longispina</u>	0	2	11	25
<u>Notholca</u> spp.**	0	0	<1	2
Total rotifers	1,144	1,972	626	312
Physicochemical Variables				
Secchi disc (m)	0.4	1.2	4.1	8.3
Temperature (°C)	23.5	23.3	20.7	19.0
Chlorophyll <u>a</u> (ug/l)	57.1	18.8	2.4	0.6
Specific conductance (umhos/cm)	636.0	277.0	228.0	210.0
Dissolved phosphorus (ug/l)	58.5	6.2	5.7	5.2
Ammonia-nitrogen (ug/l)	121.0	53.0	41.0	10.0
Chloride (ug/l)	119.0	24.4	11.9	6.3
Nc. Stations/Group	4	17	30	27

* Eutrophic indicator species

** Cold water stenothermic species

Table 63

Abundance (percent composition) of Selected Crustacean Plankters and Mean
Surface Values of Selected Limnological Variables in Groups of Saginaw
Bay Stations Identified by Cluster Analysis, October 6-8, 1974
(Gannon 1981)

Topic	I	II	III	IV	V
Taxon					
<u>Acanthocyclops vernalis</u>	4.7	0.7	3.8	0.3	2.1
<u>Diacyclops bicuspidatus thomasi</u>	0.4	0.2	0.4	0.1	2.4
<u>Bosmina longirostris</u>	6.2	2.2	0.8	4.1	4.1
<u>Eubosmina coregoni</u>	32.5	53.1	63.1	44.7	30.2
<u>Daphnia retrocurva</u>	2	2.7	9.1	2.4	5.0
<u>Eurytemora affinis</u>	0.5	1.6	0.9	2.4	0.5
<u>Diaptomid copepodids</u>	1.2	0.5	1.1	1.3	13
 Limnological Variables					
Chlorophyll a (ug/l)	34.1	31.3	33.0	26.2	6.8
Spec. cond. (umhos/cm)	846	270	273	225	206
Total phosphorus (ug/l)	235	40	34	30	13
No. Stations/Group	2	9	4	5	6

Table 64a
Organochlorine Residue Levels (mg/kg) in Herring Gull Eggs, Channel/Shelter
Island, 1980-1982, and Little Charity Island, 1980, Saginaw Bay
(Struger et al. 1985)

Compound	Channel/Shelter Island			Little Charity Island
	1980	1981	1982	1980
2,3,7,8-TCDD [*]				
egg	86 ^a 86.0 ^c	141 ^b		43 ^c
muscle	80.0 ^a			
PCB	70 69.6 ^c	65 64.1 ^{a,c}	72	41.9 ^c
DDE	8.9 8.9 ^c	7.3 7.18 ^d	8.1	6.4 ^c
DDD		0.22	0.08	
DDT		0.05	0.04	
Dieldrin		0.18 0.17 ^d	0.32	
Mirex	0.20 0.19 ^c	0.06 0.08 ^d	0.23	0.08 ^c
Photomirex		0.03 ^d		
Chlordane		0.14 ^d		
Oxychlordane		0.12 0.12 ^d	0.24	
Alpha-Chlordane		0.16	0.02	
Gamma-Chlordane		0.05	0.04	

^{*} (ng/kg)

^aNorstrom et al., 1982.

^bStalling et al., 1985.

^cKreis and Rice, 1985.

^dEllenton et al., 1985.

Table 64b

Lipid and Contaminant Levels in Herring Gull Eggs From Annual Monitor
Colonies on the Great Lakes, 1980, 1985-1988 (Great Lakes Water
Quality Board Report to the International Joint Commission, 1989)

YEAR	N	% LIPID	DOE	DIELDRIN	MIREX	HCB	PCBs	2,3,7,8-TCDD
1. SNAKE ISLAND, LAKE ONTARIO								
1980	10	7.9 (0.61)	7.1 (4.1)	0.20 (0.09)	1.6 (0.77)	0.15 (0.08)	53 (24)	185 *
1985	10	9.2 (0.66)	7.2 (3.0)	0.18 (0.05)	1.7 (0.63)	0.07 (0.02)	35 (15)	67
1986	10	7.5 (0.84)	4.7 (2.2)	0.18 (0.11)	1.2 (0.42)	0.07 (0.02)	29 (9.2)	65
1987	1	8.9	2.9	0.15	0.86	0.05	17	80
1988	1	8.9	5.2	0.18	0.94	0.09	27	47
2. MUGG'S ISLAND, LAKE ONTARIO								
1980	9	7.6 (0.8)	8.2 (5.8)	0.10 (0.10)	1.72 (1.10)	0.20 (0.10)	60 (29)	-
1985	10	9.1 (0.7)	4.9 (1.3)	0.13 (0.03)	1.30 (0.56)	0.06 (0.03)	37 (9)	39
1986	10	8.1 (1.2)	4.0 (1.0)	0.14 (0.04)	0.98 (0.29)	0.07 (0.02)	25 (5.5)	49
1987	1	9.0	2.3	0.11	0.50	0.03	16	45
1988	1	8.6	3.3	0.12	0.69	0.05	20	40
3. NIAGARA RIVER								
1979	10	8.7 (0.51)	4.0 (1.3)	0.20 (0.08)	0.49 (0.24)	0.17 (0.05)	50 (23)	87 *
1985	10	9.2 (0.79)	4.1 (1.1)	0.20 (0.05)	0.59 (0.31)	0.05 (0.01)	29 (11)	41
1986	10	8.4 (0.50)	2.7 (1.0)	0.17 (0.07)	0.36 (0.14)	0.06 (0.02)	23 (11)	40
1987	1	8.9	1.5	0.14	0.24	0.03	13	23
1988	1	7.8	1.7	0.17	0.21	0.04	12	12
4. PORT COLBORNE, LAKE ERIE								
1980	9	7.6 (0.47)	3.4 (1.5)	0.27 (0.13)	0.28 (0.18)	0.08 (0.02)	38 (16)	-
1985	10	9.2 (0.61)	3.6 (1.1)	0.16 (0.06)	0.24 (0.08)	0.05 (0.01)	30 (13)	17
1986	1	7.6	3.2	0.20	0.25	0.05	24	32
1987	10	9.6 (1.3)	1.7 (0.95)	0.14 (0.06)	0.21 (0.17)	0.03 (0.01)	16 (5.6)	15
1988	1	8.5	1.9	0.18	0.18	0.03	18	17
5. MIDDLE ISLAND, LAKE ERIE								
1980	10	7.1 (1.0)	2.6 (0.66)	0.16 (0.06)	0.07 (0.07)	0.09 (0.02)	54 (12)	25 *
1985	10	9.0 (0.87)	2.0 (0.57)	0.22 (0.06)	0.05 (0.02)	0.07 (0.01)	47 (10)	15
1986	1	7.7	2.3	0.26	0.03	0.06	43	16
1987	10	8.7 (1.2)	1.7 (0.47)	0.14 (0.11)	0.01 (0.01)	0.04 (0.01)	28 (6.3)	21
1988	1	7.3	2.2	0.17	0.03	0.06	37	12
6. FIGHTING ISLAND, DETROIT RIVER								
1980	10	9.0 (0.76)	6.8 (1.9)	0.16 (0.08)	0.12 (0.06)	0.37 (0.09)	133 (44)	49 *
1985	10	8.6 (1.38)	3.5 (2.2)	0.15 (0.09)	0.37 (0.05)	0.10 (0.03)	48 (17)	23
1986	1	6.7	2.4	0.09	0.11	0.06	41	16
1987	10	8.0 (0.95)	2.2 (0.84)	0.09 (0.03)	0.04 (0.04)	0.06 (0.02)	34 (9.0)	14
1988	1	7.6	3.2	0.15	0.04	0.09	61	20
7. CHANTRY ISLAND, LAKE HURON								
1980	10	9.4 (0.71)	2.8 (1.4)	0.23 (0.07)	0.16 (0.16)	0.08 (0.03)	23 (15)	45 *
1985	10	9.0 (0.75)	2.5 (1.3)	0.29 (0.08)	0.14 (0.13)	0.05 (0.01)	14 (10)	24
1986	1	8.0	2.0	0.24	0.13	0.05	12	22
1987	1	9.0	1.0	0.10	0.11	0.02	7.7	14
1988	13	8.7 (0.36)	1.1 (0.69)	0.21 (0.05)	0.07 (0.07)	0.04 (0.02)	8.0 (11)	14

(Continued)

(Sheet 1 of 2)

Table 64b. (Concluded)

YEAR	N	% LIPID	DDE	DIELDRIN	MIREX	HCB	PCBs	2,3,7,8-TCDD
8. DOUBLE ISLAND, LAKE HURON								
1980	10	9.1 (1.5)	2.6 (1.3)	0.23 (0.18)	0.06 (0.05)	0.06 (0.02)	17 (7.7)	-
1985	10	9.5 (0.58)	3.1 (1.4)	0.32 (0.19)	0.29 (0.38)	0.07 (0.02)	20 (5.8)	37
1986	1	8.3	2.1	0.17	0.11	0.04	12	31
1987	1	8.6	1.6	0.33	0.06	0.02	9.0	27
1988	13	8.4 (0.58)	1.7 (0.76)	0.24 (0.11)	0.07 (0.08)	0.04 (0.01)	9.3 (2.3)	19
9. CHANNEL/SHELTER ISLAND, LAKE HURON								
1980	10	8.9 (0.53)	8.9 (3.8)	0.18 (0.08)	0.20 (0.28)	0.19 (0.06)	70 (23)	155 *
1985	10	8.8 (0.53)	4.8 (1.4)	0.21 (0.08)	0.08 (0.12)	0.09 (0.02)	48 (15)	-
1986	1	7.9	6.0	0.18	0.13	0.07	46	88
1987	1	9.6	4.0	0.19	0.05	0.07	31	137
1988	16	9.1 (1.1)	4.5	0.19 (0.08)	0.09 (0.12)	0.08 (0.02)	38 (13)	86
10. BIG SISTER ISLAND, LAKE MICHIGAN								
1980	10	8.3 (0.98)	11 (2.6)	0.65 (0.22)	0.07 (0.04)	0.08 (0.02)	57 (12)	24
1985	10	9.9 (0.34)	7.9 (7.4)	0.54 (0.15)	0.18 (0.47)	0.05 (0.03)	37 (37)	14
1986	1	10	7.1	0.28	0.05	0.07	27	17
1987	1	10	12	0.85	0.10	0.07	45	-
1988	1	9.3	-	-	-	-	-	10
11. GULL ISLAND, LAKE MICHIGAN								
1980	10	8.5 (0.93)	13 (6.5)	0.75 (0.34)	0.14 (0.13)	0.10 (0.03)	59 (23)	58 *
1985	9	9.6 (0.81)	5.9 (1.6)	0.40 (0.14)	0.04 (0.03)	0.05 (0.01)	27 (7)	12
1986	1	7.9	7.9	0.49	0.09	0.08	28	-
1987	1	9.2	4.0	0.33	0.06	0.04	17	17
1988	1	9.3	6.1	0.55	0.04	0.06	22	14
12. AGAWA ROCK, LAKE SUPERIOR								
1980	10	8.3 (0.71)	3.7 (3.5)	0.35 (0.21)	0.17 (0.11)	0.08 (0.02)	24 (12)	79 *
1985	10	9.7 (0.78)	3.0 (0.7)	0.36 (0.12)	0.12 (0.13)	0.05 (0.01)	12 (3)	16
1986	1	7.8	3.1	0.32	0.12	0.05	14	28
1987	1	9.2	2.2	0.13	0.16	0.04	11	37
1988	1	9.6	2.7	0.37	0.09	0.05	11	19
13. GRANITE ISLAND, LAKE SUPERIOR								
1980	10	6.9 (1.1)	3.6 (0.99)	0.33 (0.11)	0.09 (0.11)	0.08 (0.03)	27 (9.3)	-
1985	10	9.4 (0.5)	3.3 (1.84)	0.28 (0.10)	0.09 (0.04)	0.06 (0.02)	20 (8.7)	19
1986	1	7.4	3.3	0.37	0.09	0.05	14	-
1987	1	8.9	2.9	0.26	0.03	0.04	13	-
1988	1	9.0	3.2	0.31	0.03	0.05	16	16

*1981.

Figures followed by numbers in () are means and (standard deviations), N = 8-11.

Numbers not followed by () are results of single analyses of colony egg pools (N = 8-11). N may differ for 2,3,7,8-TCDD.

All contaminant values (except 2,3,7,8-TCDD) are in mg/kg (wet weight). 2,3,7,8-TCDD is in ng/kg. 2,3,7,8-TCDD data are from Reference (57).

Table 65

Geometric Means, Ranges and Numbers of Eggs with Quantifiable Residues of Organic and Inorganic Contaminants (mg/kg) in Common Tern Eggs Collected From Three Subcolonies

Nesting in Saginaw Bay, 1984 (USFWS, unpublished)

Compound	SB-1 (N = 12)			SB-2 (N = 15) ^a			SB-3 (N = 12)		
	$\bar{x}$	range	n	$\bar{x}$	range	n	$\bar{x}$	range	n
P,p'-DDE	2.1	1.4 - 3.3	12	1.7	0.6 - 3.4	15	1.7	1.1 - 3.8	12
P,p'-DDD	nq	nq - 0.14	1	nq	nq - 0.17	4	nq	nq - 0.23	1
P,p'-DDT	nq	nq	0	nq	nq	0	nq	nq	0
Dieldrin	0.15	0.10- 0.29	12	0.10	nq - 0.38	10	0.08	nq - 0.19	6
Heptachlor epoxide	nq	nq	0	nq	nq - 0.11	1	nq	nq	0
Oxychlorthane	nq	nq - 0.11	3	nq	nq - 0.17	6	nq	nq - 0.15	2
cis-Chlordane	nq	nq	0	nq	nq - 0.17	2	nq	nq - 0.15	3
trans-Nonachlor	nq	nq - 0.11	1	nq	nq - 0.17	2	nq	nq - 0.35	2
cis-Nonachlor	nq	nq	0	nq	nq - 0.11	2	nq	nq - 0.11	2
Endrin	nq	nq	0	nq	nq	0	nq	nq	0
Toxaphene (estimated)	0.08	nq - 0.24	6	0.08	nq - 0.25	7	nq	nq - 0.44	4
PCBs (estimated/1260)	9.8	5.0 -14.2	12	10.9	5.4 -23.9	15	9.5	5.8 -23.3	12
Mercury	0.40	0.25- 0.66	12	0.30	0.14- 0.47	14	0.33	0.12- 1.87	12
Selenium	0.72	0.46- 0.85	12	0.65	0.37- 1.87	15	0.71	0.40- 0.93	12

^aTotal of 14 samples analyzed for mercury

nq = not quantifiable

Table 66
Total PCB and DDE Concentrations (mg/kg) in Mallard Carcasses After 0, 10,
25, 44, 84 and 86 Days of Exposure on the Channel/Shelter Island
Confined Disposal Facility, Saginaw Bay
(USFWS, unpublished)

Parameter	Days of Exposure					
	Control	10	25	44	84	86
n	4	4	3	4	3	4
PCB	ND	0.17	1.4	2.6	2.0	1.7
	ND	0.35	1.1	4.2	1.76	6.11
	ND	0.38	0.75	2.5	0.62	1.9
	ND	0.44	-	3.9	-	3.31
	mean	-	0.34	1.08	1.44	3.25
DDE	0.01	0.02	0.06	0.11	0.15	0.27
	0.02	0.03	0.10	0.19	0.14	0.60 ^a
	0.01	0.01	0.08	0.13	0.05	0.18
	0.01	0.03	-	0.16	-	0.34
	mean	0.01	0.02	0.08	0.11	0.35

^aConfirmed by GC/Mass Spectrometry

ND = None Detected

Table 67

Chemicals Found in the Great Lakes Which May Have Adverse Impacts on
Human Health in the Event of High Local Contamination* (IJC 1983)

Extremely toxic chemicals (LD₅₀ 50 mg/kg)

Aldrin
 Carbofuran
 Dieldrin
 2,3,7,8-Tetrachlorodibenzodioxin (2,3,7,8-TCDD)
 Endosulfan
 Endrin
 Ethion
 Methyl mercury (chloride)
 Oxychlordane
 Toxaphene
 1,1,2-Trichloro- 1,2,2-trifluoroethane

Very toxic chemicals (LD₅₀ 50-500 mg oral/kg)

aniline
 Bromochloroethane
 Carbon disulphide
 Chlordane
 2-Chloroaniline
 4-Chloroaniline
 O-Cresol
 DDT
 Diazinon
 1,2-Dibromoethane
 1,2-Dichlorobutadiene
 2,4-Dichlorophenoxyacetic acid (2,4-d)
 1,3-Dichloropropene
 2,3-Dichloroprpoene
 Diphenylamine
 N-Ethylaniline
 Furfural
 a-Hexachlorocyclohexzne
 y-Hexachlorocyclocyclohexane (Lindane)
 Hexchlorobutadiene
 Mirex
 Pentachlorophenol
 Phenol
 Photomirex **
 Tetrachloroethane
 1,1,2,3-Tetrachloropropene
 2,4,5-Trichlorophenoxyacetic acid (2,4,5-T)
 Vinyl Bromide
 Vinyl Chloride

Table 67. (Concluded)

Elements which form toxic compounds (LD ₅₀ 500 mg oral/kg)	
Arsenic	(trioxide ³⁺)
Cadmium	(chloride)
Cobalt	(cobaltous ²⁺)
Lead	(alkyl ⁴⁺)
Mercury	(elemental ⁰)
Nickel	(acetate ³⁺)
Silver	(nitrate ³⁺)
Vanadium	(trioxide ³⁺)

* Based on acute oral exposure in rats. Principal data base:
NIOSH Registry of Toxic Effects of Chemical Substances, 1979, USHHS.

** Unspecified isomer(s)

Table 68

Municipal Wastewater Treatment Facility Construction Grants by River
Basin in the Saginaw Bay Watershed, 1972-1988

Basin/Municipality	County
Pigeon	
Port Austin	Huron
Gagetown	Tuscola
Owendale	Huron
Wiscoggin	
Akron/Fairgrove	Tuscola
Hampton Township	Bay
Unionville	Tuscola
Saginaw	
Alma	Gratiot
Alma, Arcada & Pine River Townships	Gratiot
Argentine Township	Genesee
Bay City	Bay
Bay County Westside Area	Bay
Birch Run	Saginaw
Bridgeport Township	Saginaw
Caro	Tuscola
Cass City	Tuscola
Chesaning	Saginaw
Durand	Shiawassee
Elba Township	Lapeer
Essexville	Bay
Fenton	Genesee
Flint	Genesee
Flushing	Genesee
Frankenmuth	Saginaw
Gaines	Genesee
Genesee County	Genesee
Genesee County-Ragnone WWTP	Genesee
Gladwin	Gladwin
Holly	Oakland
Howell	Livingston
Lapeer	Lapeer
Lapeer Township	Lapeer
Lennon	Genesee
Mayfield Township	Lapeer
Marlette	Sanilac
Merrill	Saginaw
Mt. Pleasant	Isabella
Otisville	Genesee
Owosso	Shiawassee
Owosso and Caledonia Township	Shiawassee
Richland Township	Saginaw

(Continued)

(Sheet 1 of 2)

Table 68. (Concluded)

Basin/Municipality	County
Saginaw (continued)	
Saginaw	Saginaw
Saginaw Township, Saginaw Metro	Saginaw
St. Louis	Gratiot
Tittabawassee Township	Saginaw
Union Township	Isabella
Vassar	Tuscola
Kawkawlin	
None	
Rifle	
Standish	Arenac
West Branch	Ogemaw
Au Gres	
Tawas City	Iosco

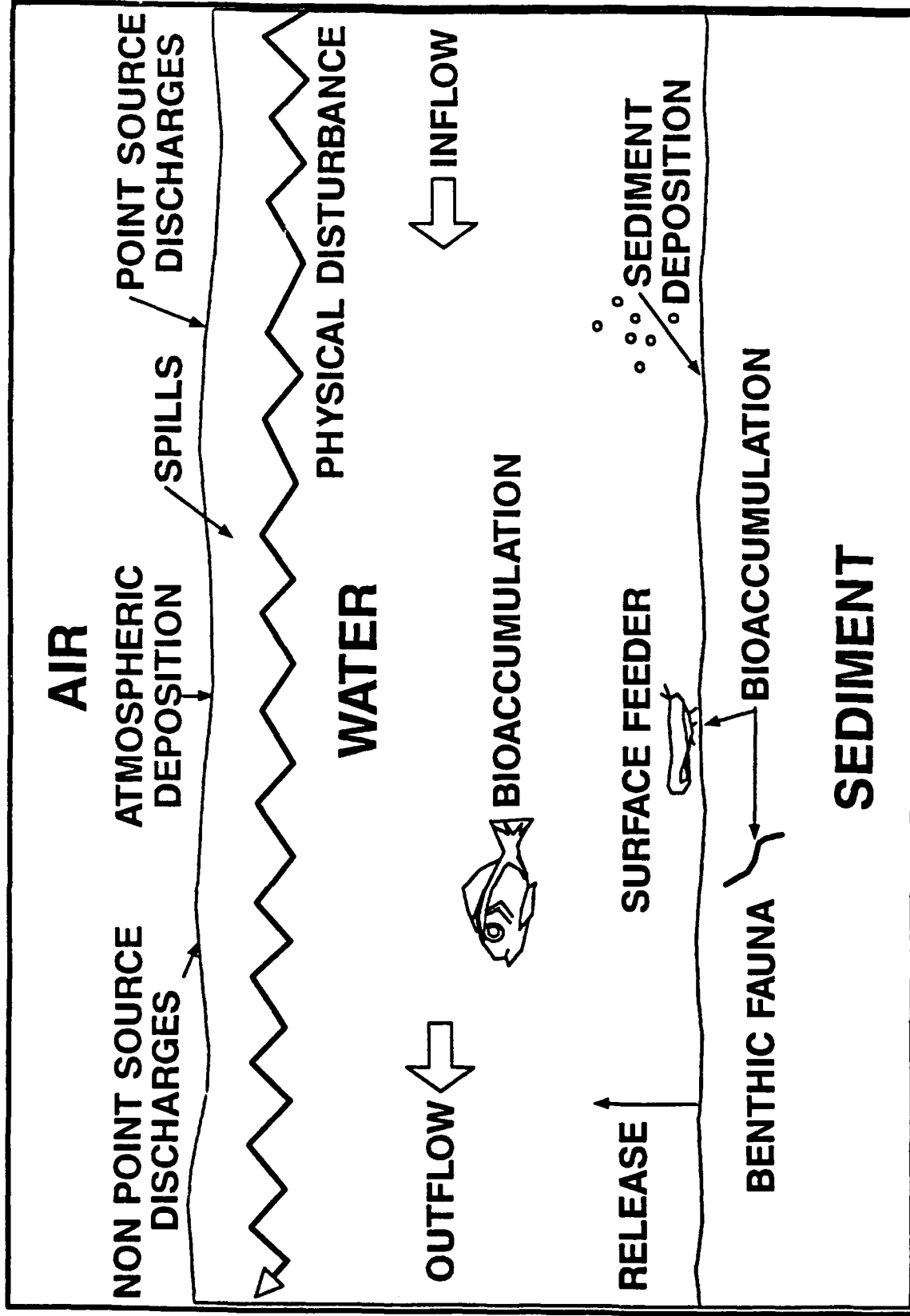


Figure 1. Contaminant migration pathways for evaluation of in-place contaminated sediments

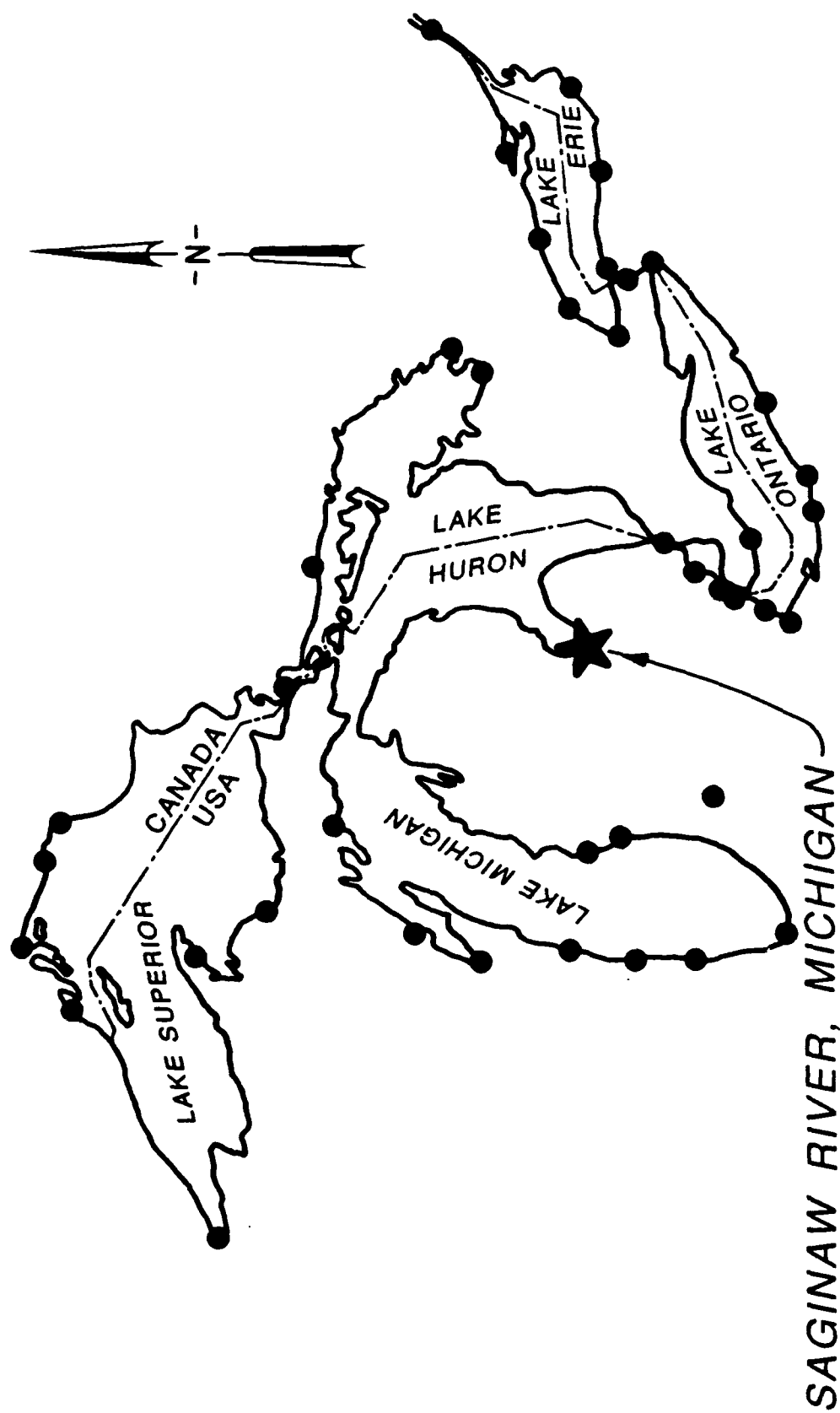


Figure 2. Location of the Saginaw River and Saginaw Bay AOC

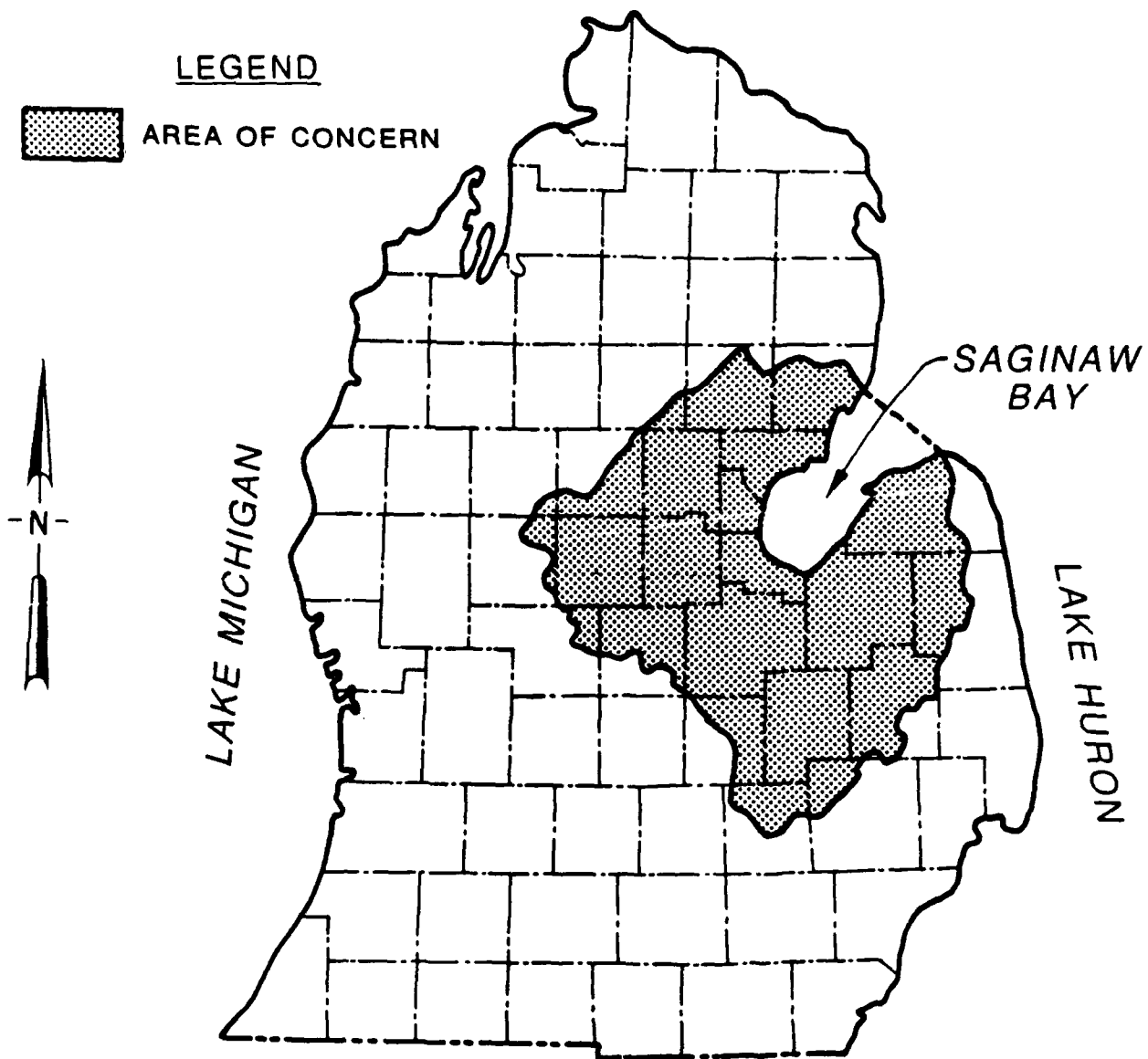


Figure 3. Boundary of the Saginaw River and Saginaw Bay AOC

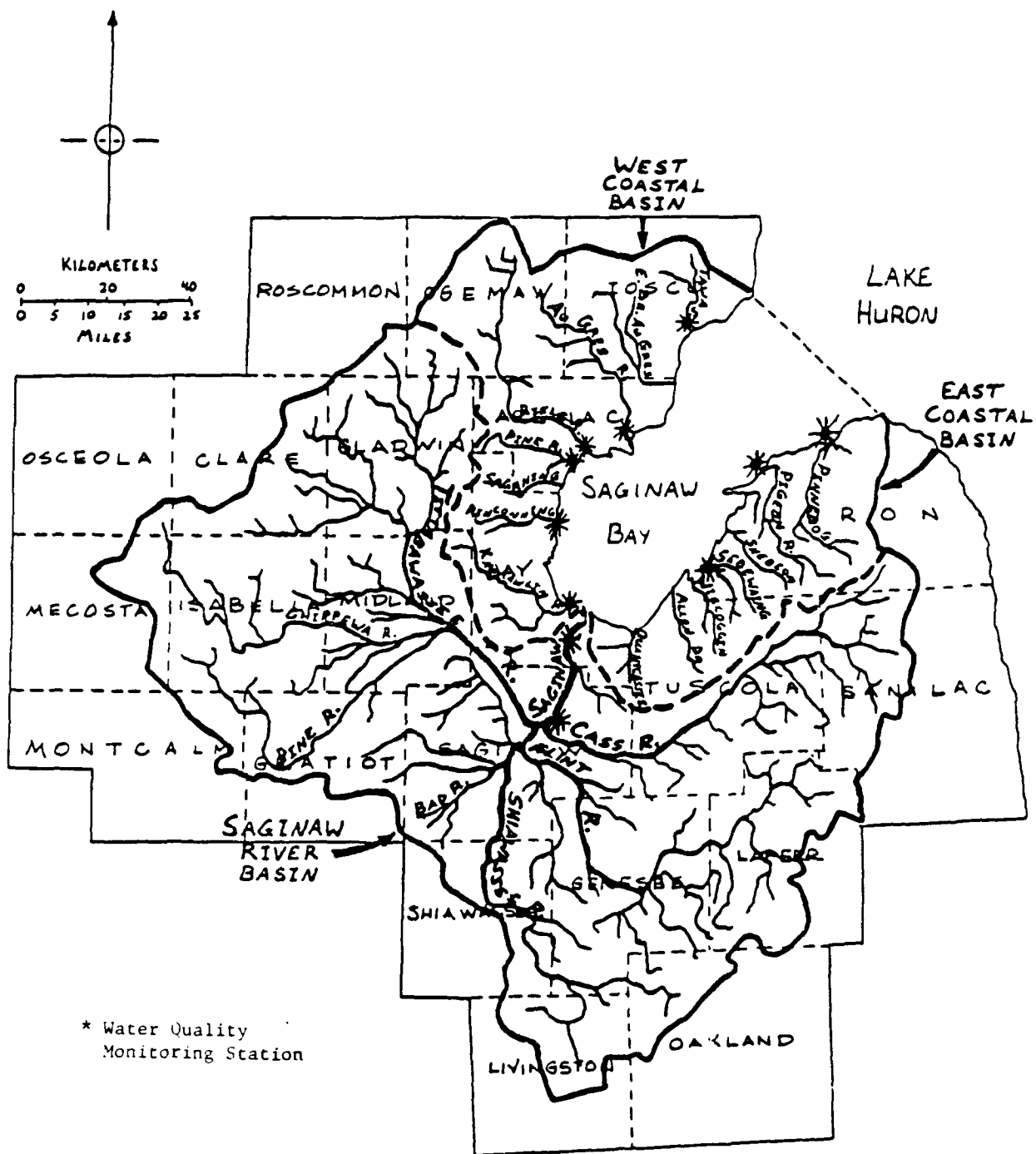


Figure 4. Major tributaries to Saginaw Bay

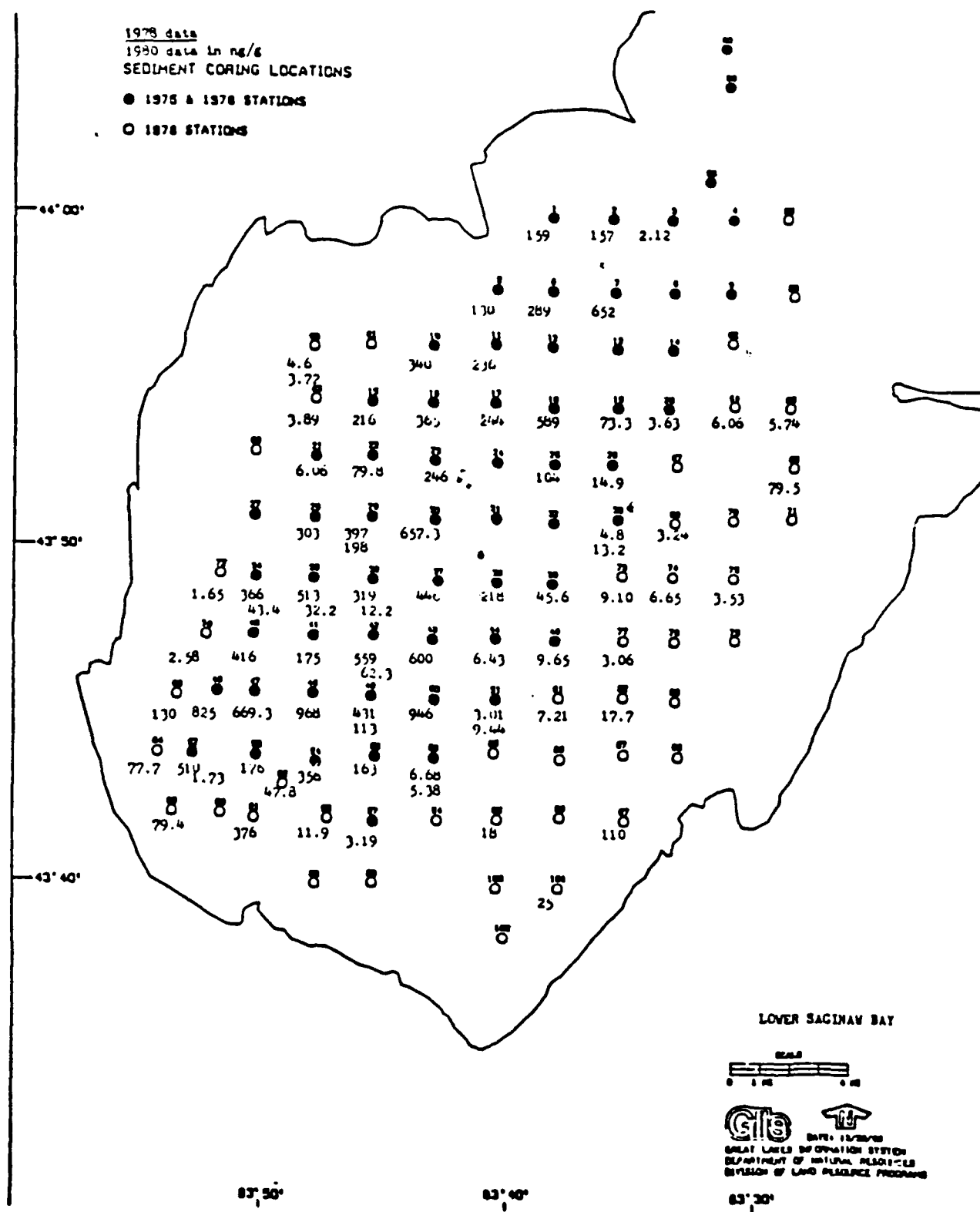


Figure 5a. Spatial distribution of PCB concentrations in surface sediments (1-2 cm) of inner Saginaw Bay, 1978 and 1980 (USEPA unpublished)

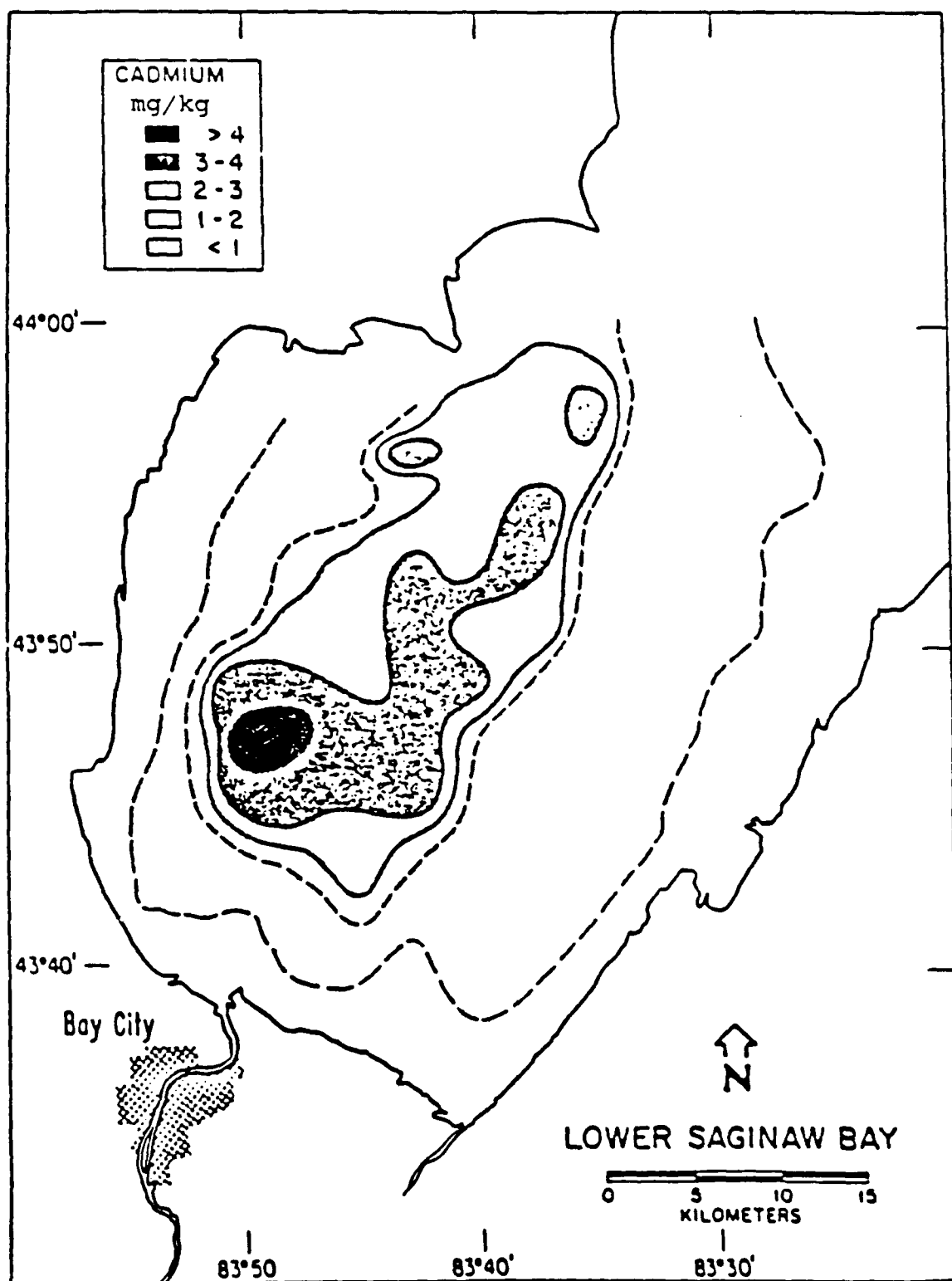


Figure 5b. Spatial distribution of cadmium concentrations in surface sediments (1-2 cm) of inner Saginaw Bay, 1978 (Robbins 1986)

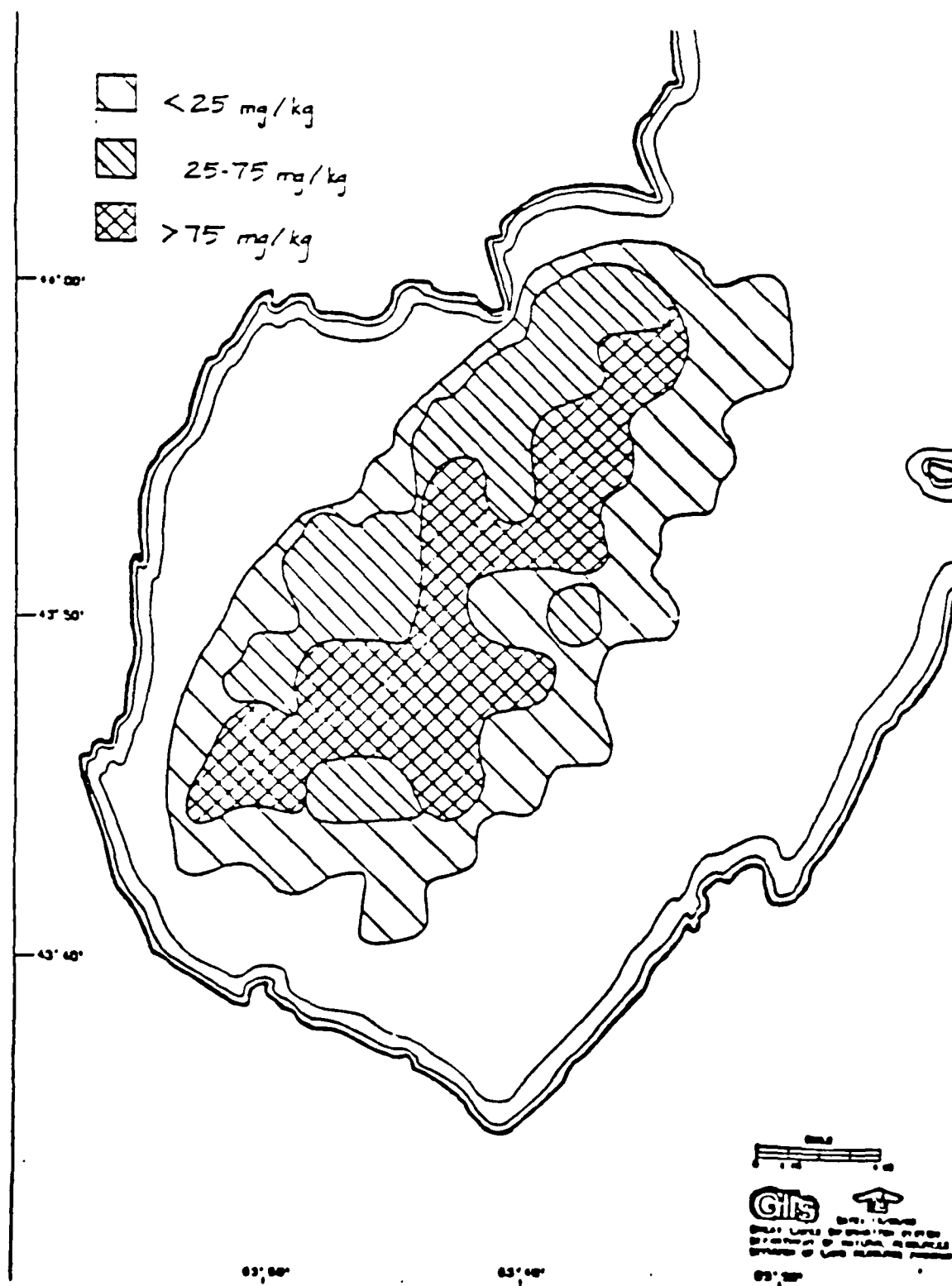


Figure 5c. Spatial distribution of chromium concentrations in surface sediments (1-2 cm) of inner Saginaw Bay, 1978 (Robbins 1986)

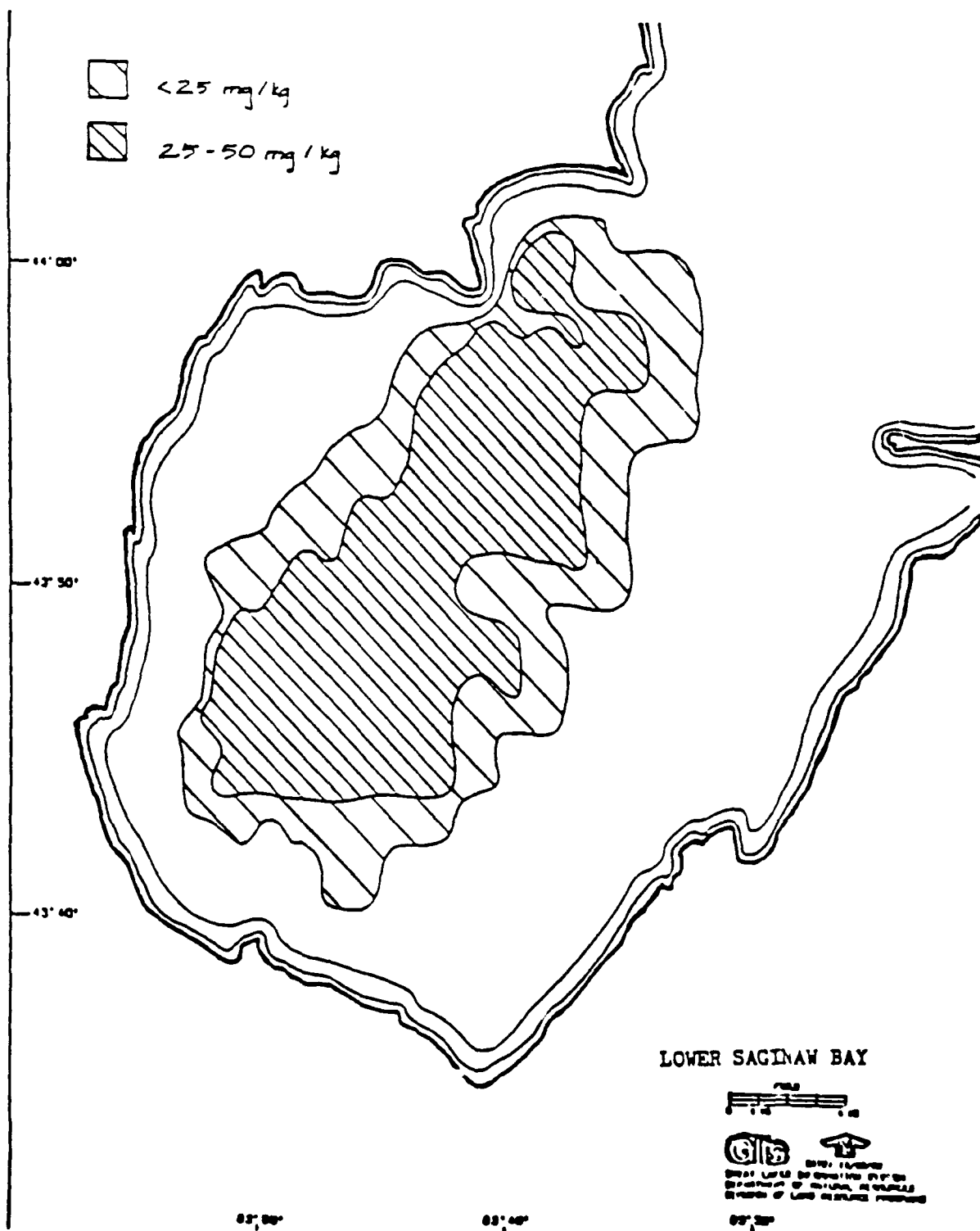


Figure 5d. Spatial distribution of copper concentrations in surface sediments (1-2 cm) of inner Saginaw Bay, 1978 (Robbins 1986)

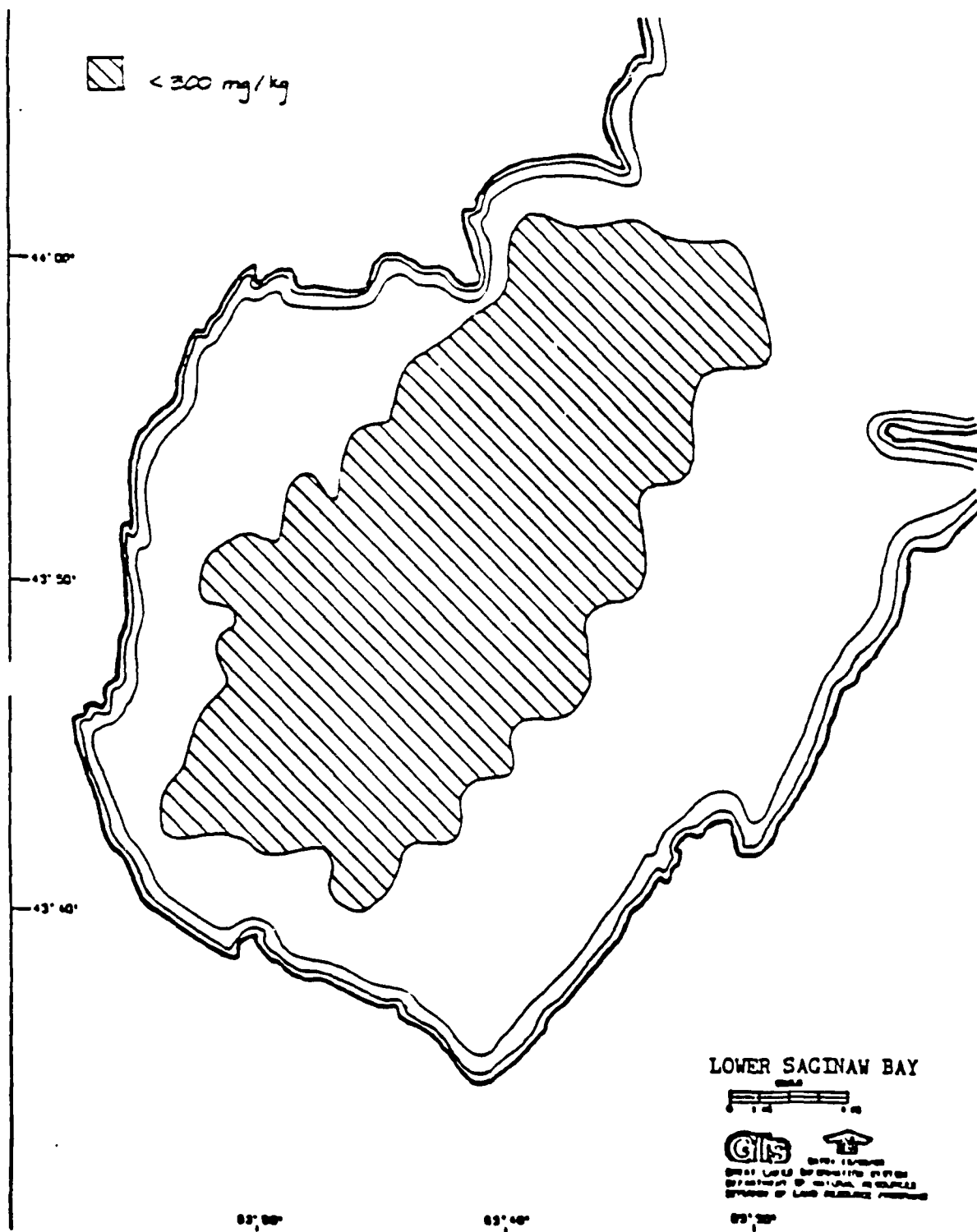


Figure 5e. Spatial distribution of nickel concentrations in surface sediments (1-2 cm) of inner Saginaw Bay, 1978 (Robbins 1986)

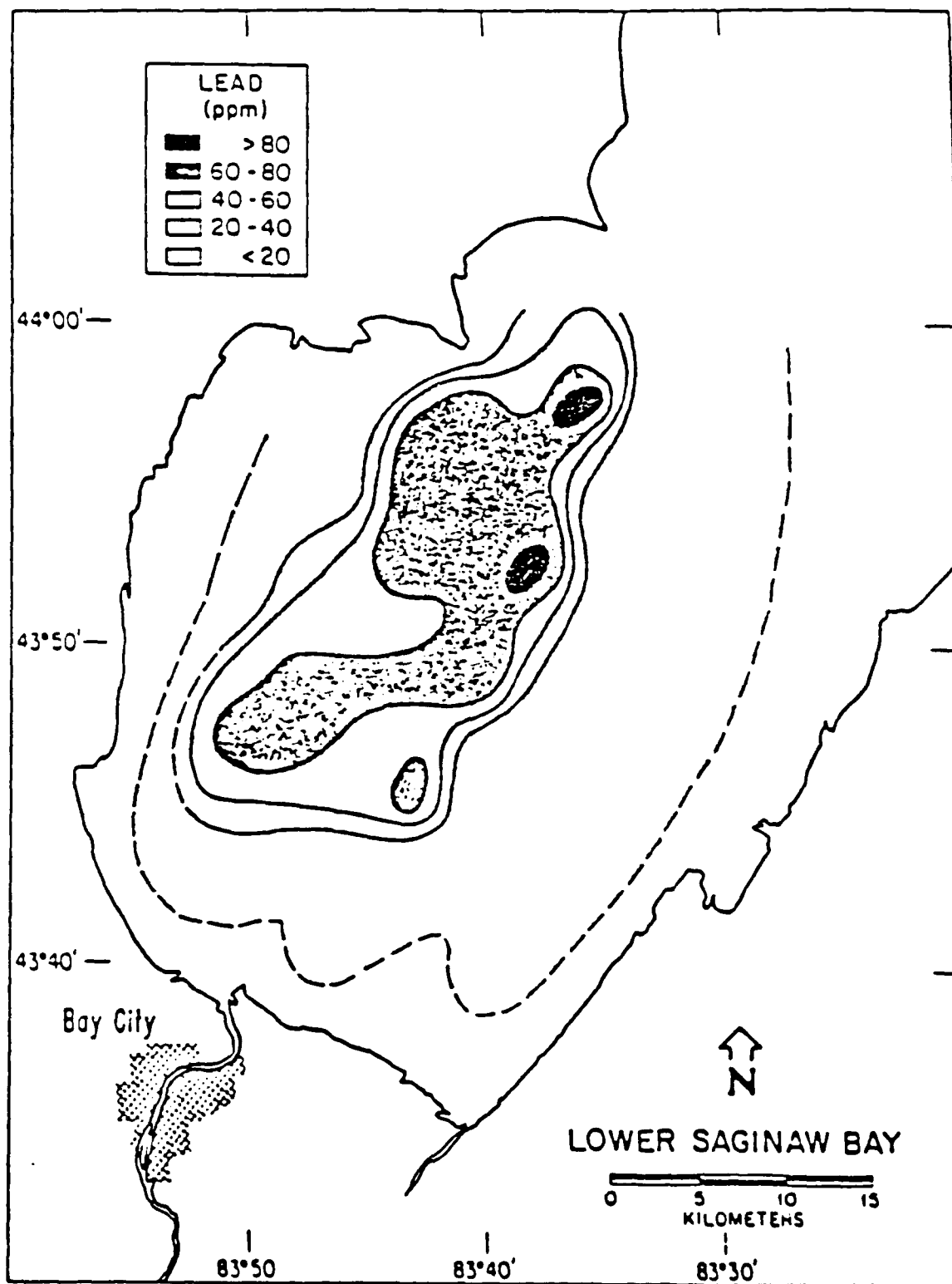


Figure 5f. Spatial distribution of lead concentrations in surface sediments (1-2 cm) of inner Saginaw Bay, 1978 (Robbins 1986)

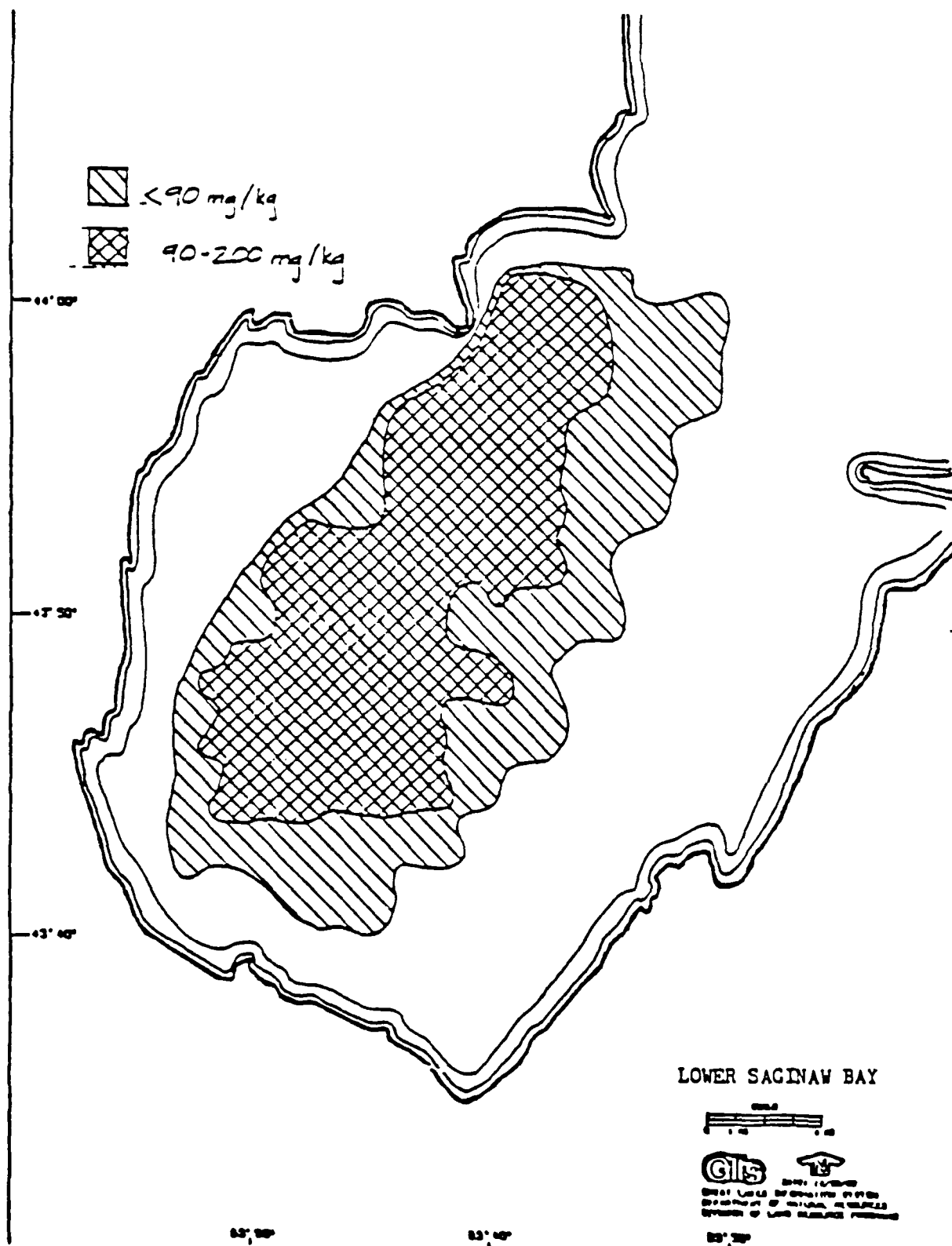


Figure 5g. Spatial distribution of zinc concentrations in surface sediments (1-2 cm) of inner Saginaw Bay, 1978 (Robbins 1986)

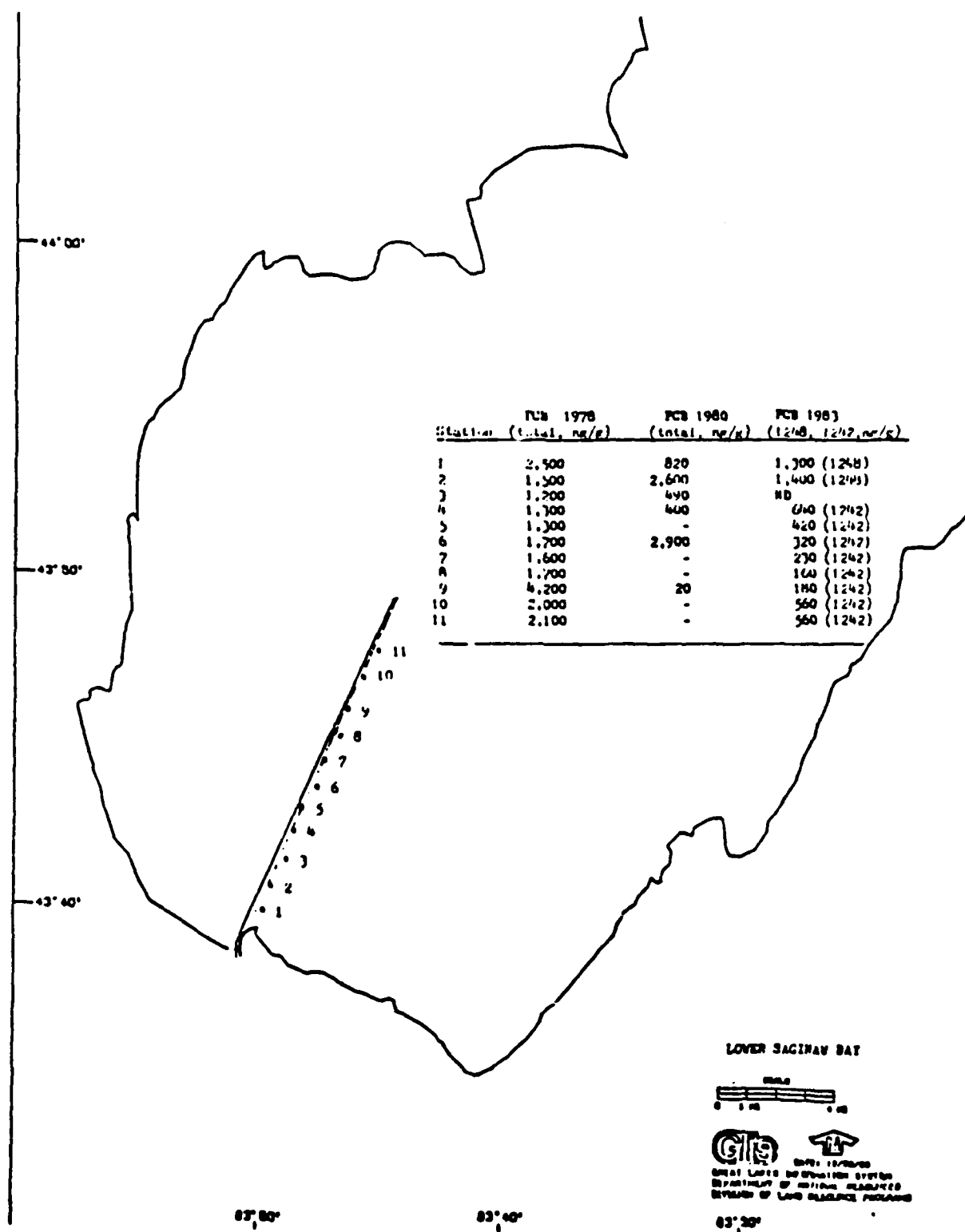


Figure 6. PCB concentrations in sediments of inner Saginaw Bay collected from the navigation channel at the mouth of the Saginaw River, 1978, 1980, and 1983 (USACE unpublished)

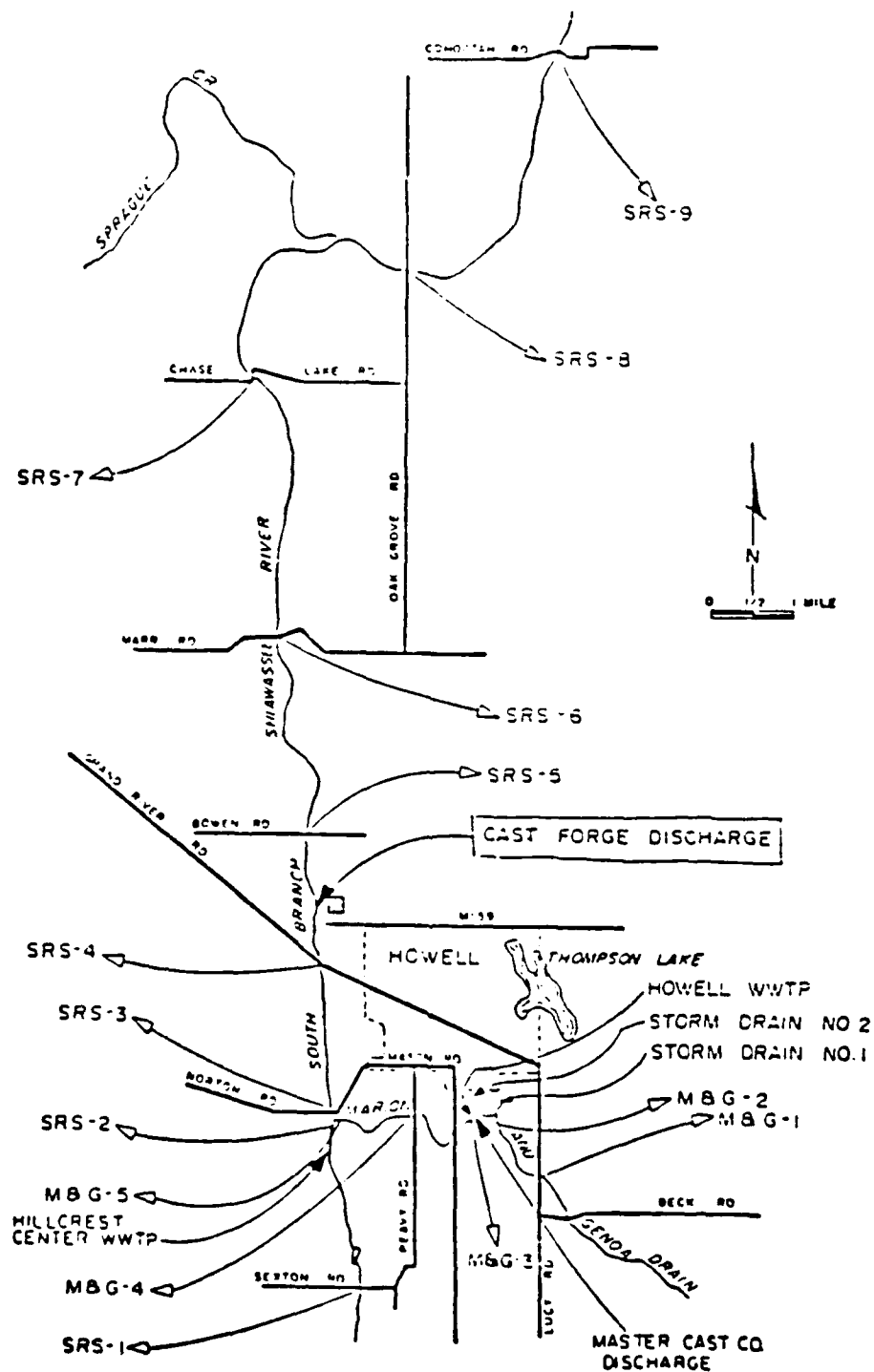


Figure 7. South Branch, Shiawassee River, 1974 sampling station locations and wastewater discharges (MDNR 1979a)

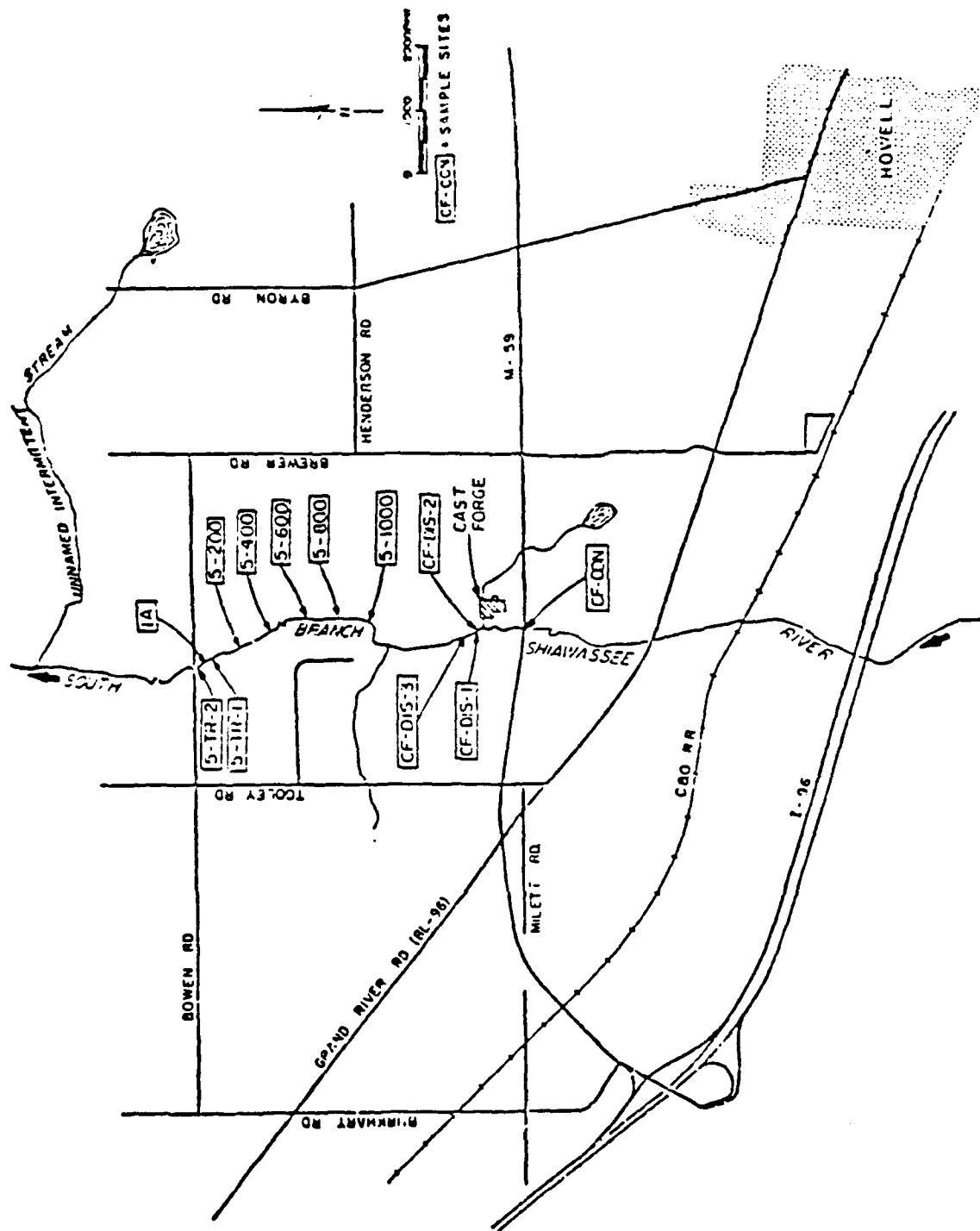


Figure 8. South Branch, Shiawassee River, sediment survey sampling locations, August 1977 (MDNR 1977)

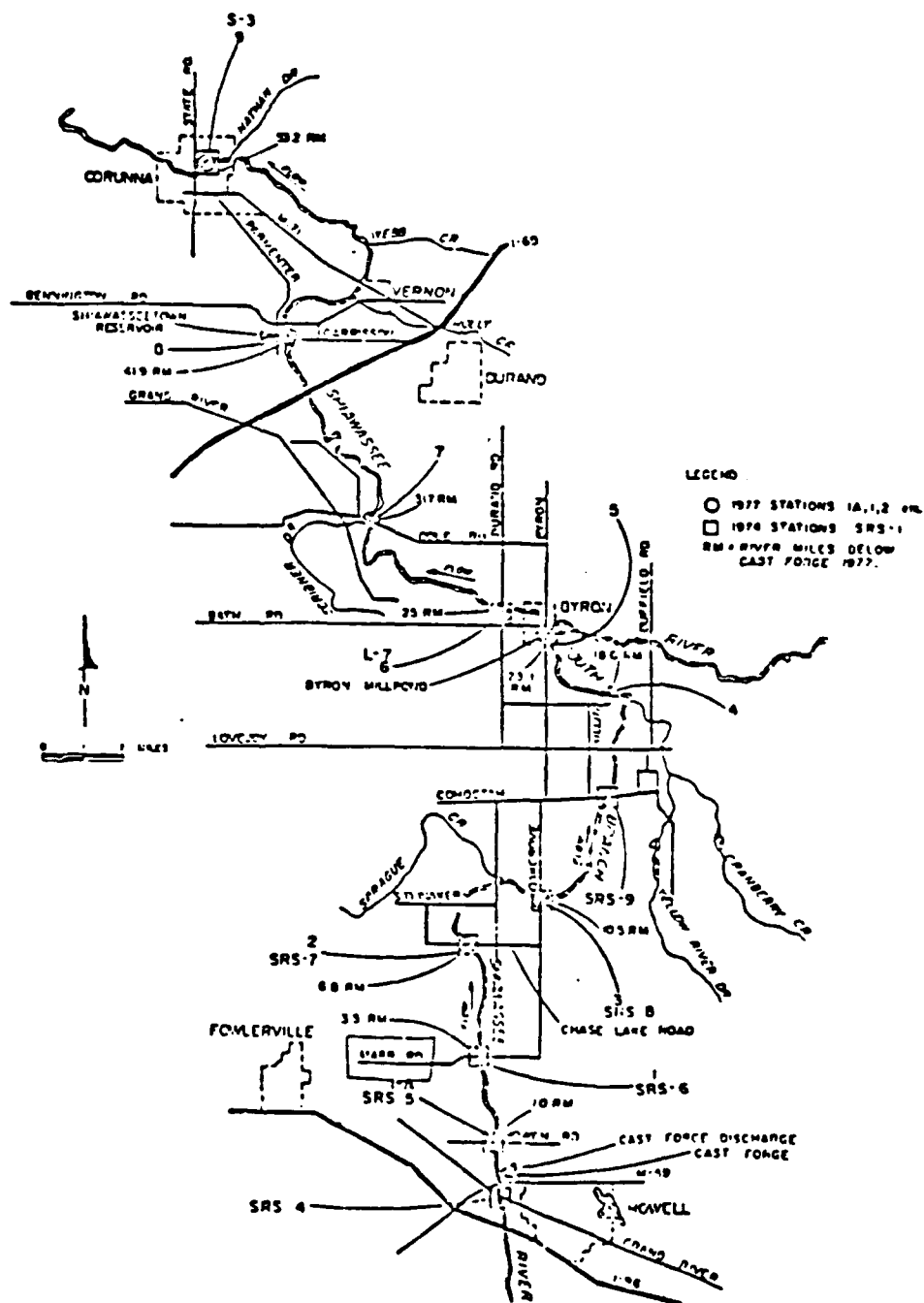


Figure 9. 1974 and 1977 sampling locations for sediments,
South Branch, Shiawassee River, Howell to Corunna
(MDNR 1977)

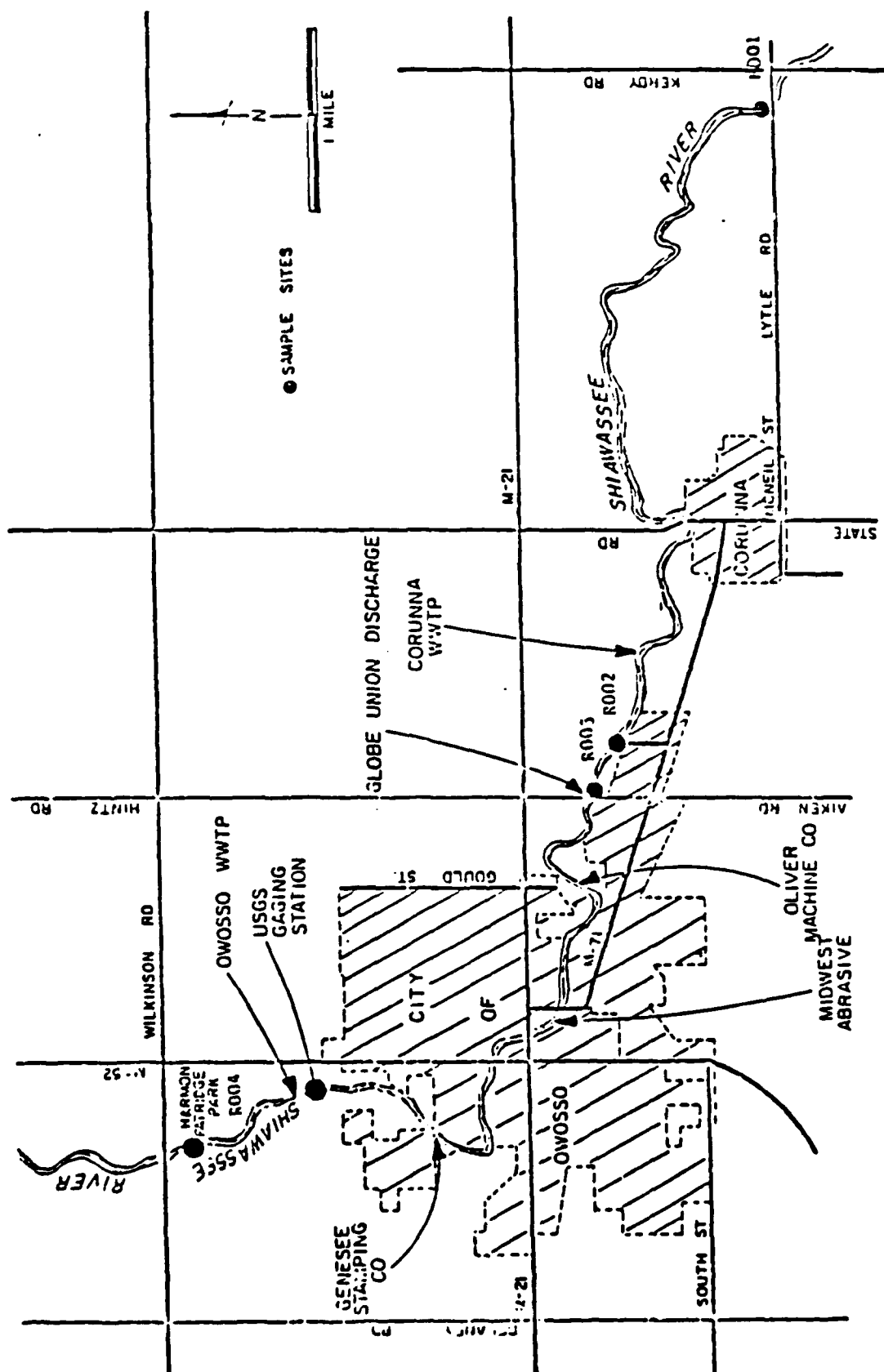


Figure 10. Shiawassee River sediment sampling stations near Owosso, 1980 (MDNR 1980)

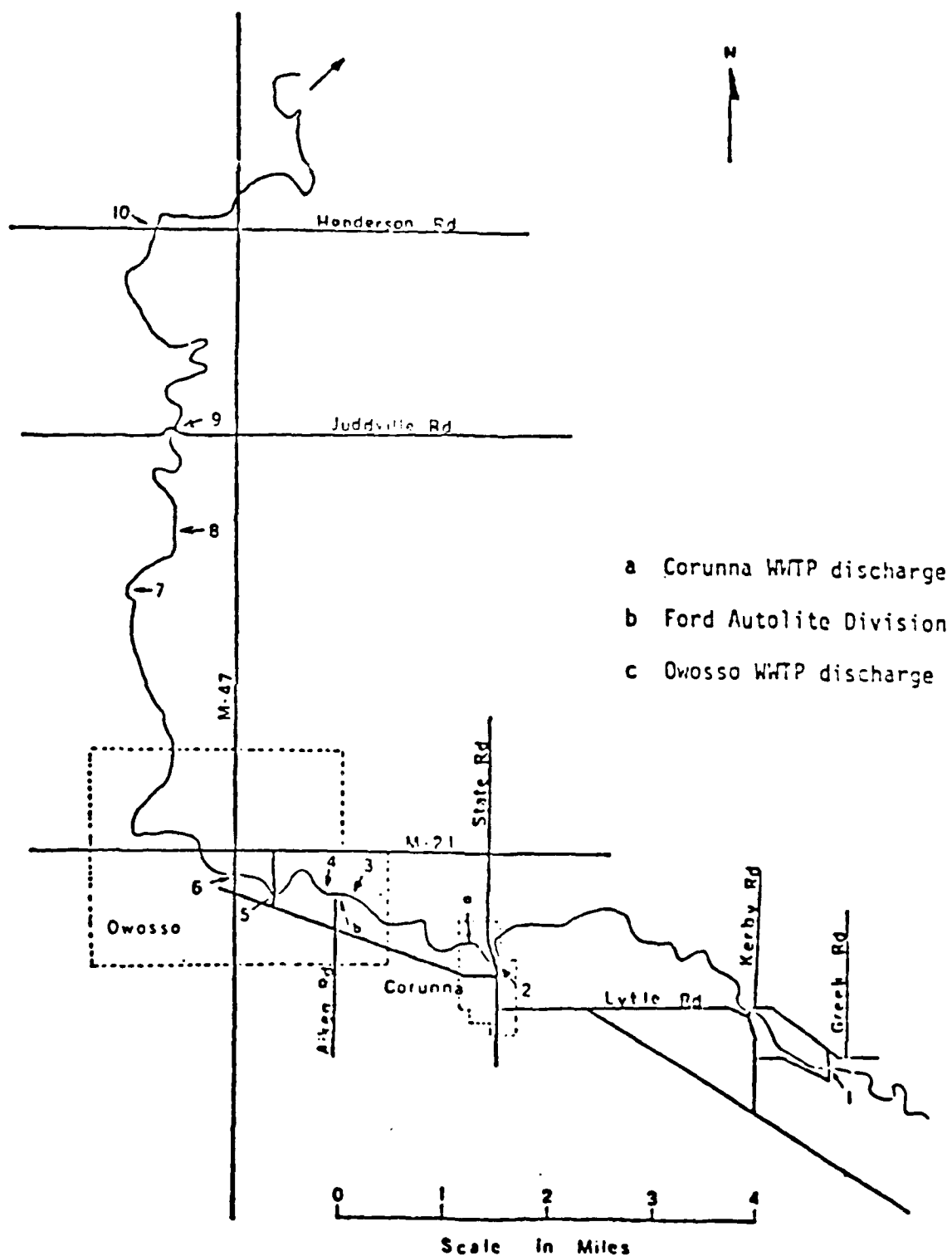


Figure 11. Sediment sampling stations on the Shiawassee River, Owosso, 1972 (MDNR 1972)

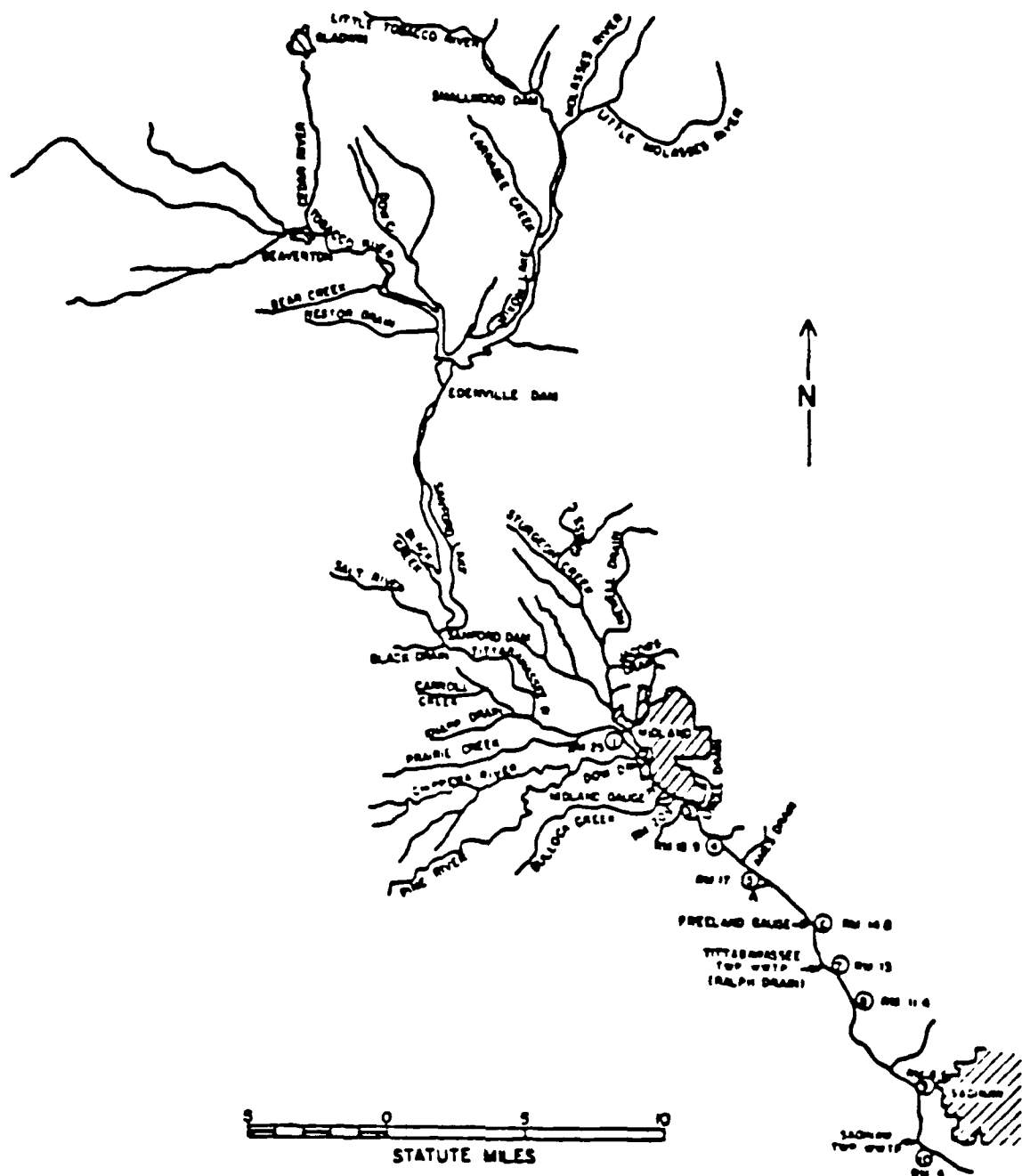


Figure 12. Tittabawassee River sediment sampling sites for 1981 (Rossmann et al. 1983; see Tables 12 and 13)

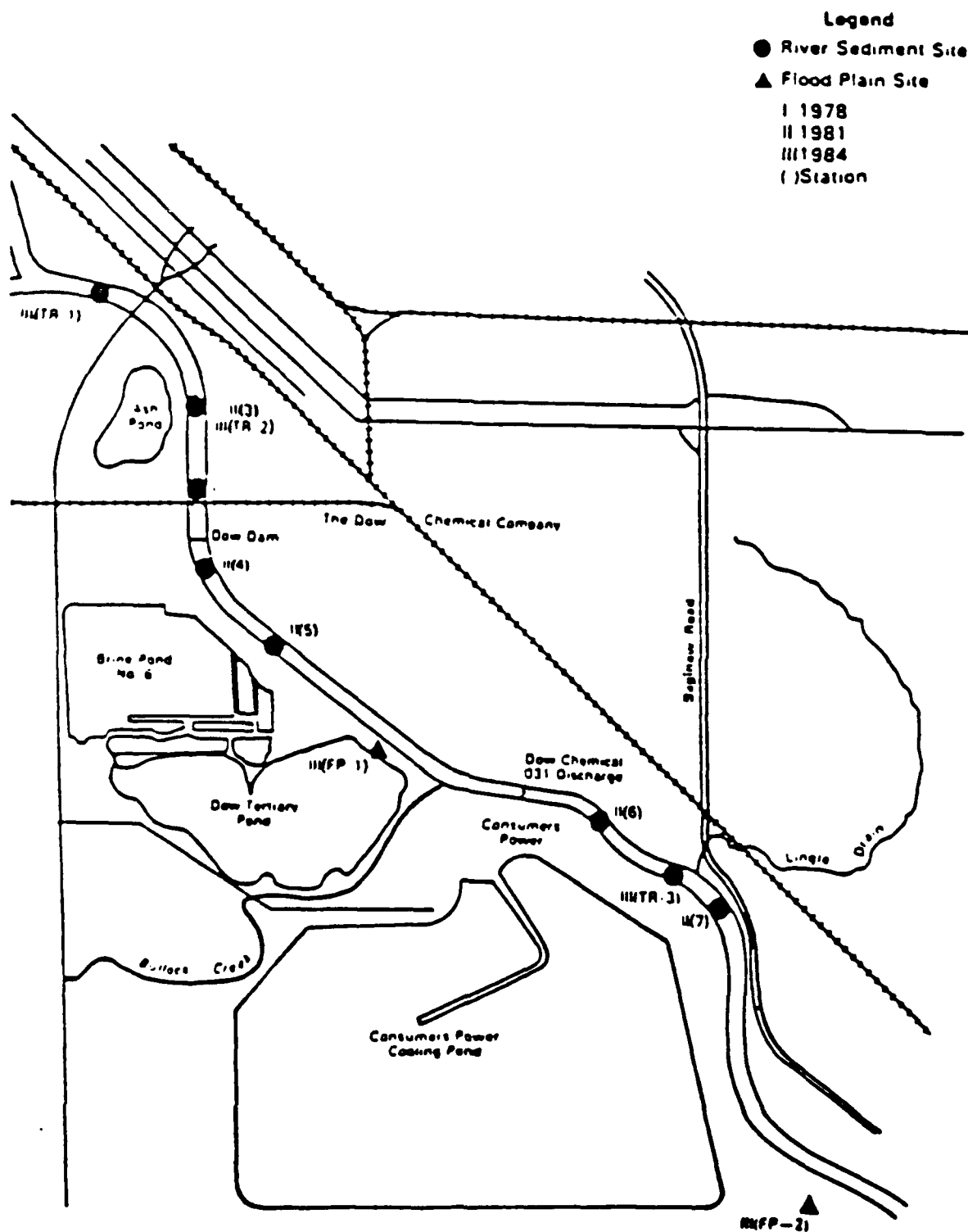


Figure 13a. Tittabawassee River sediment sampling sites, 1981
(Rossmann et al. 1983; see Tables 12 and 13)

Legend

- River Sediment Site
- ▲ Flood Plain Site
- I 1978
- II 1981
- III 1984
- (I) Station

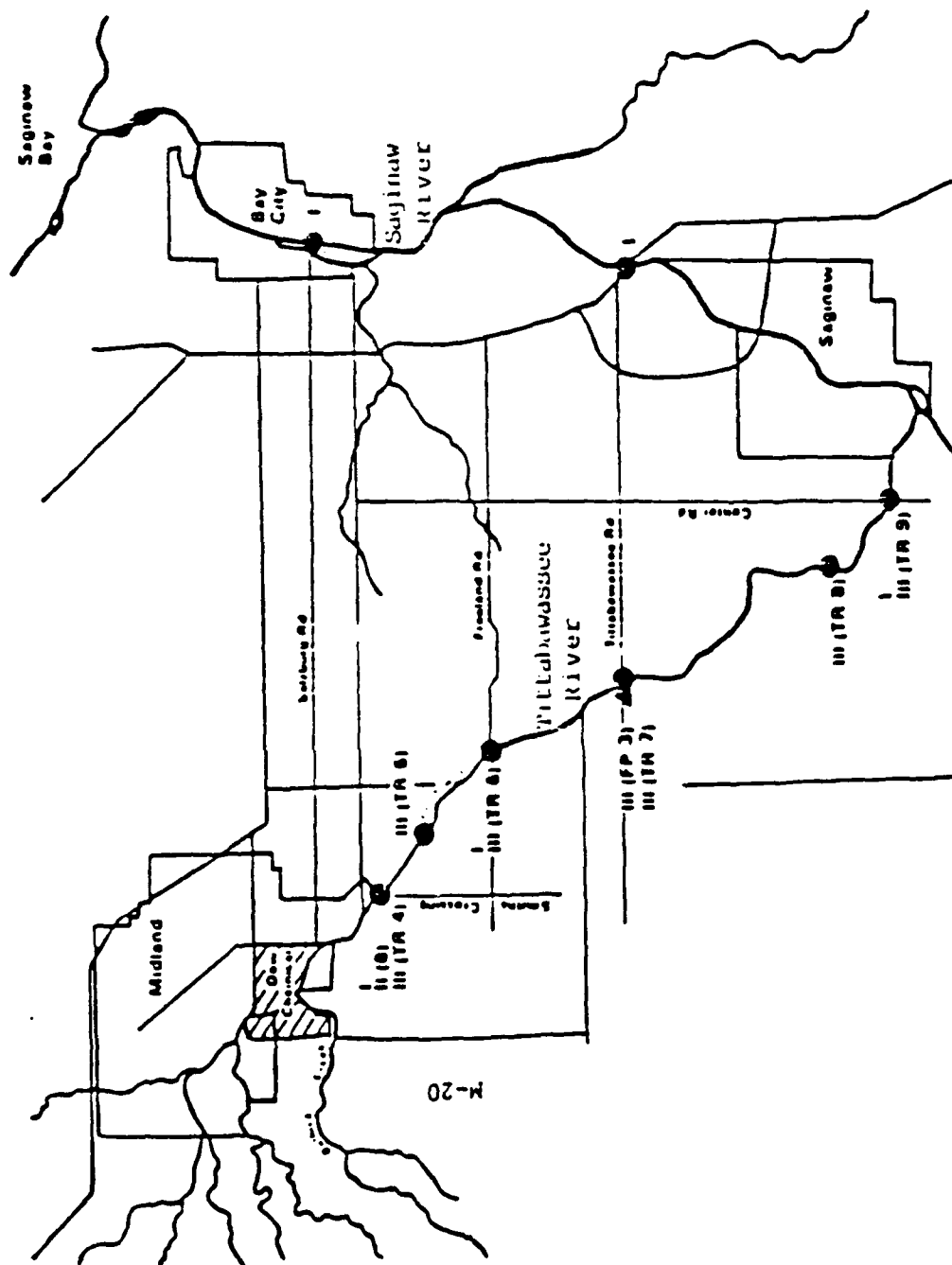


Figure 13b. Tittabawassee River and Saginaw River sediment sampling stations, 1978-1984 (USEPA 1986; see Tables 12 and 13)

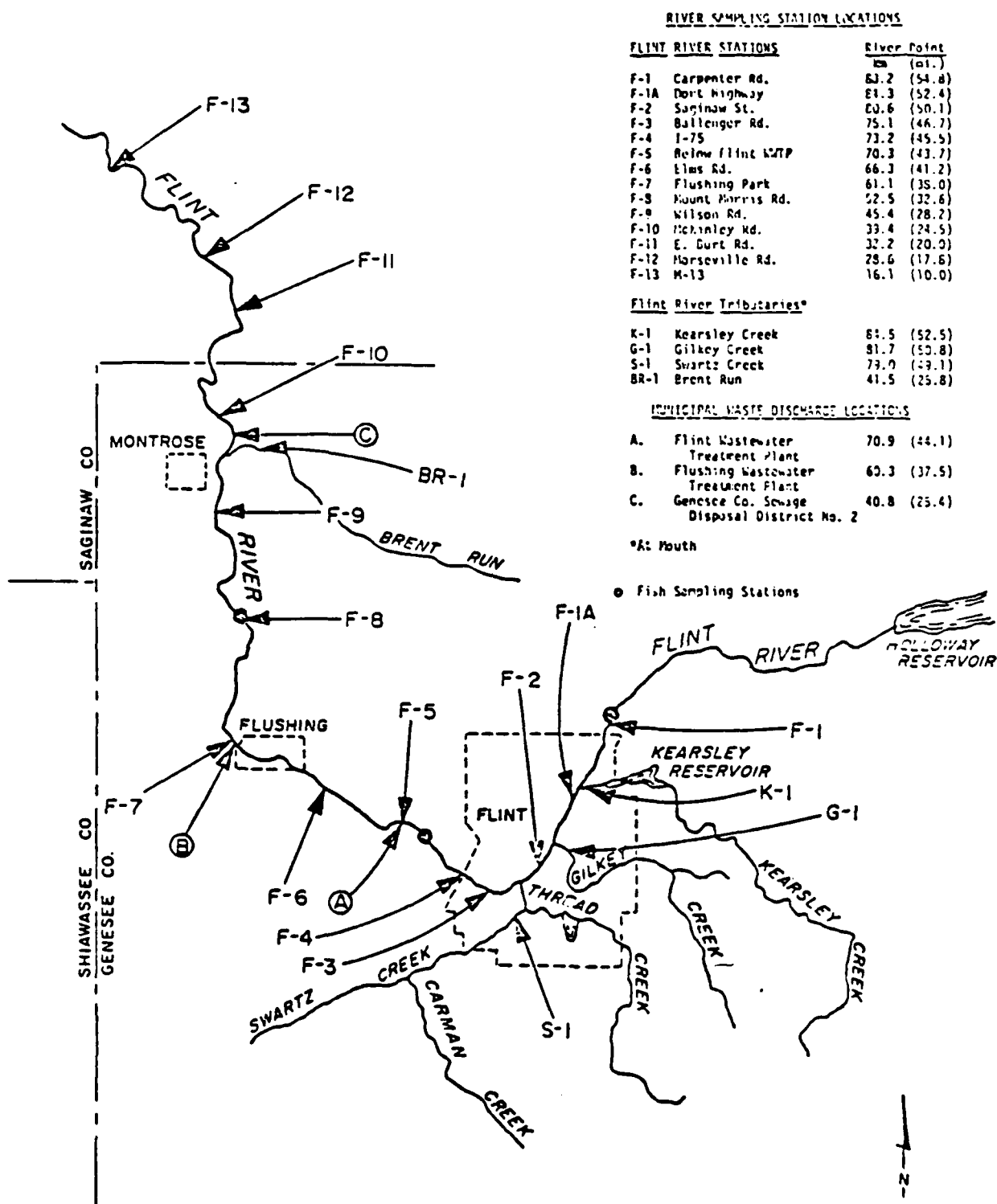


Figure 14. Flint River sampling stations and municipal waste discharges, 1974 (see Table 14)

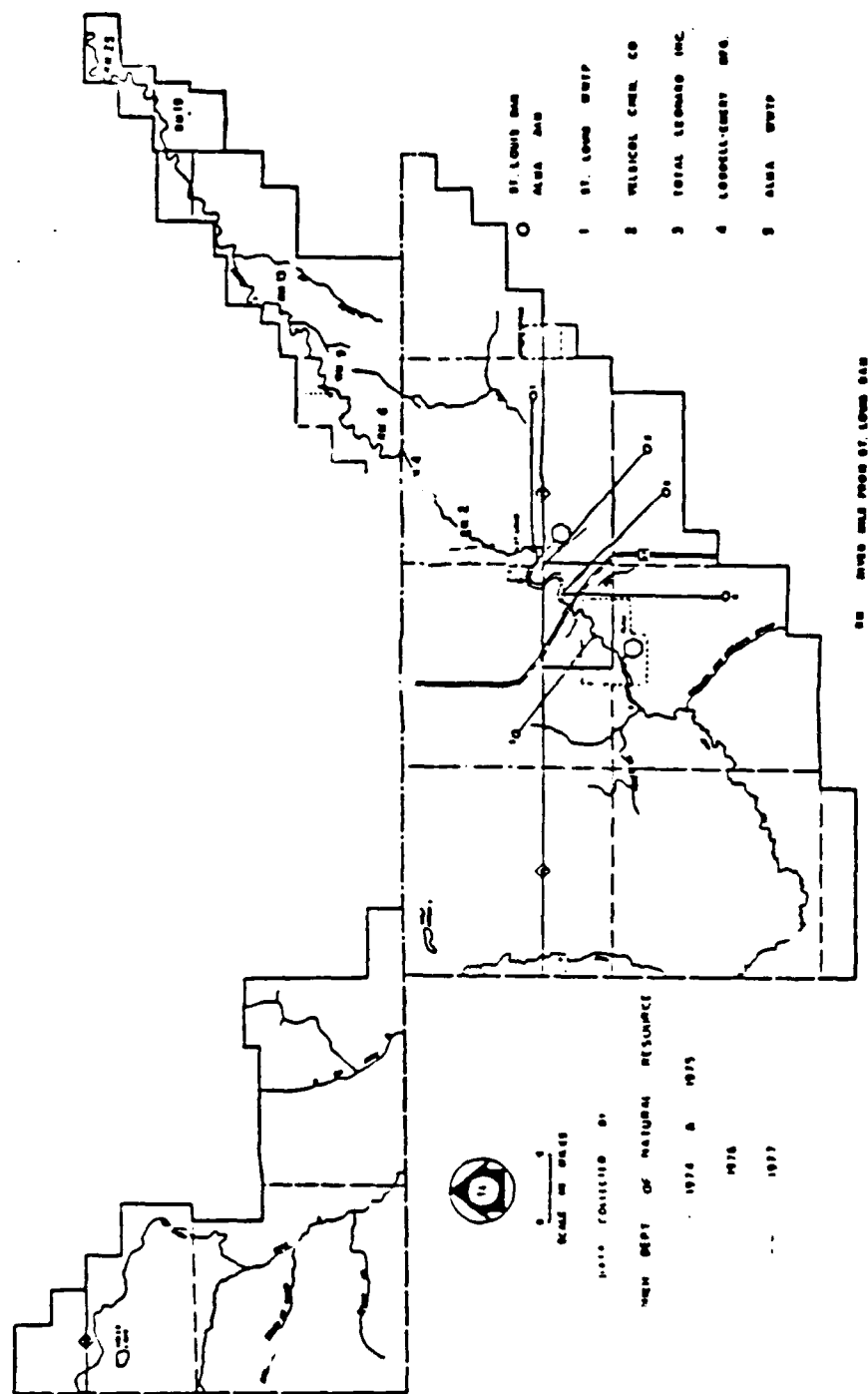


Figure 15. Sediment sampling stations in the Pine River, 1974-1977 (ECMPDR 1983; see Tables 15, 16a and 16b)

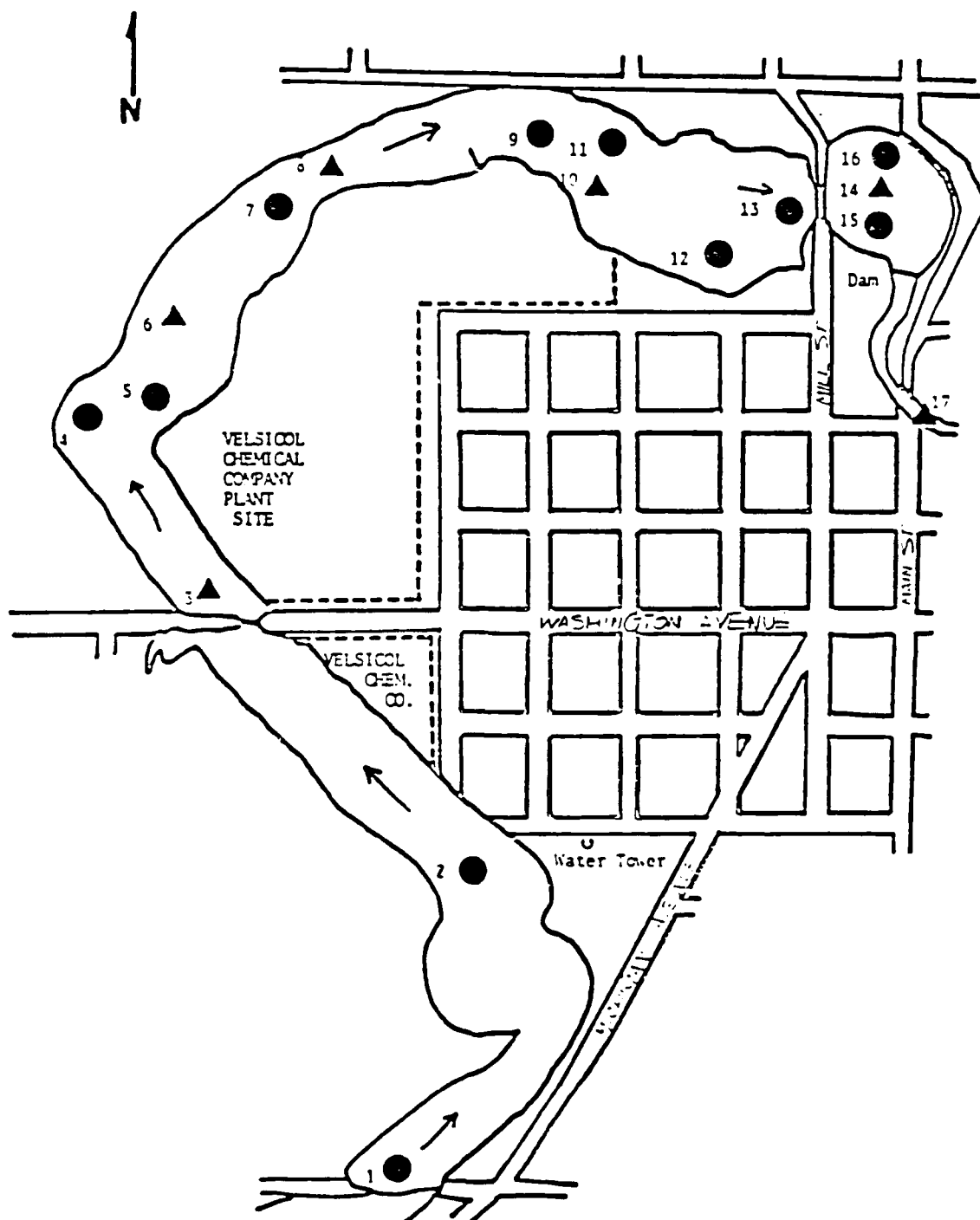


Figure 16. St. Louis Reservoir sediment sampling locations, 1980-1981
(ECMPDR 1983; see Tables 16a and 16b)

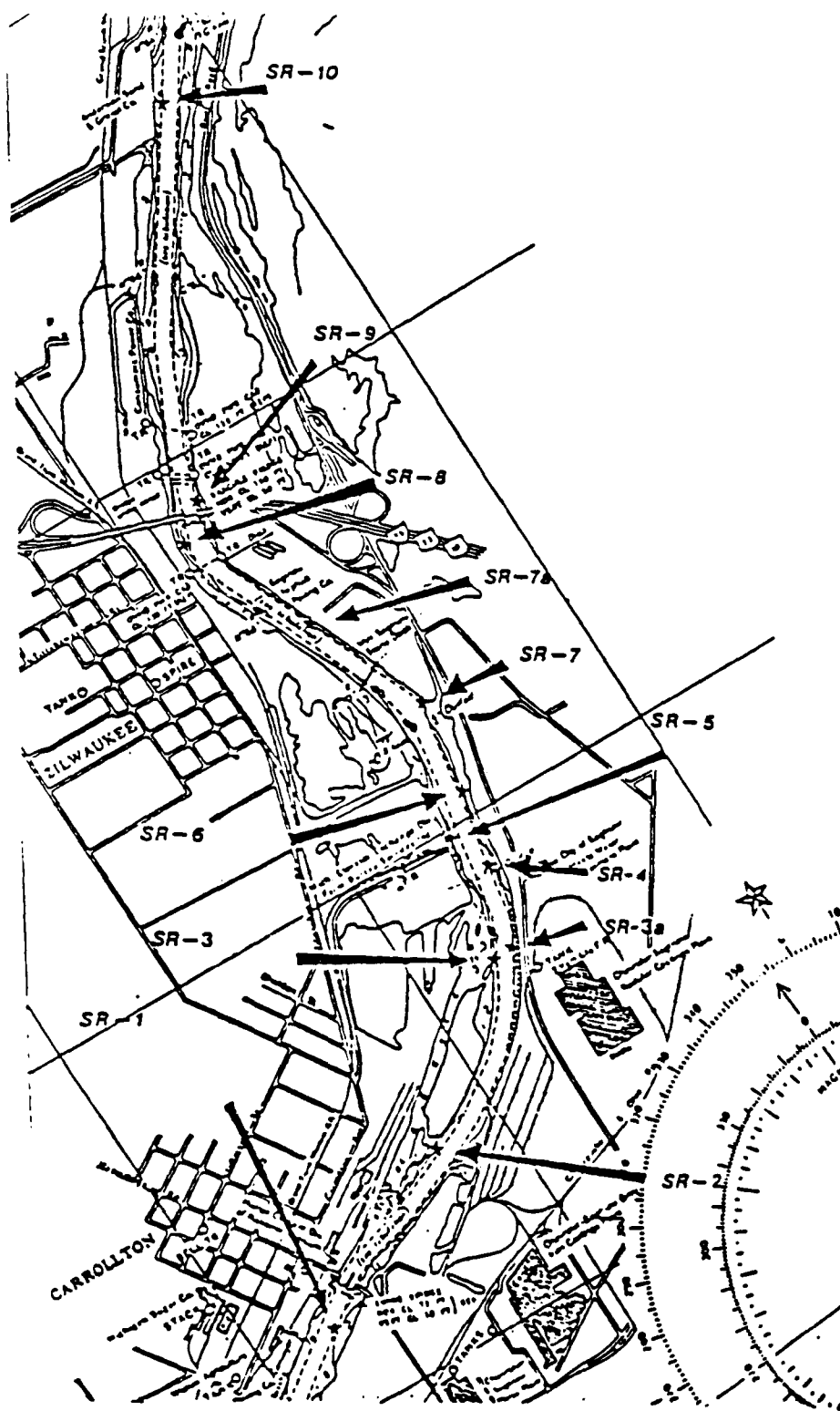


Figure 17a. Saginaw River sediment sampling stations, near the city of Saginaw, 1983 (USACE 1983; see Table 17a)

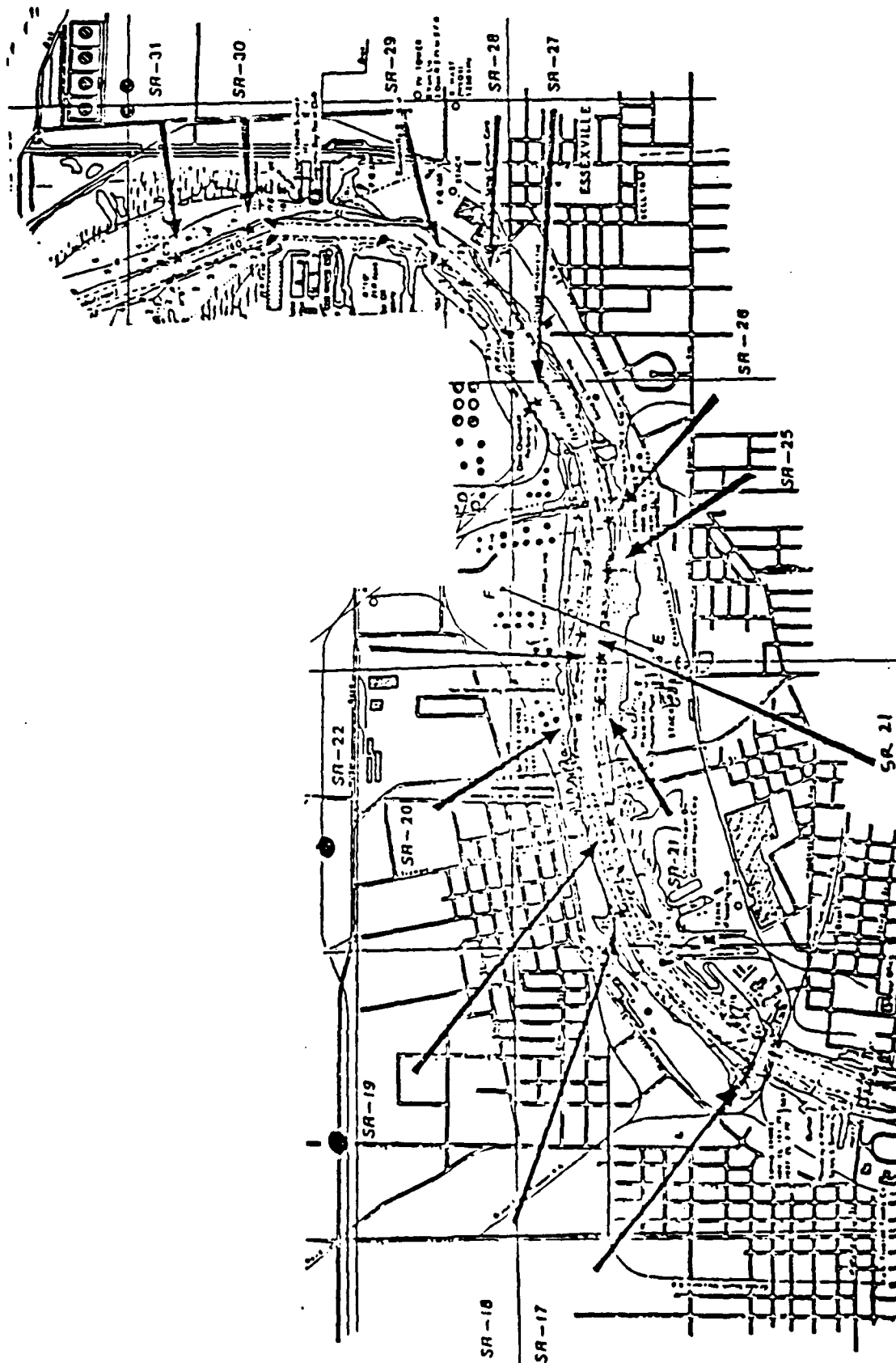


Figure 17b. Saginaw River sediment sampling stations, near Bay City, 1983 (USACE 1983; see Tables 17b and 17c)

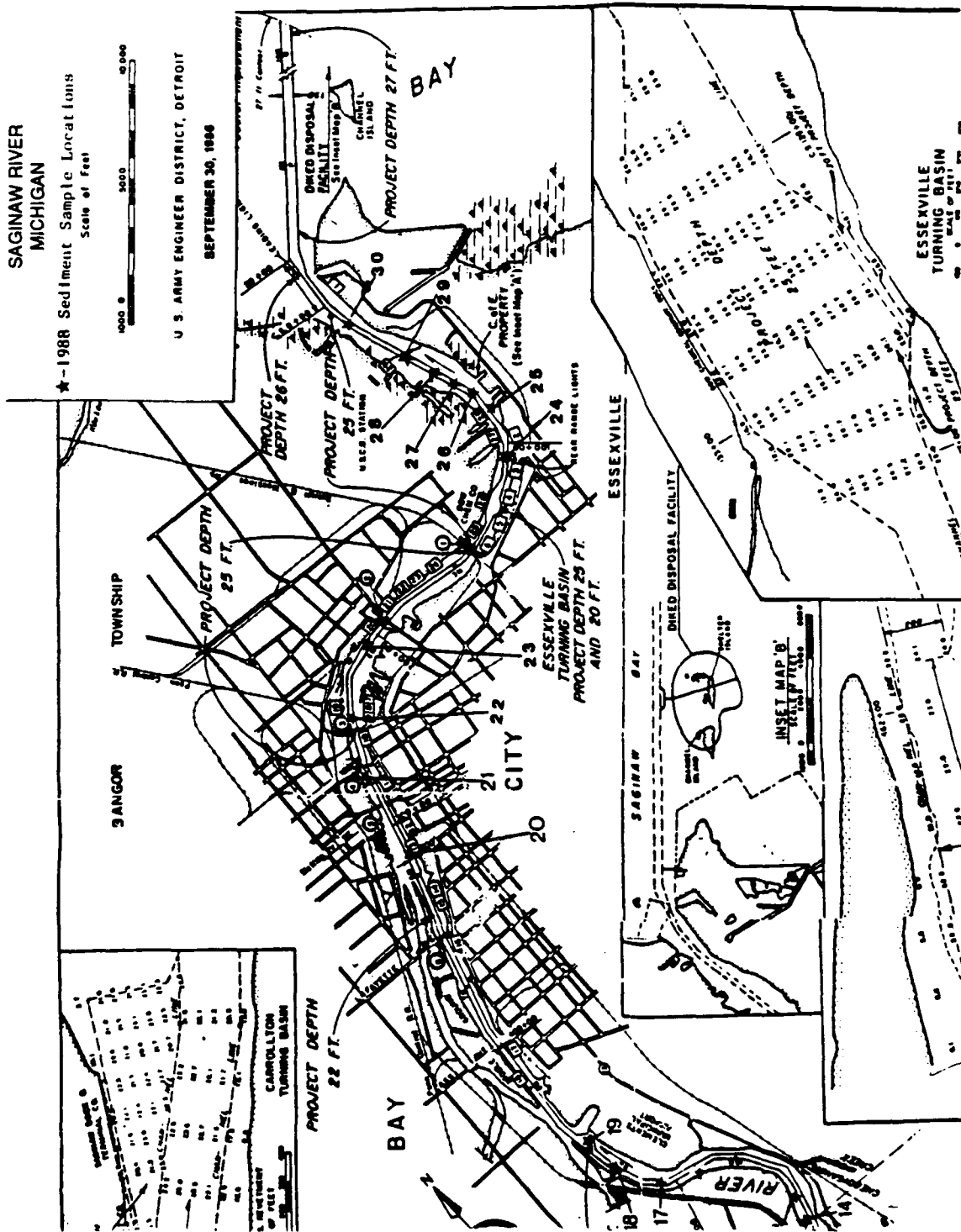


Figure 18b. Saginaw River sediment sampling stations, near Bay City, 1988 (USACE, Detroit 1988; see Tables 18b and 18c)

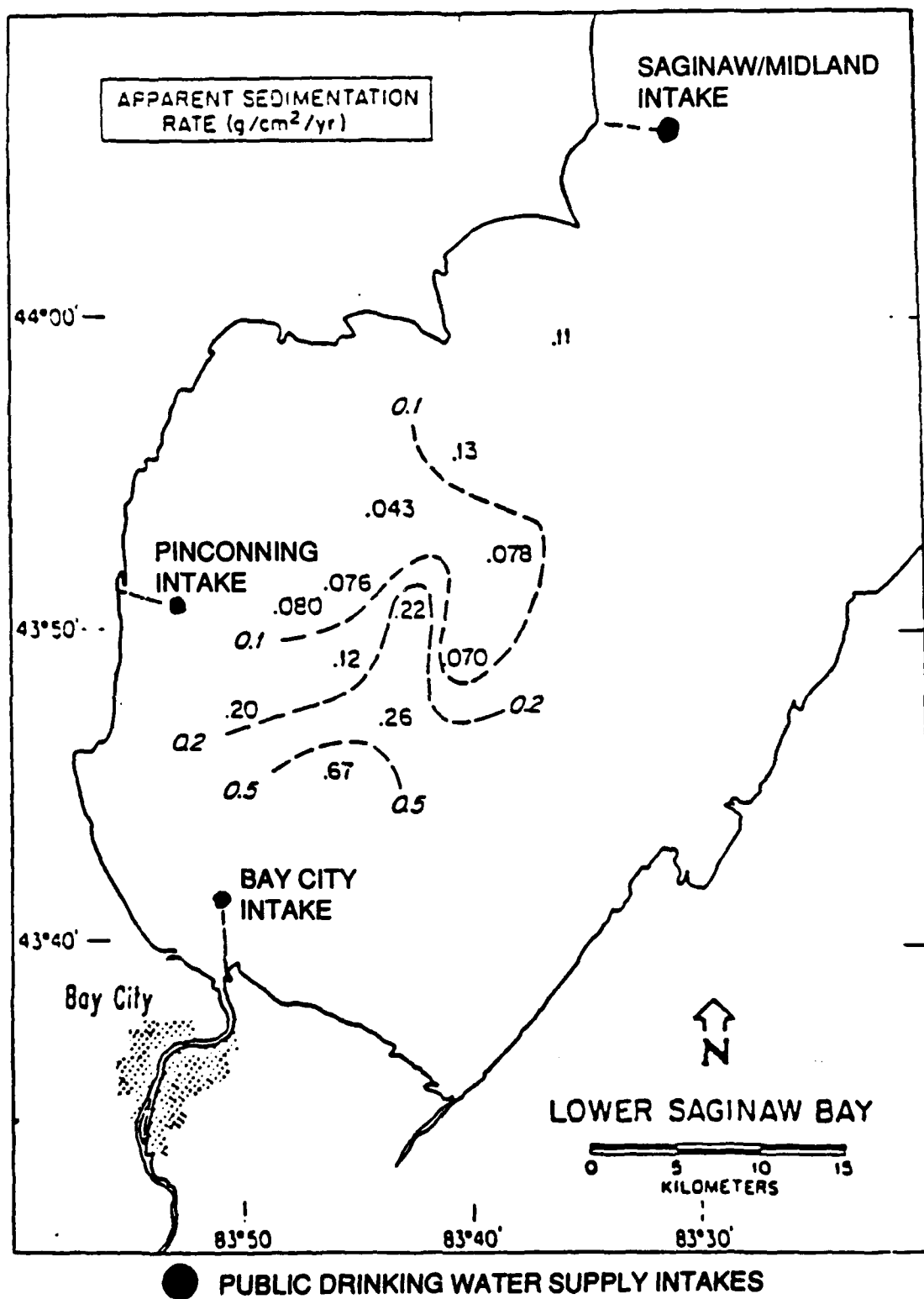


Figure 19a. Apparent sedimentation rates in inner Saginaw Bay (Robbins 1986)

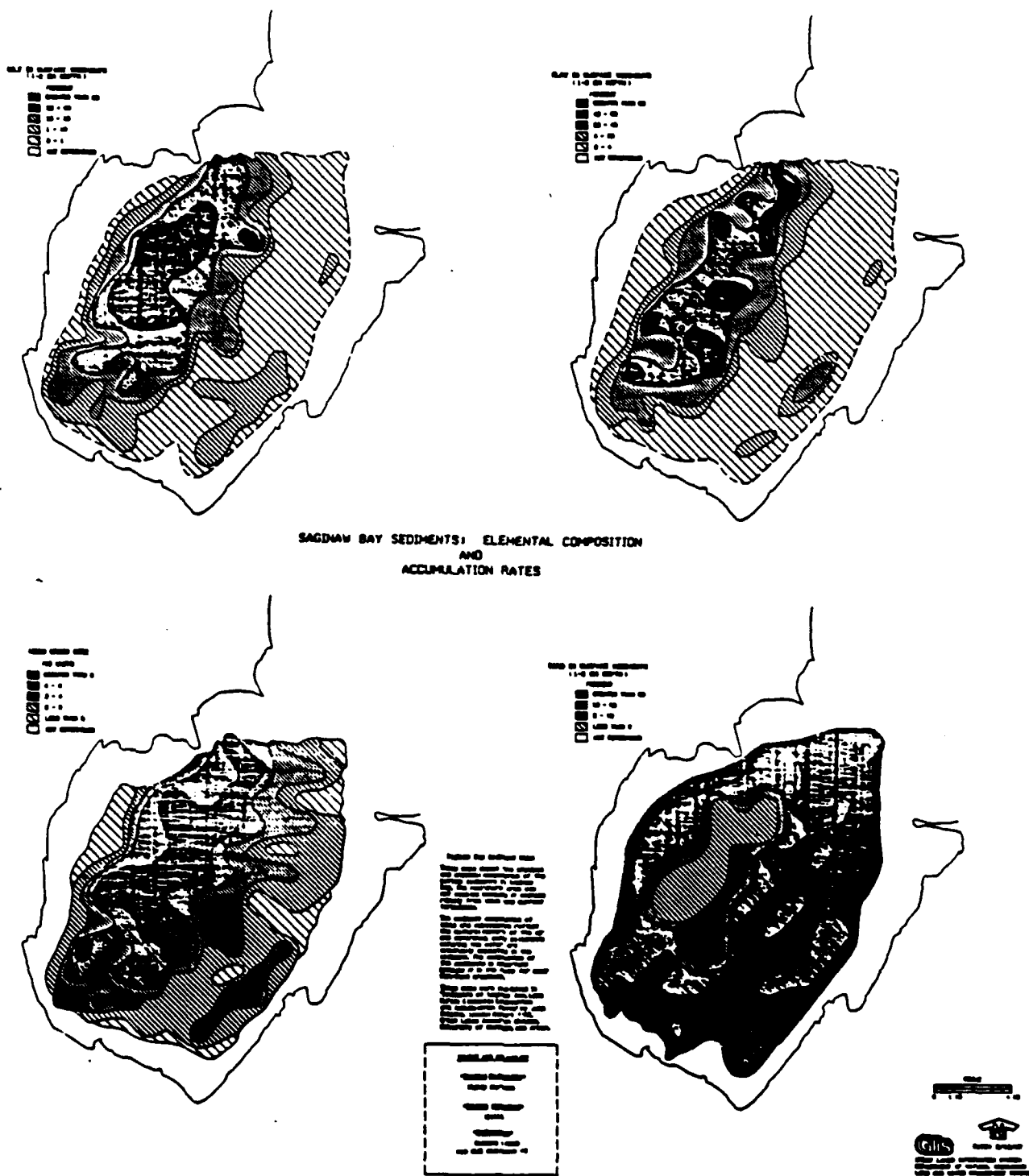


Figure 19b. Saginaw Bay sediments: elemental composition and accumulation rates (GLIS)

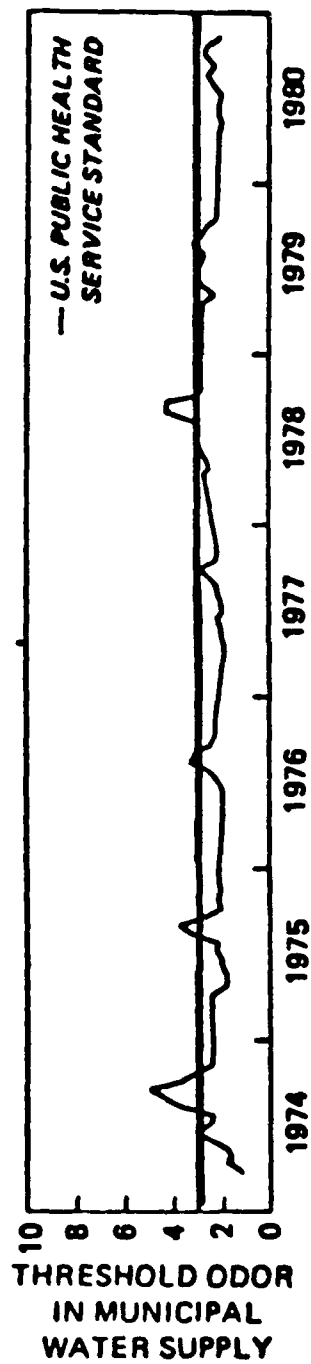


Figure 20. Taste and odor in water from the Saginaw-Midland water intake, 1974-1980 (Dolan et al. 1986)

WATER TEMPERATURE (CELCIUS)

SAGINAW RIVER

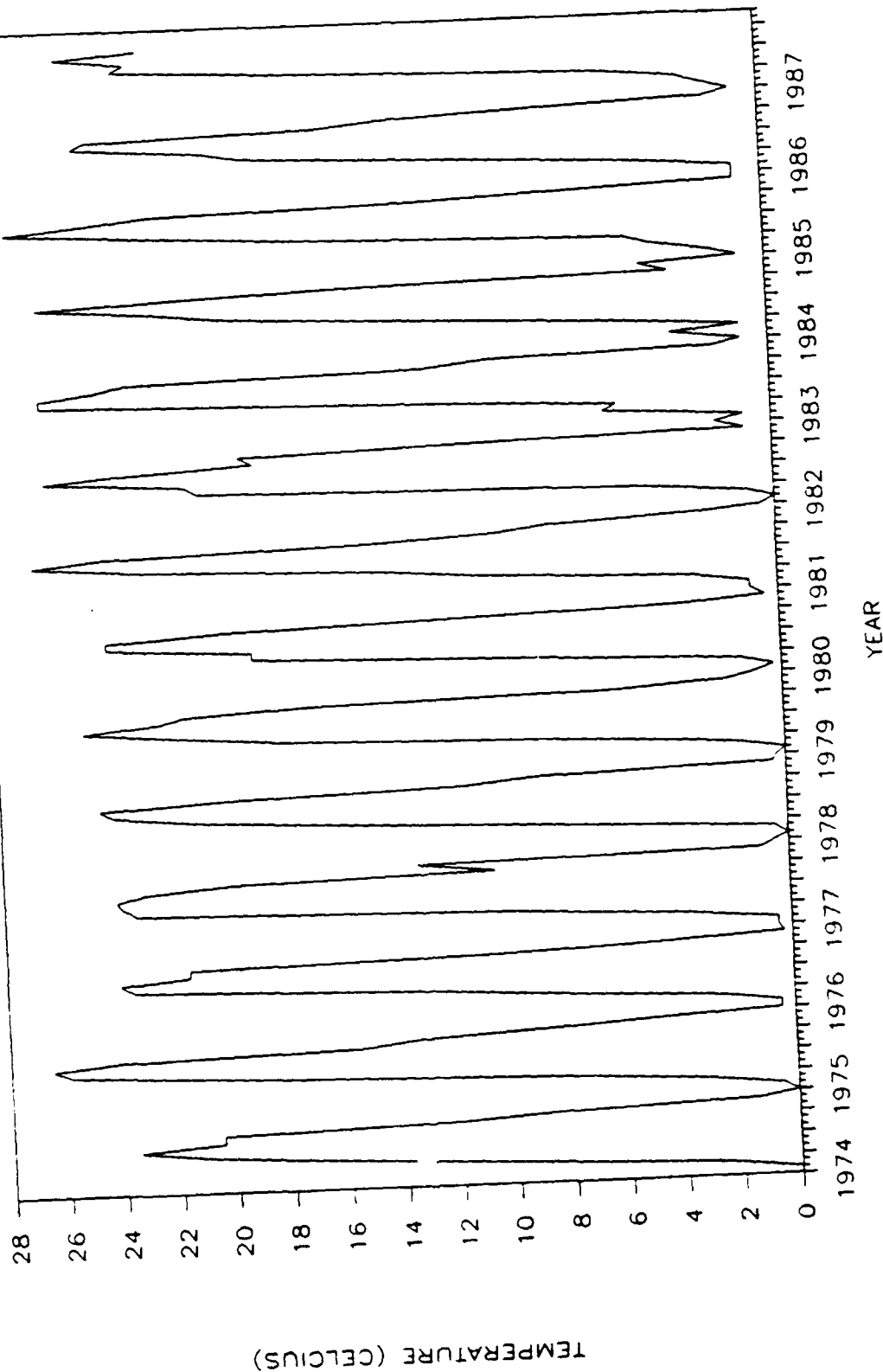


Figure 21. Monthly water temperatures in the Saginaw River, 1974-1987

BOD CONCENTRATION SAGINAW RIVER

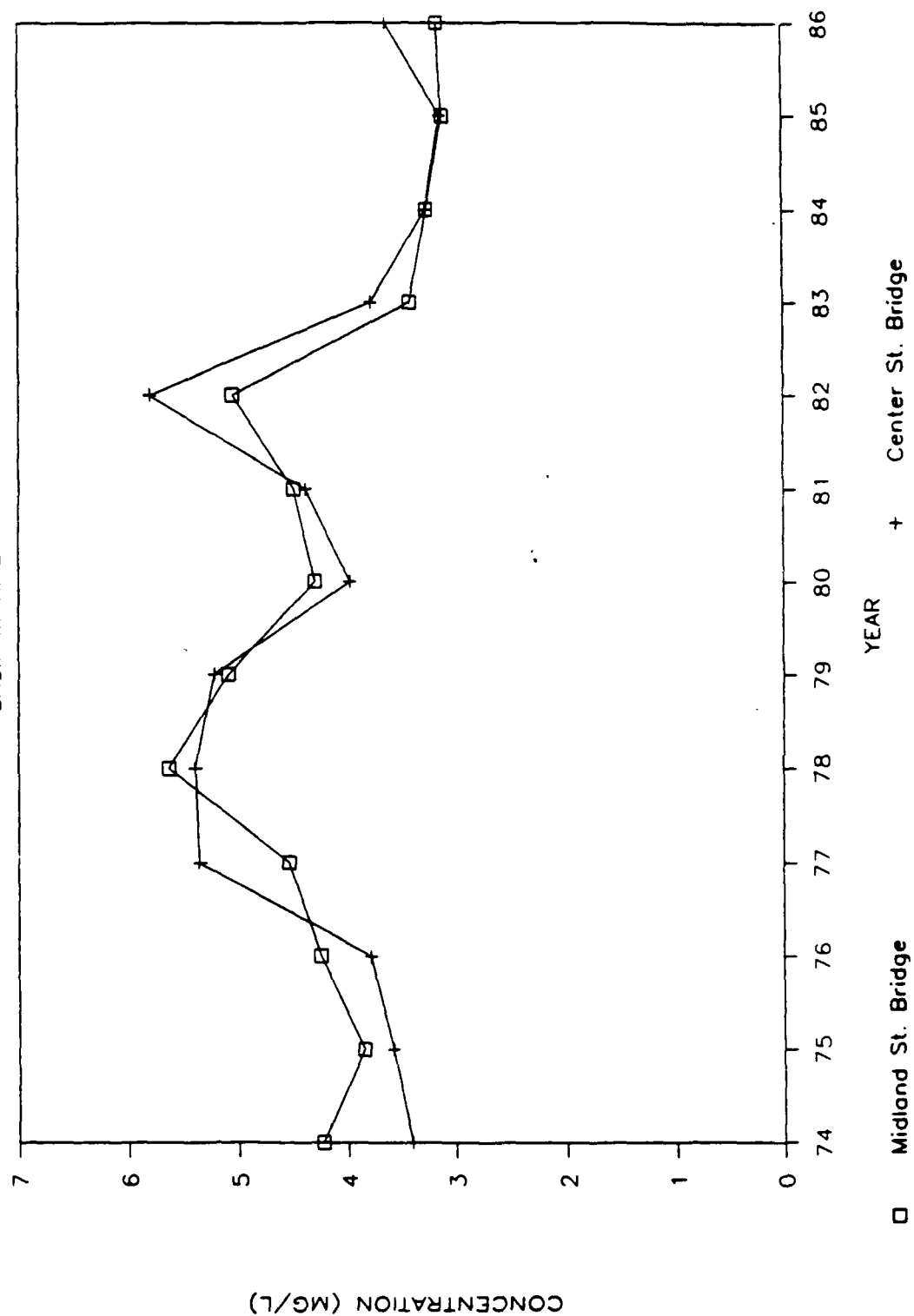


Figure 22a. Annual average biochemical oxygen demand in the Saginaw River, 1974-1986

BOD CONCENTRATION

TRIBUTARIES TO THE SAGINAW RIVER

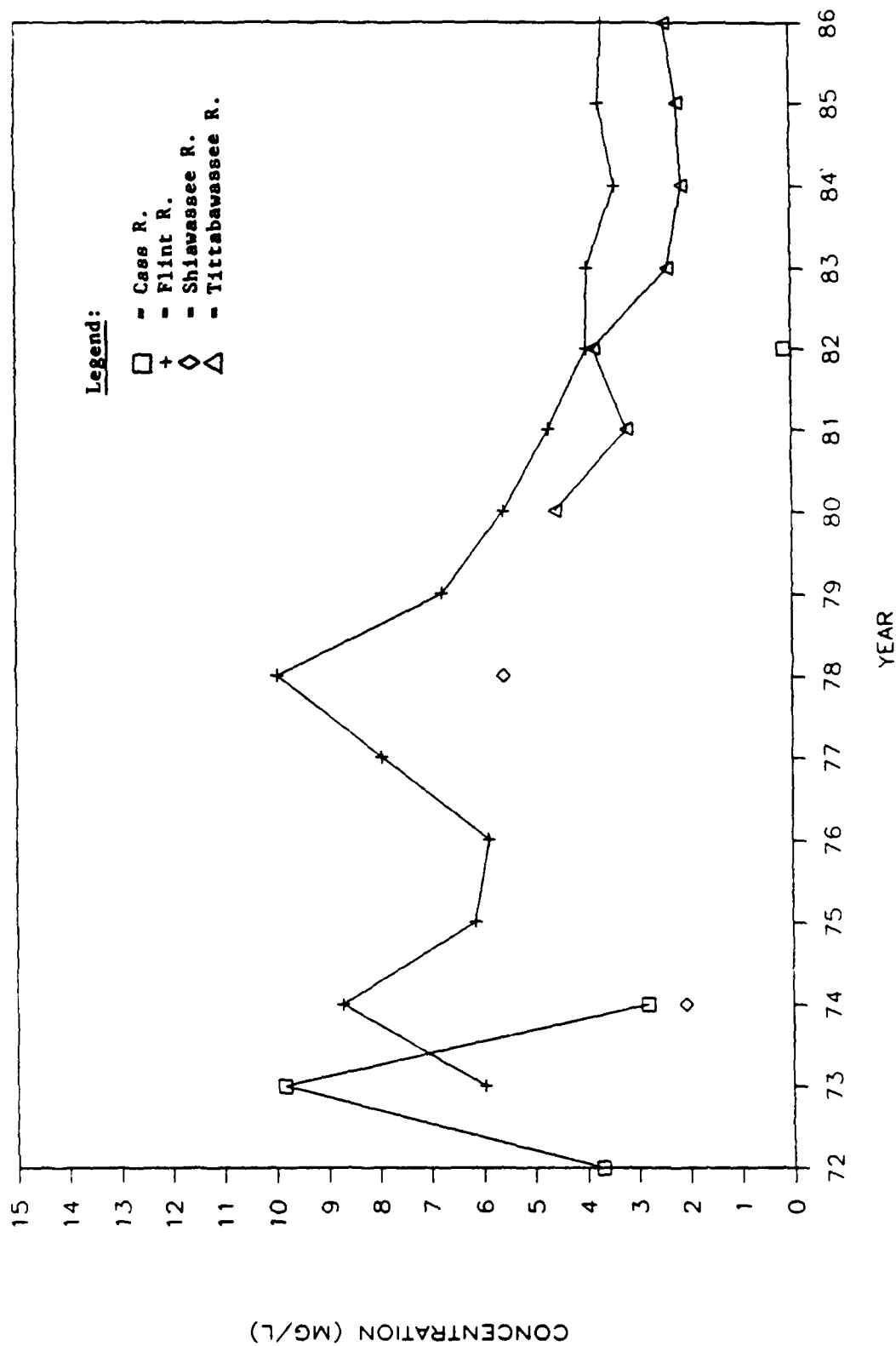


Figure 22b. Annual average biochemical oxygen demand in Saginaw River tributaries, 1972-1986

BOD CONCENTRATION WEST COASTAL BASIN TRIBUTARIES

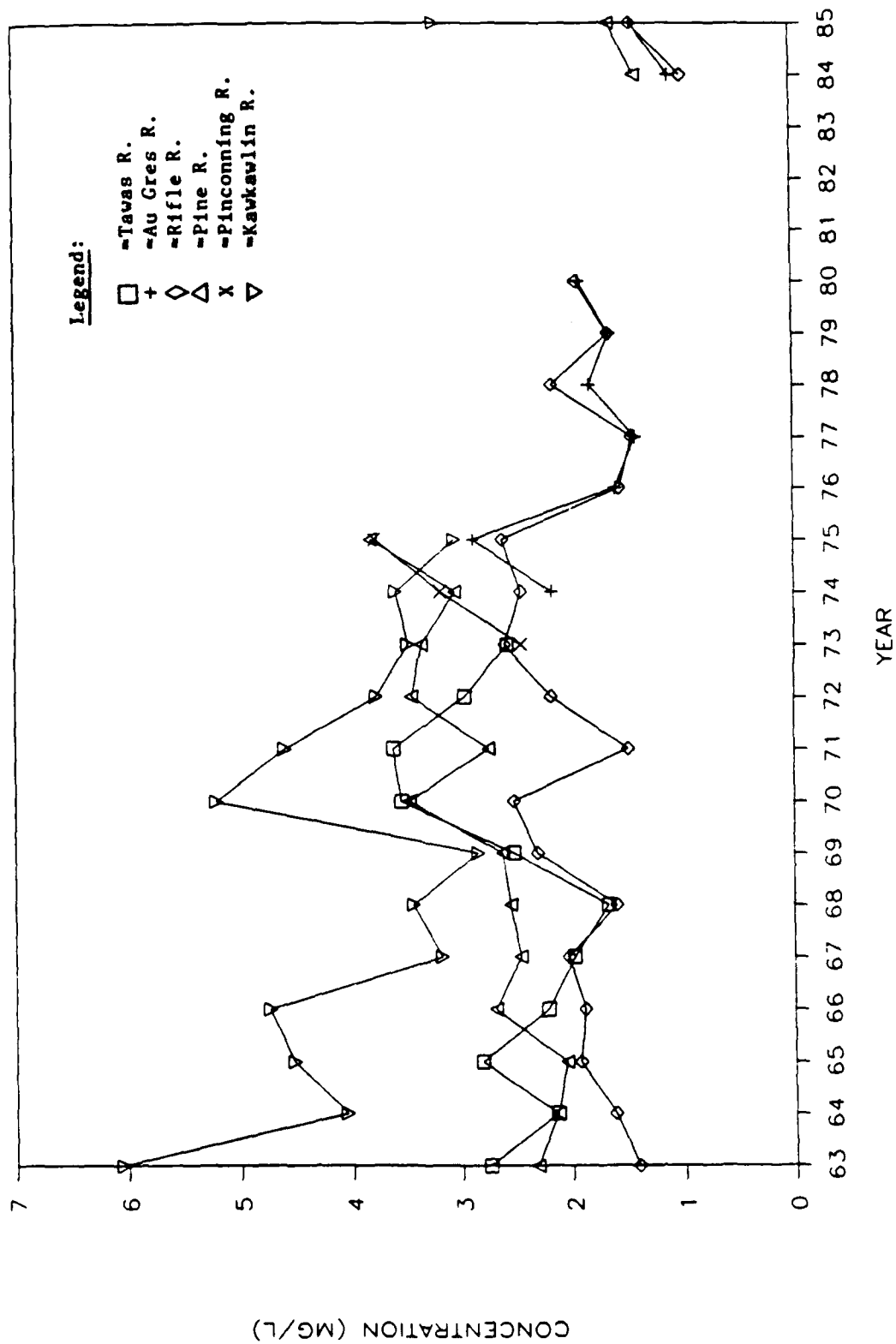


Figure 22c. Annual average biochemical oxygen demand in west coastal basin tributaries, 1963-1989

BOD CONCENTRATION EAST COASTAL BASIN TRIBUTARIES

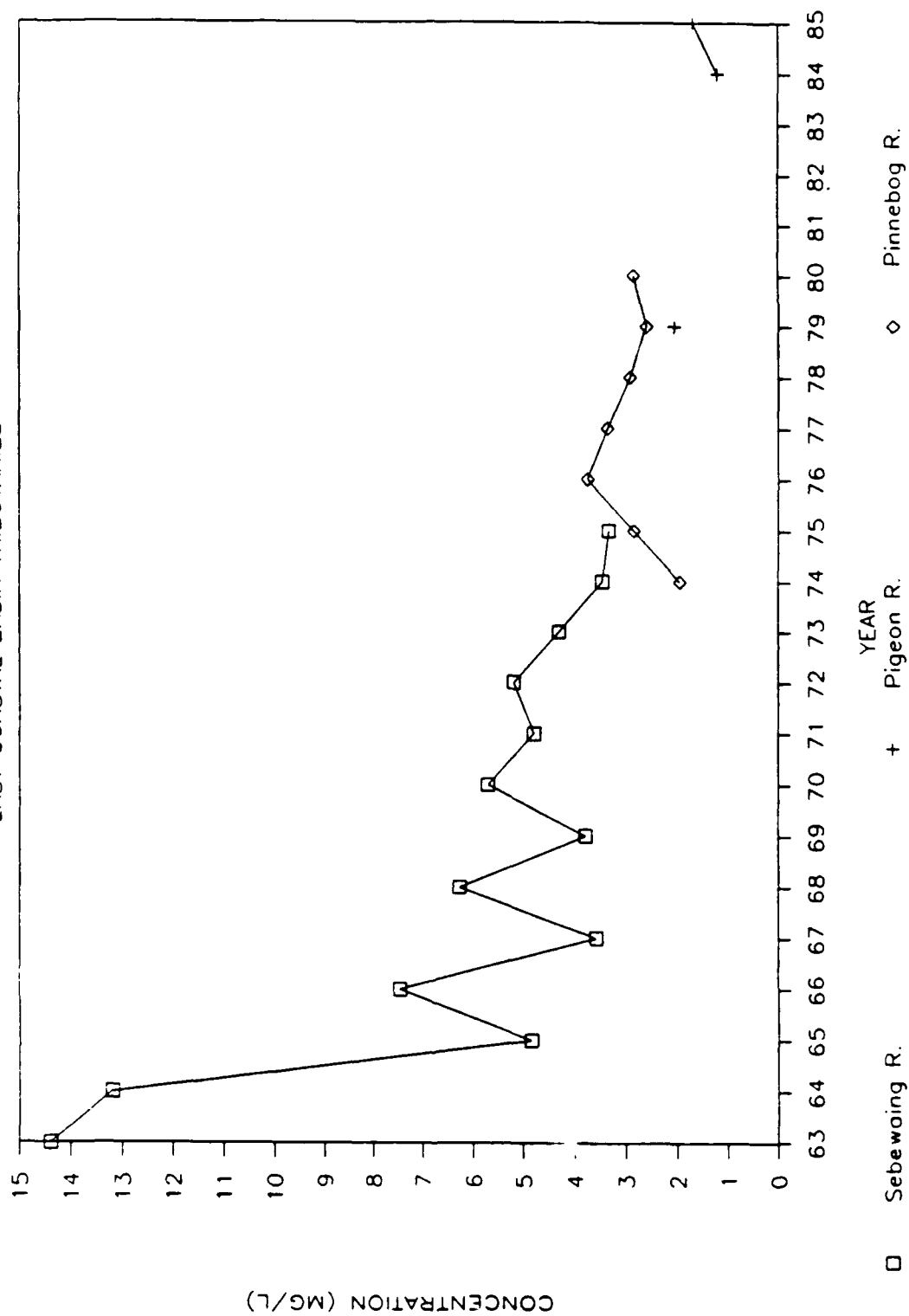


Figure 22d. Annual average biochemical oxygen demand in east coastal basin tributaries, 1963-1985

DISSOLVED OXYGEN CONCENTRATION

SAGINAW RIVER (MIDLAND ST. BRIDGE)

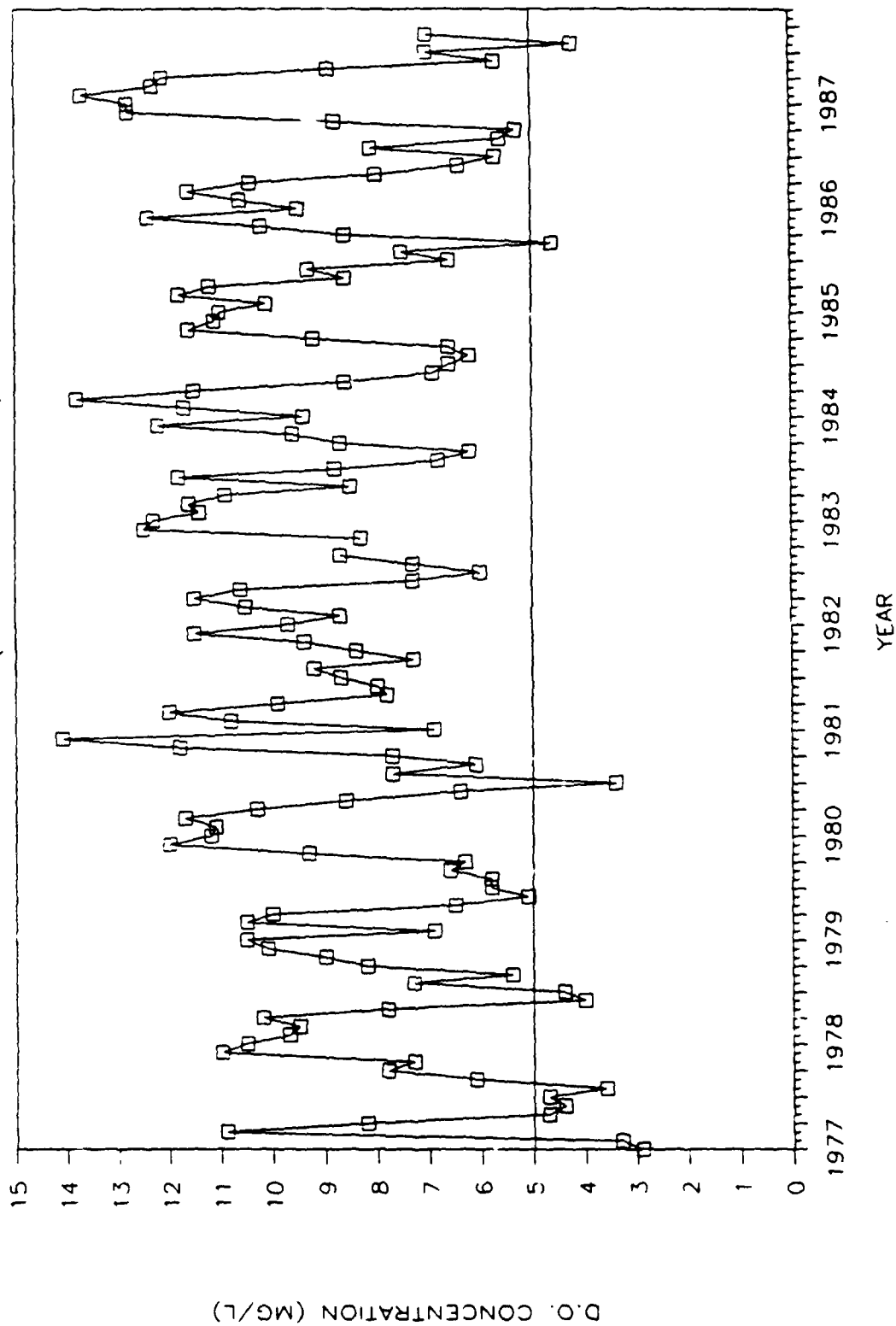


Figure 23a. Monthly dissolved oxygen concentrations in the Saginaw River at the Midland Street Bridge, 1977-1987

DISSOLVED OXYGEN CONCENTRATION

SAGINAW RIVER (CENTER ST. BRIDGE)

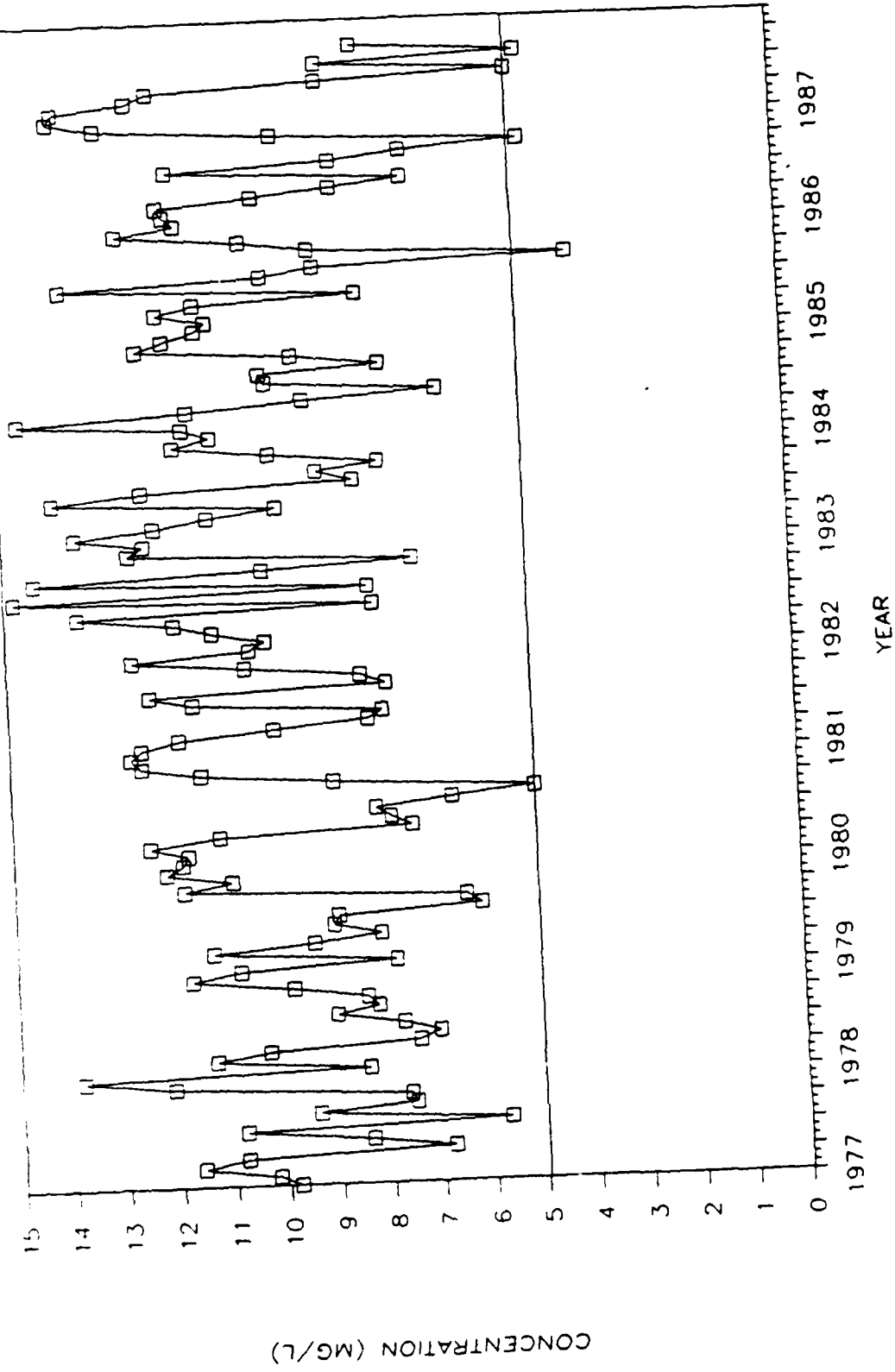


Figure 23b. Monthly dissolved oxygen concentrations in the Saginaw River
(at the Center Street Bridge, 1977-1987)

SUSPENDED SOLIDS CONCENTRATION

SAGINAW RIVER

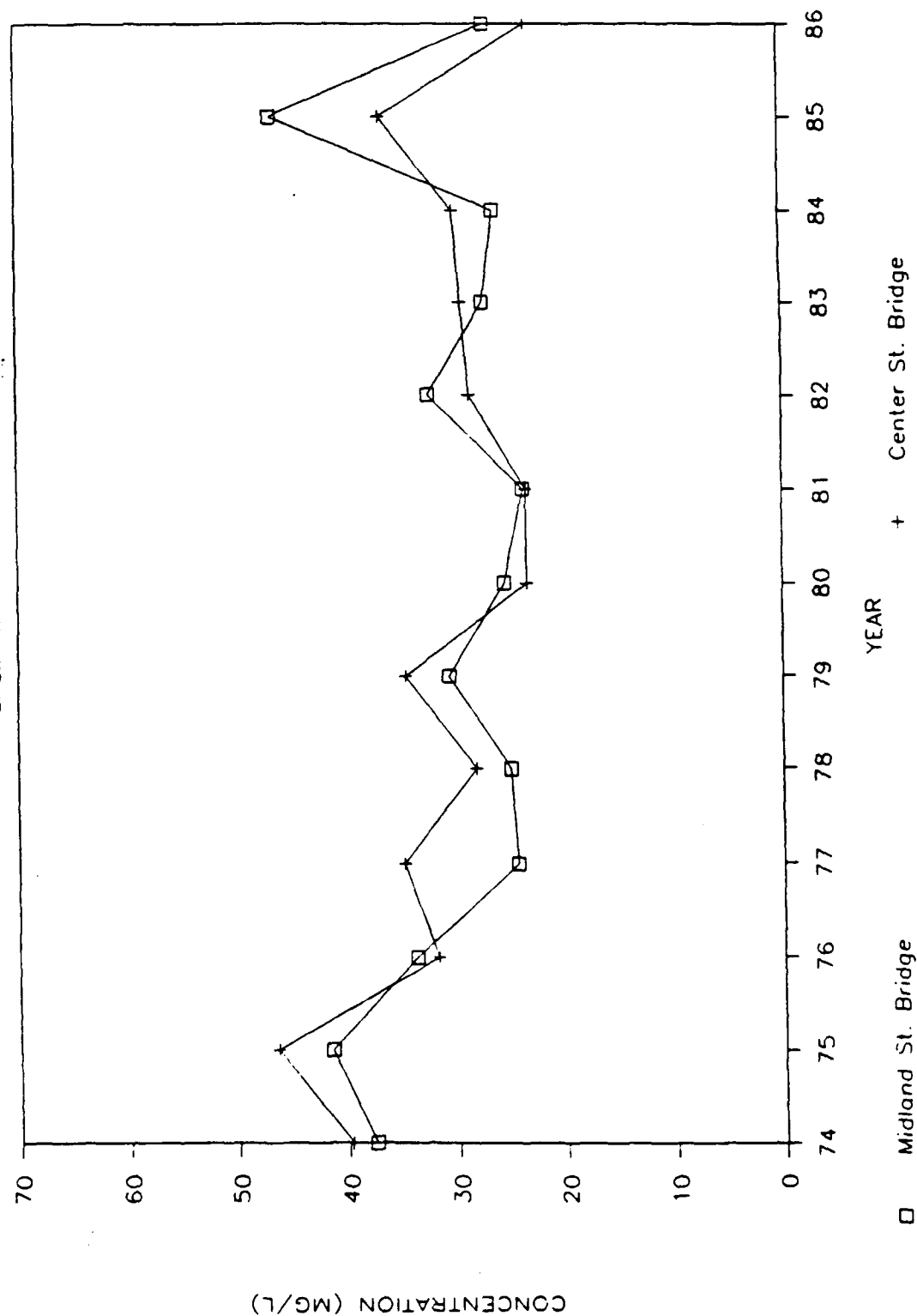


Figure 24a. Annual average suspended solids concentrations in Saginaw River water samples, 1974-1986

SUSPENDED SOLIDS CONCENTRATION

TRIBUTARIES TO THE SAGINAW RIVER

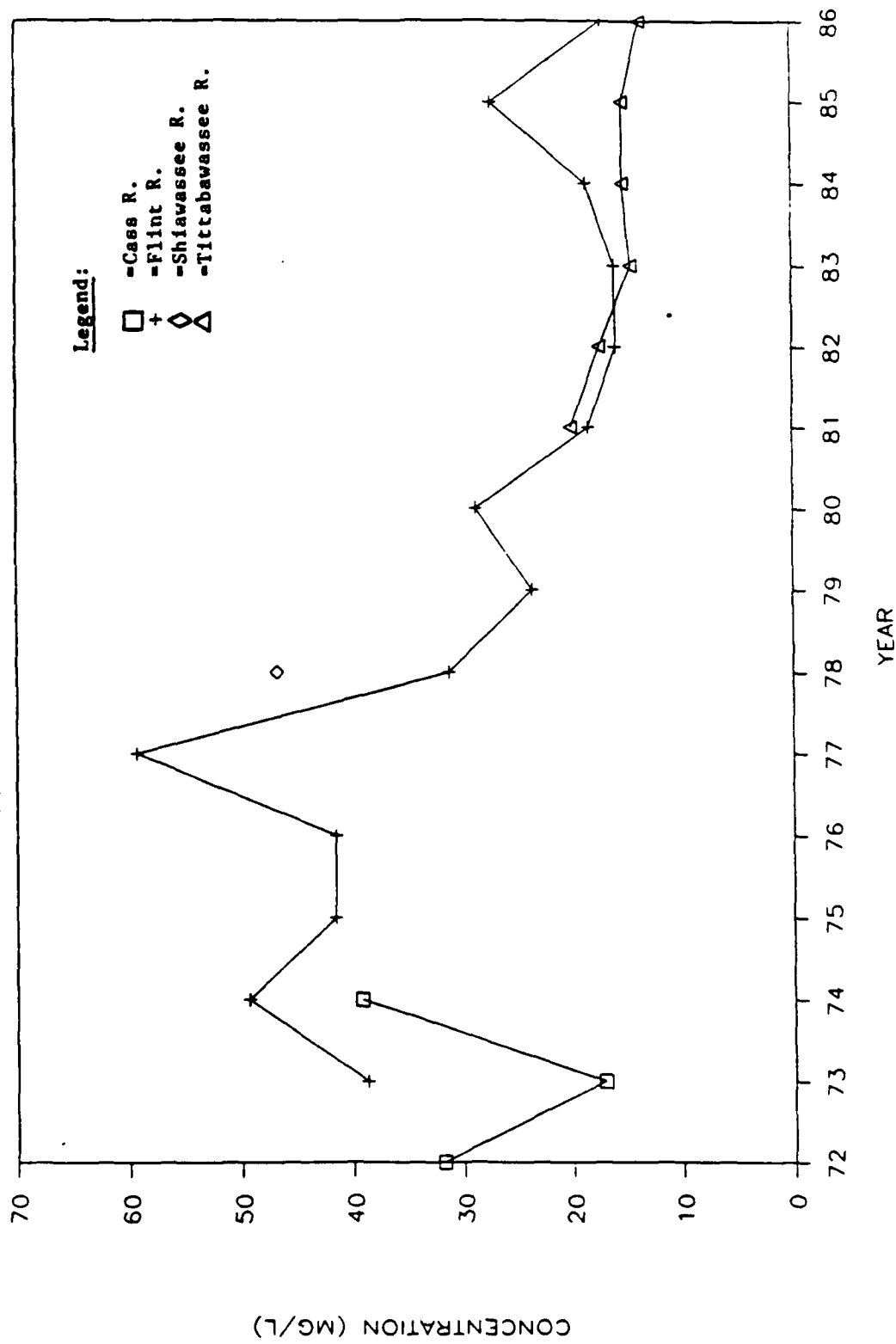


Figure 24b. Annual average suspended solids concentrations in Saginaw River tributaries, 1972-1986

SUSPENDED SOLIDS CONCENTRATION

WEST COASTAL BASIN TRIBUTARIES

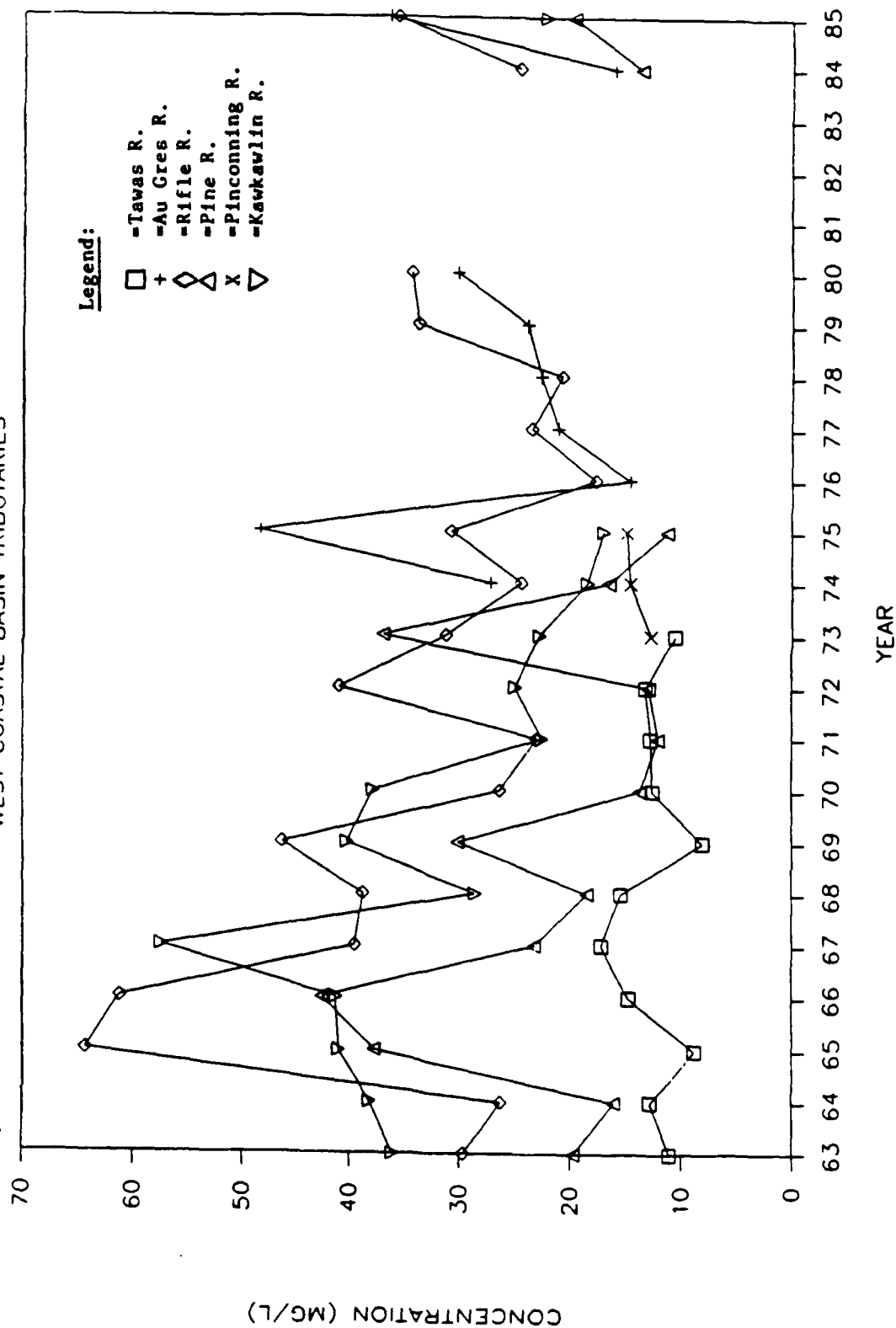


Figure 24c. Annual average suspended solids concentrations in Saginaw Bay west coastal basin tributaries, 1963-1985

SUSPENDED SOLIDS CONCENTRATION

EAST COASTAL BASIN TRIBUTARIES

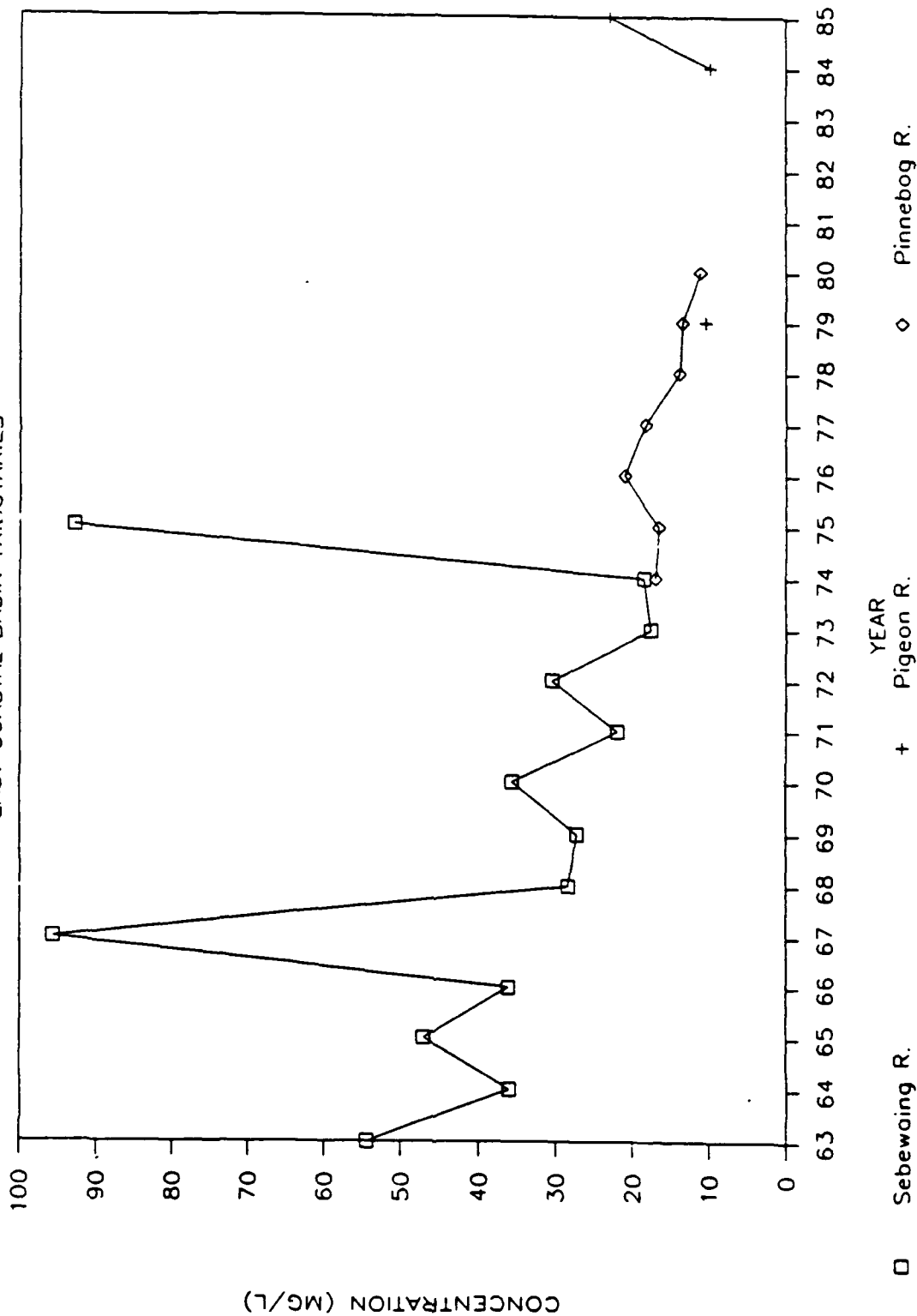


Figure 24d. Annual average suspended solids concentrations in Saginaw Bay east coastal basin tributaries, 1963-1985

TOTAL SOLIDS CONCENTRATION

SAGINAW RIVER

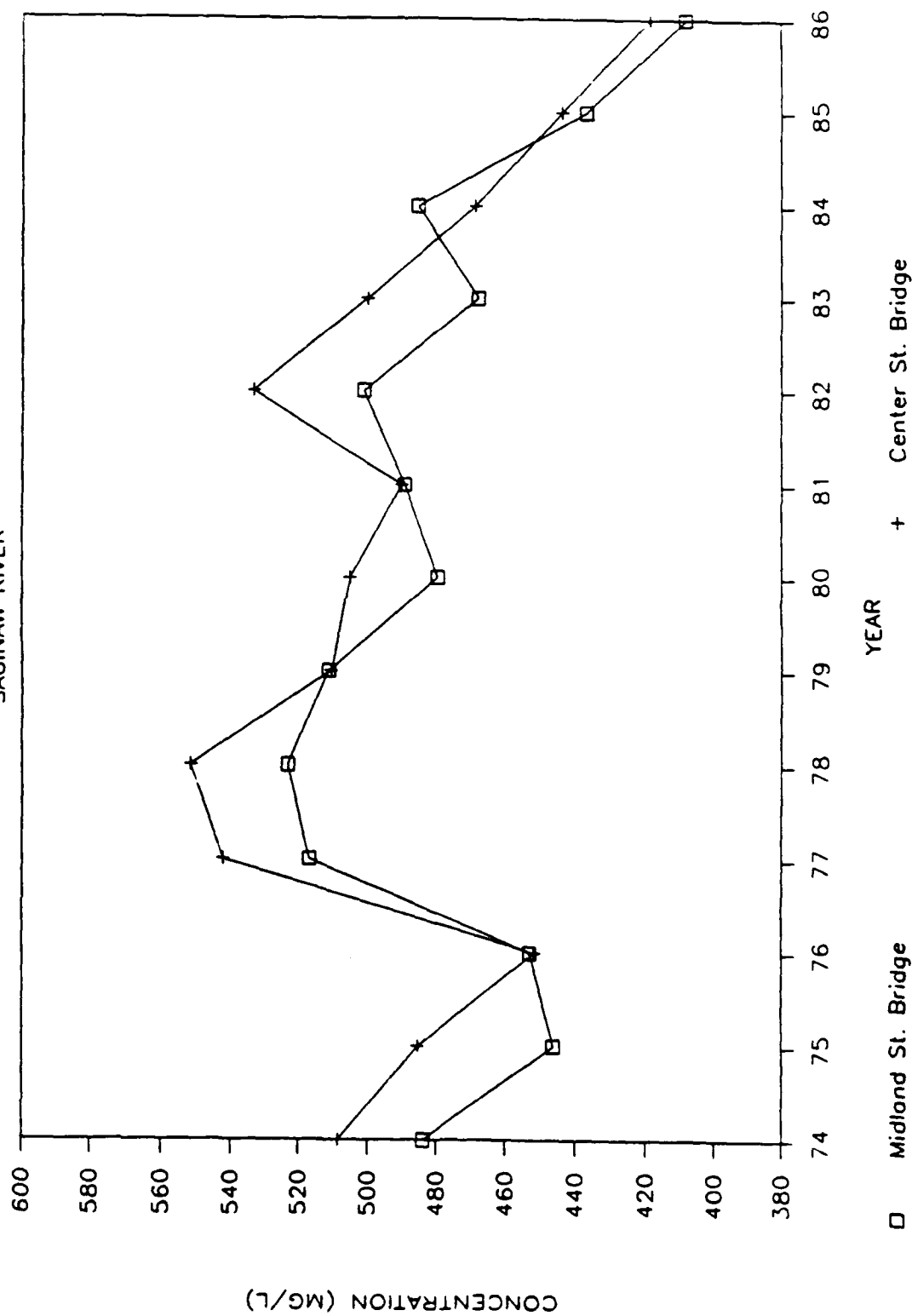


Figure 25a. Annual average total solids concentrations in Saginaw River water samples, 1974-1986

TOTAL SOLIDS CONCENTRATION TRIBUTARIES TO THE SAGINAW RIVER

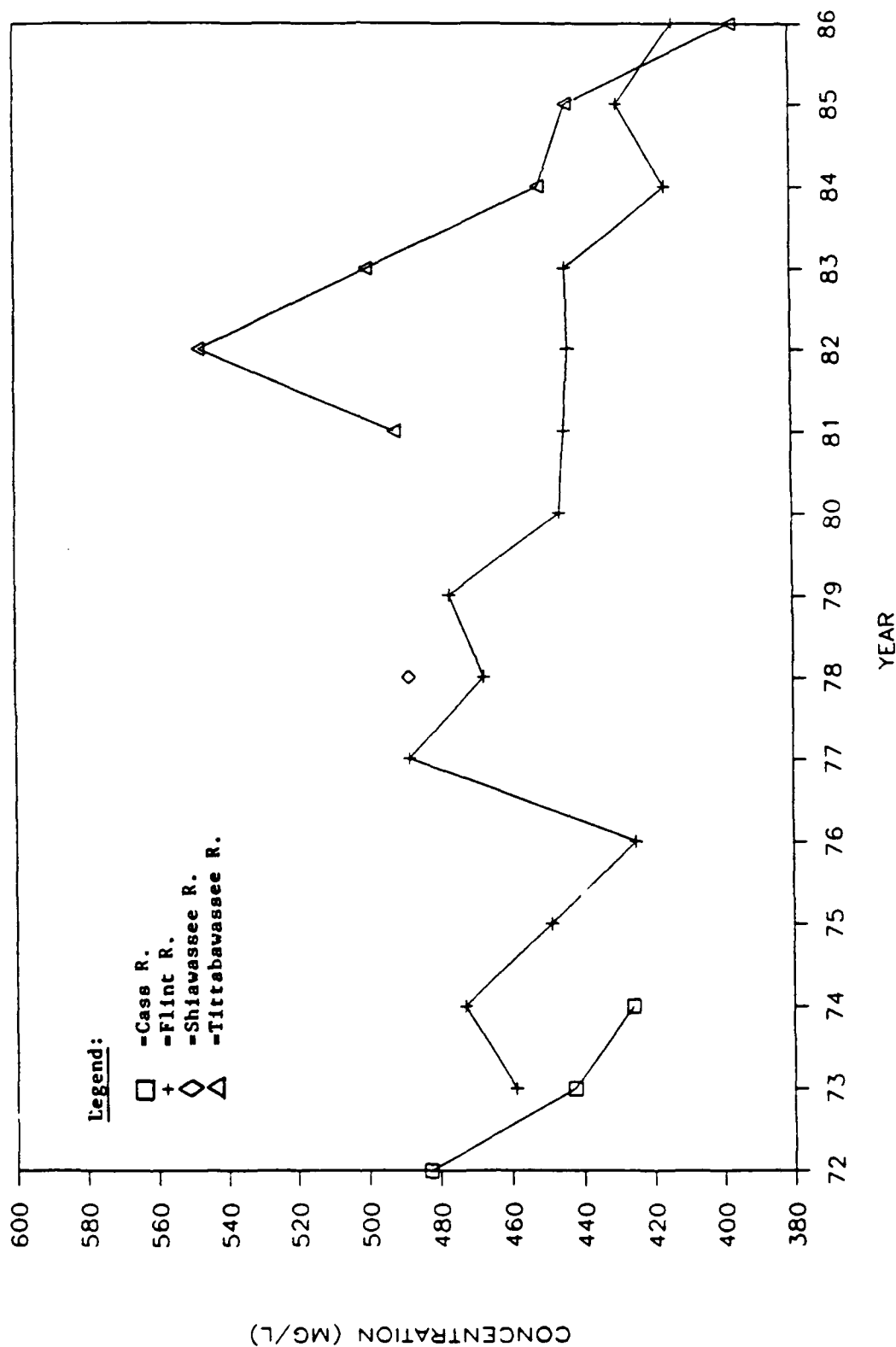


Figure 25b. Annual average total solids concentrations in Saginaw River tributaries, 1972-1986

TOTAL SOLIDS CONCENTRATION WEST COASTAL BASIN TRIBUTARIES

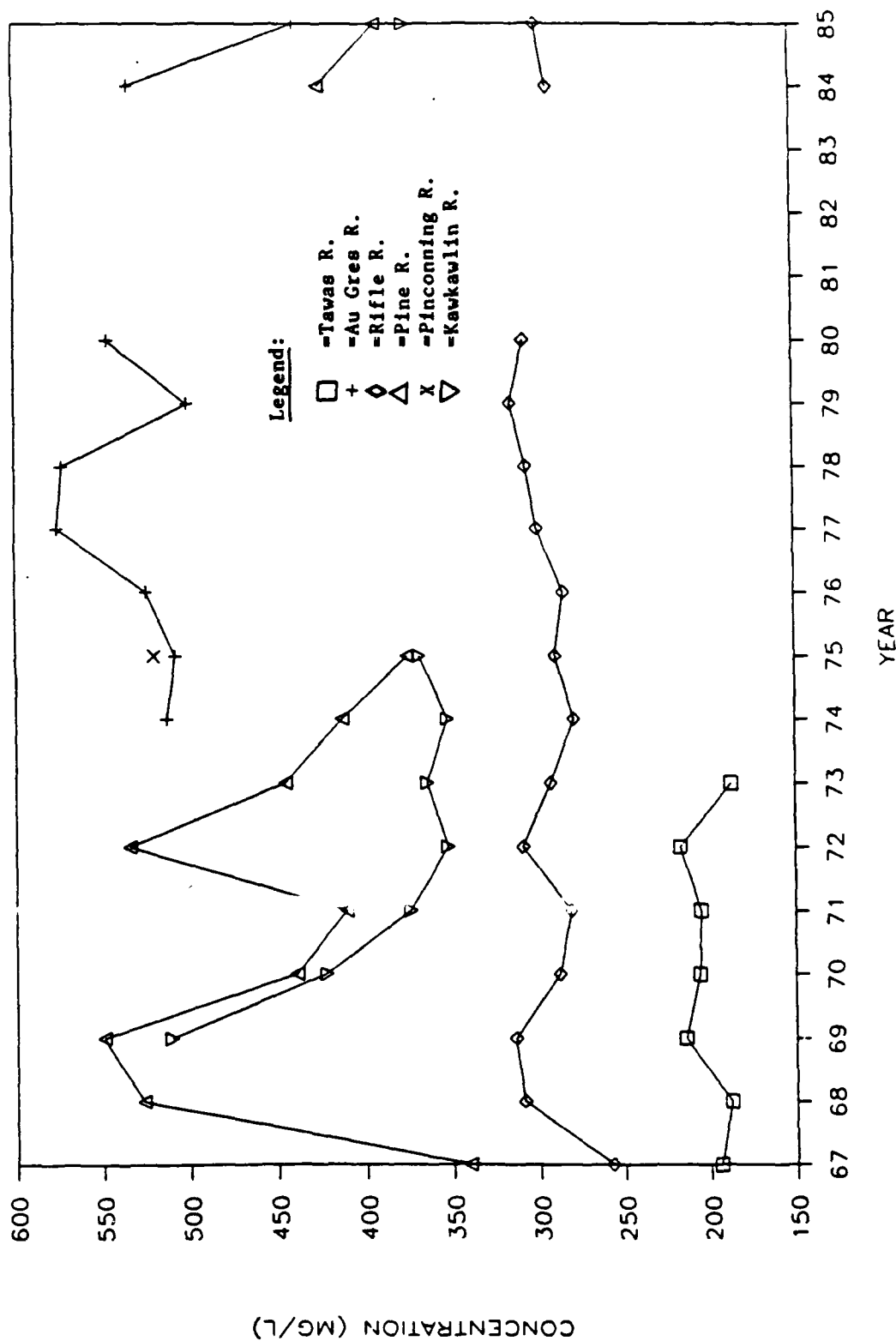


Figure 25c. Annual average total solids concentrations in Saginaw Bay west coastal basin tributaries, 1967-1985

TOTAL SOLIDS CONCENTRATION EAST COASTAL BASIN TRIBUTARIES

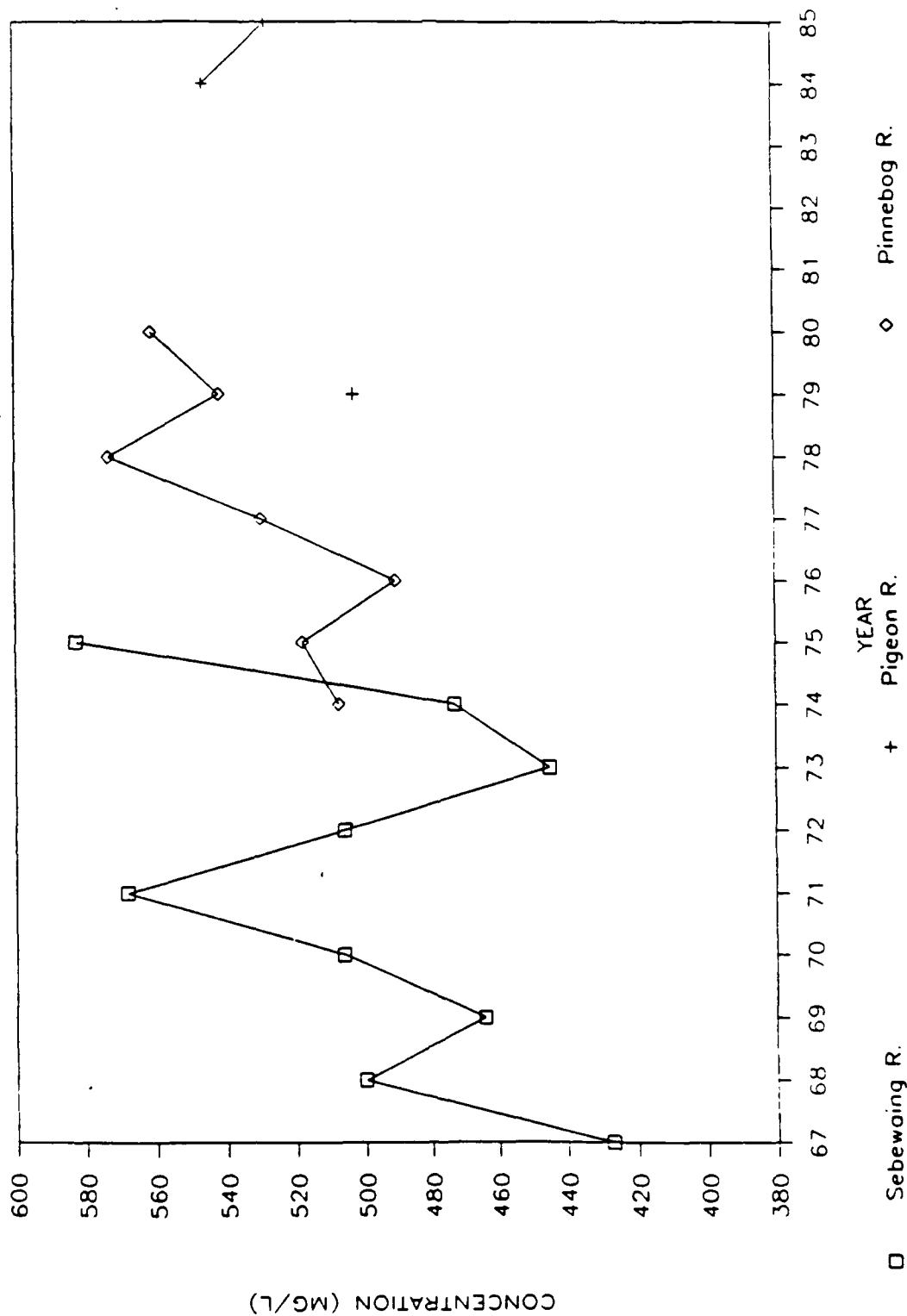


Figure 25d. Annual average total solids concentrations in Saginaw Bay
east coastal basin tributaries, 1967-1985

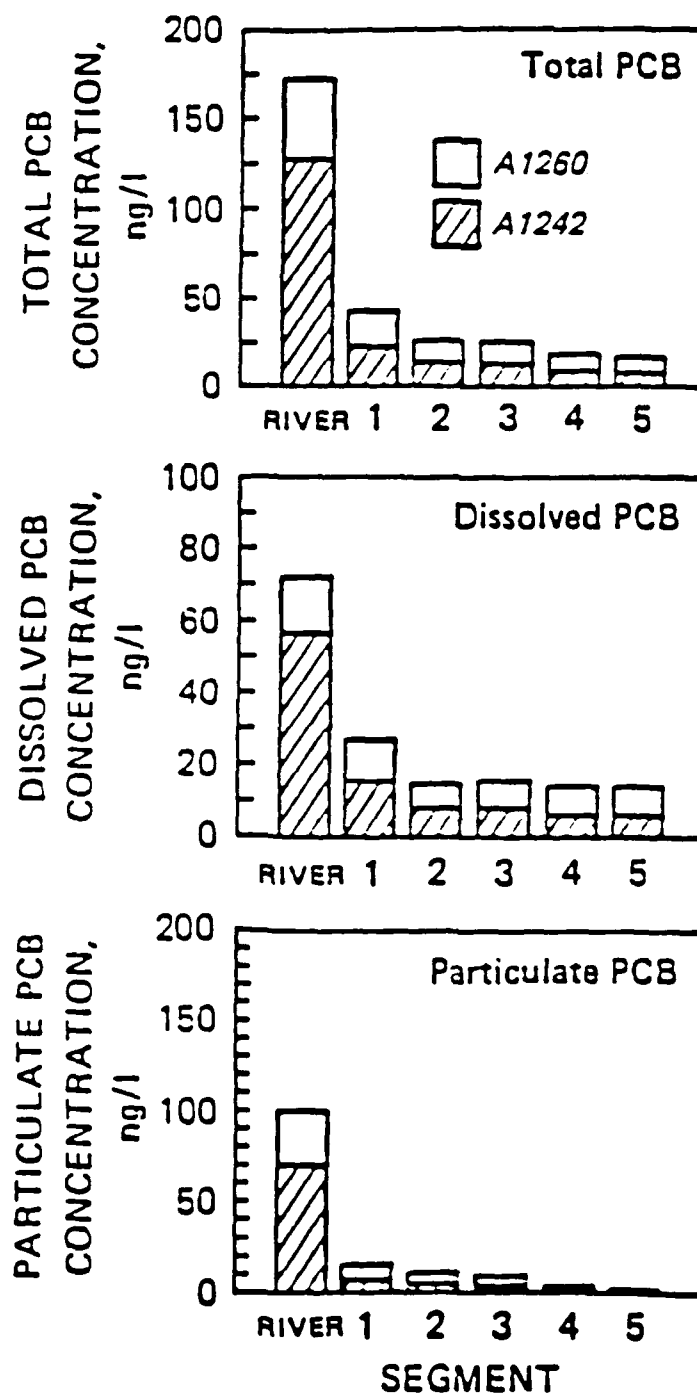
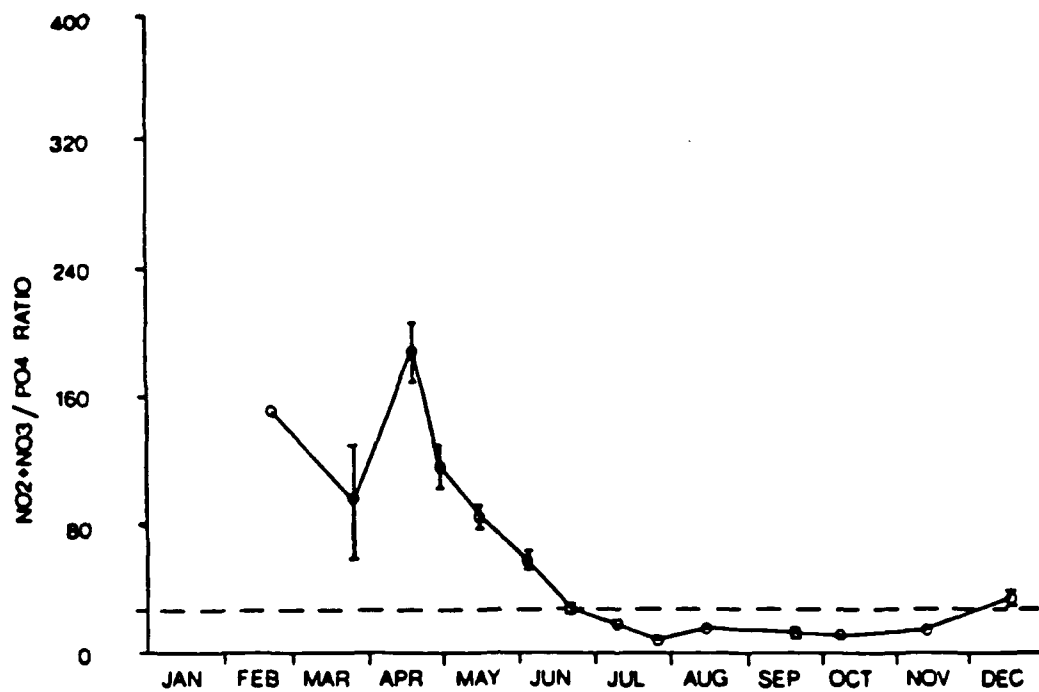
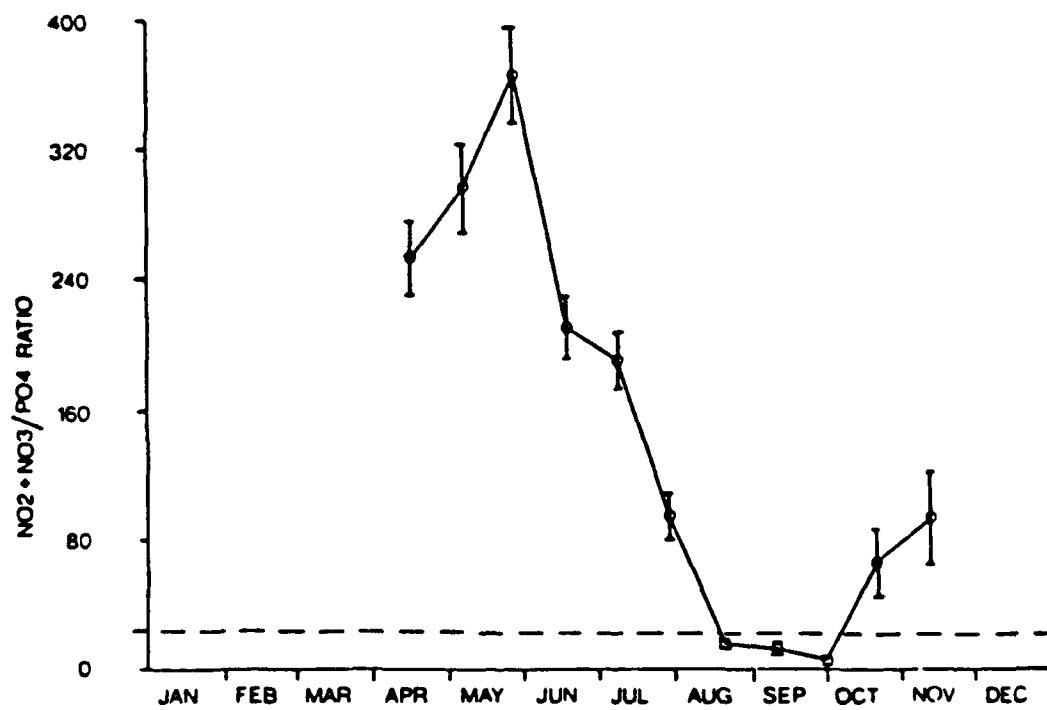


Figure 26. Average of total PCB concentrations by particulate and dissolved fractions, Saginaw River and five segments of Saginaw Bay, 1979 (Richardson et al. 1983)



Segment 2, 1974



Segment 2, 1980

Figure 27a. Nitrogen/phosphorus ratios in Saginaw Bay, 1974 and 1980
(Dolan et al. 1986)

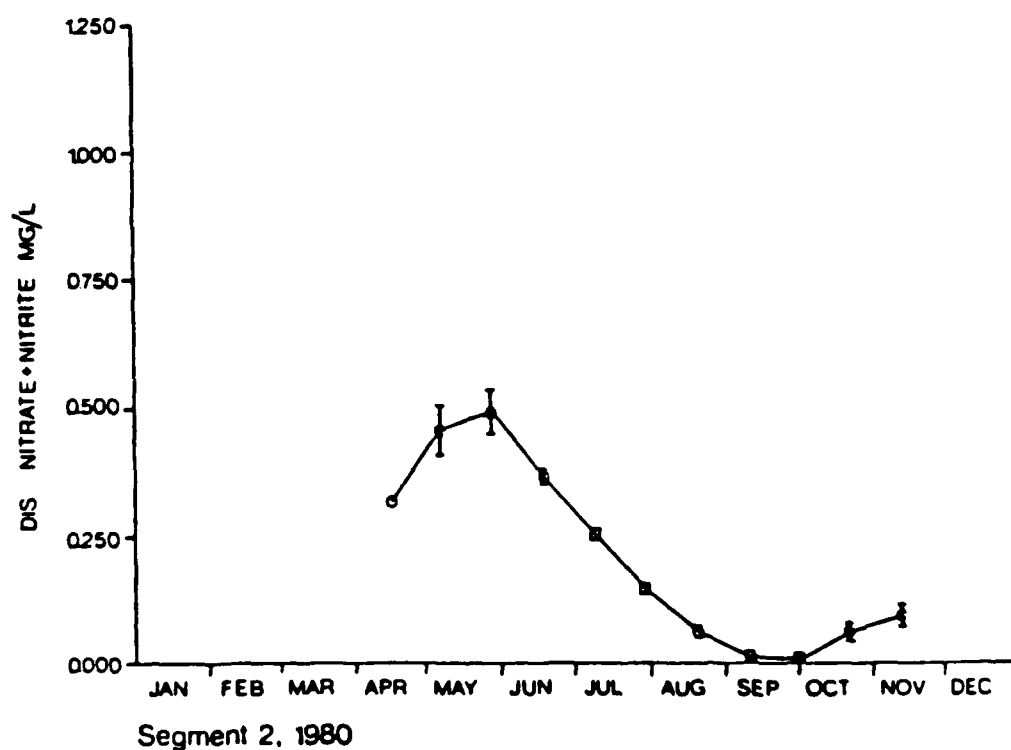
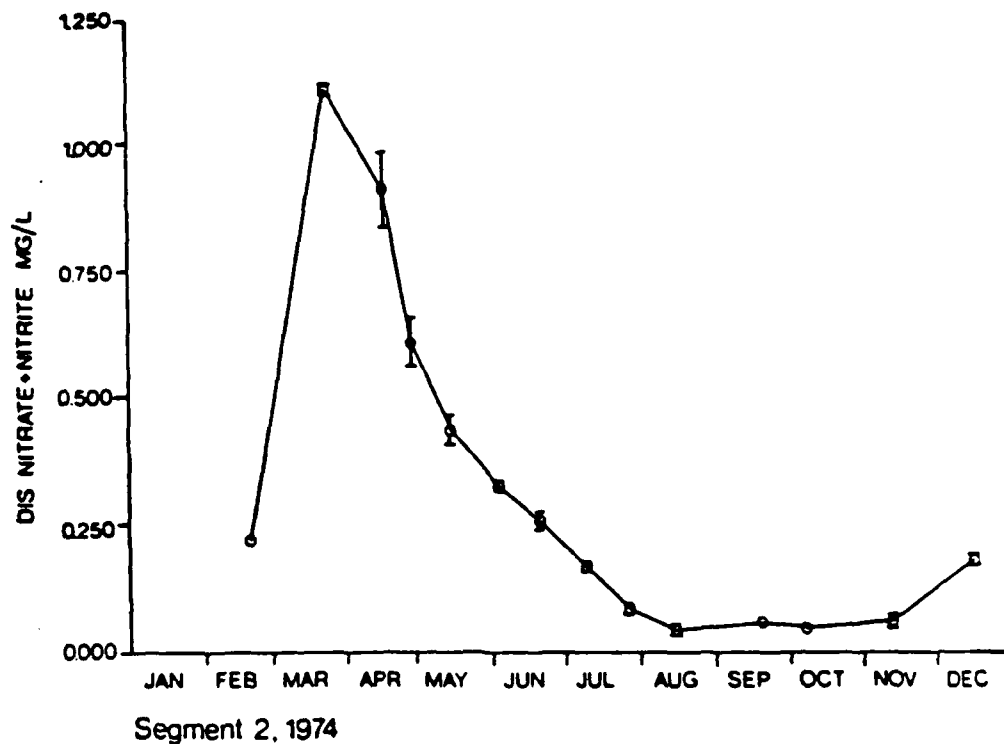


Figure 27b. Nitrate-nitrite concentrations (mg/l) in Saginaw Bay, 1974 and 1980 (Dolan et al. 1986)

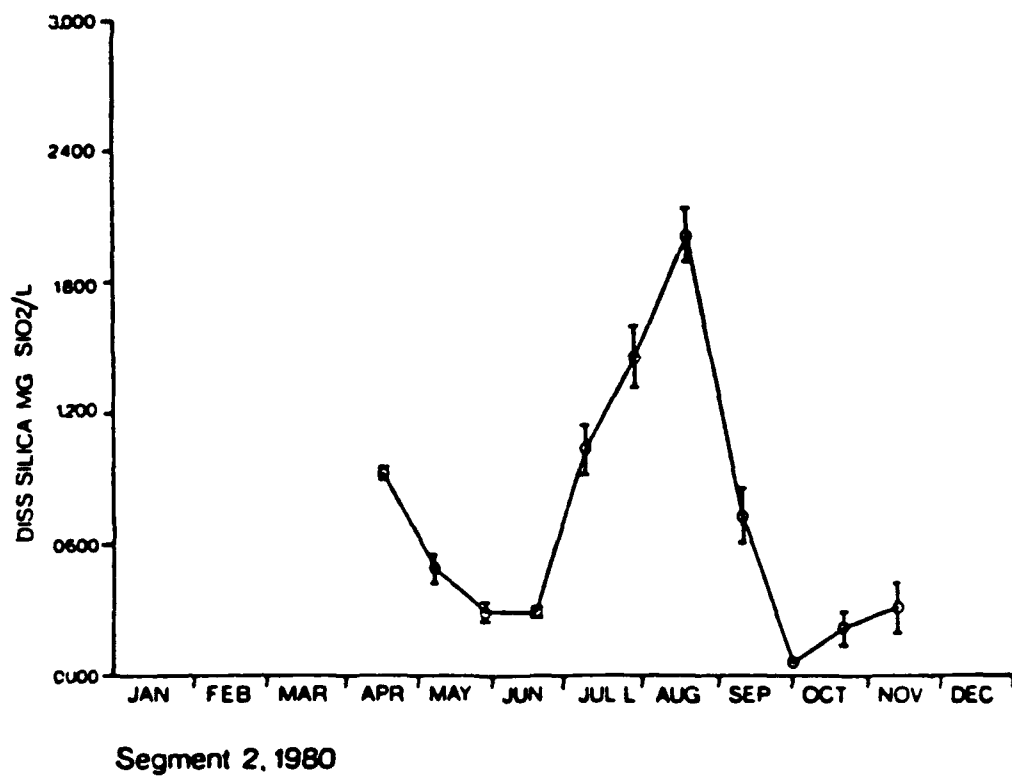
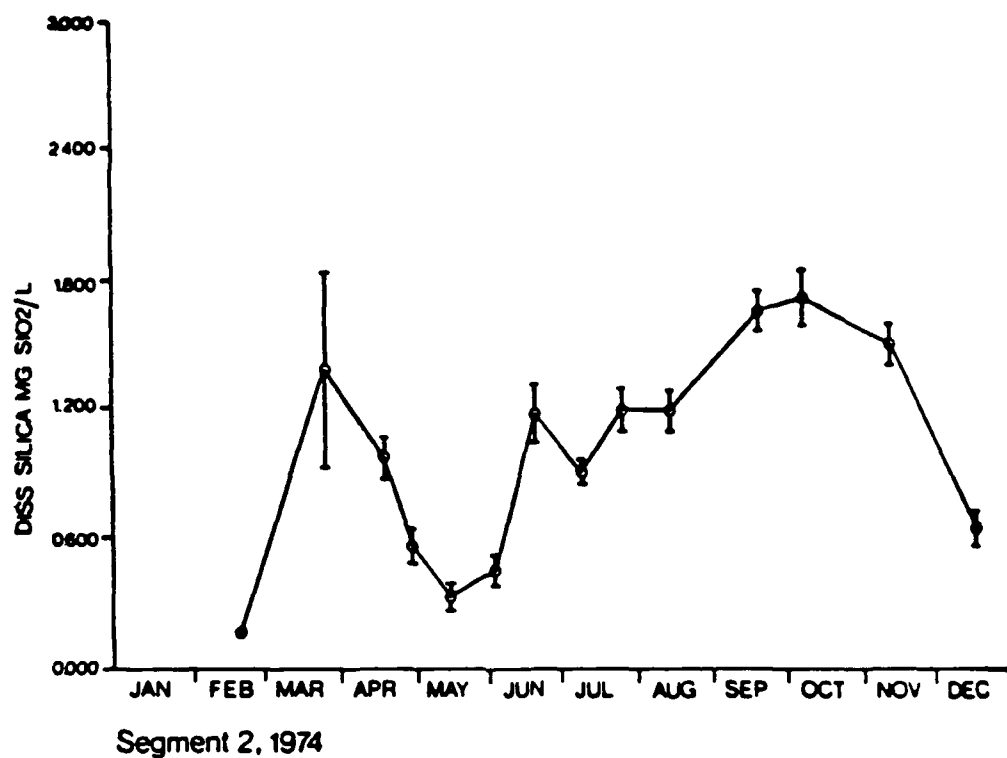


Figure 27c. Dissolved silica concentrations (mg/l) in Saginaw Bay, 1974 and 1980 (Dolan et al. 1986)

TOTAL PHOSPHORUS CONCENTRATION

SAGINAW RIVER

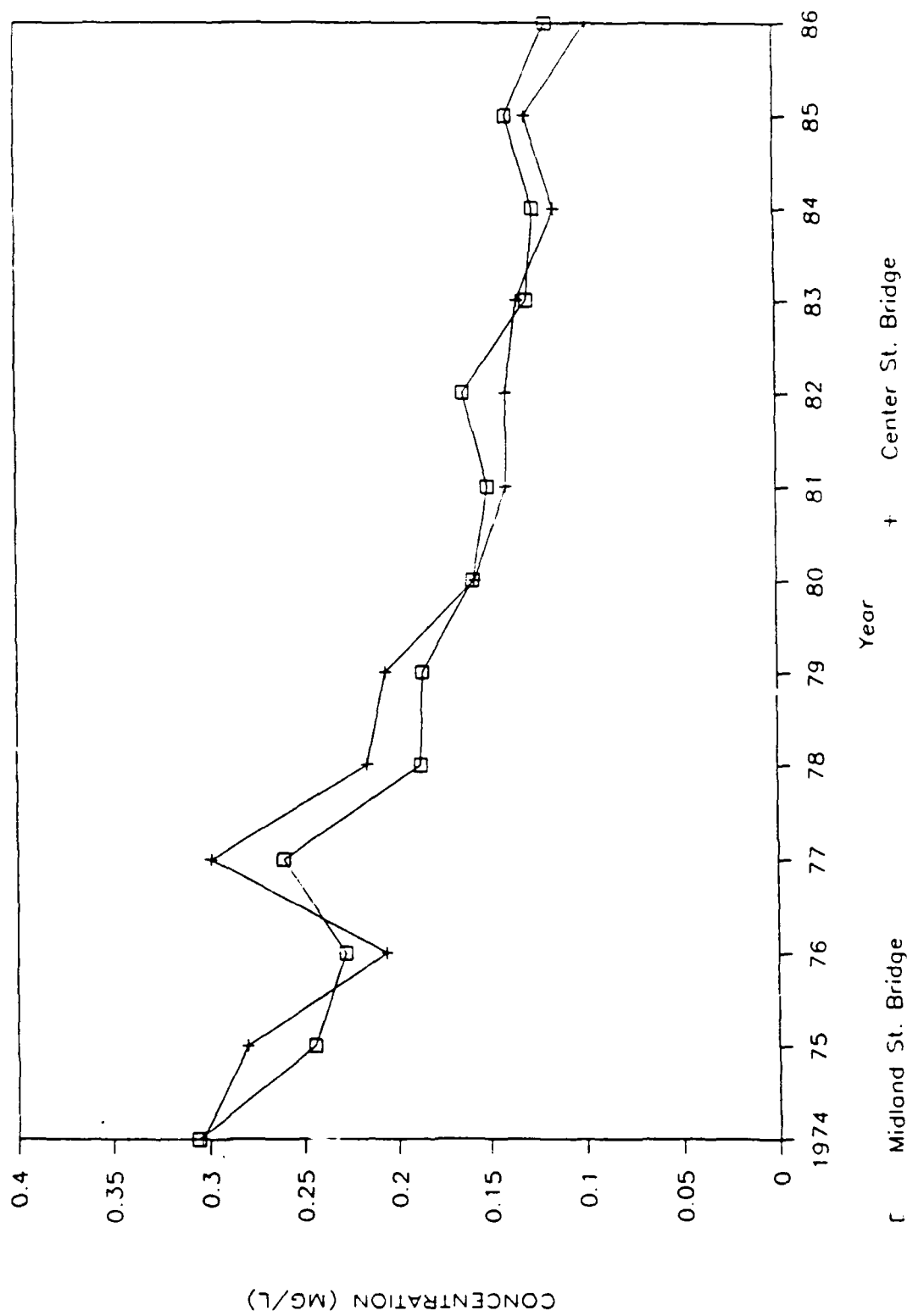


Figure 28a. Annual average total phosphorus concentrations in Saginaw River water samples, 1974-1986

TOTAL PHOSPHORUS CONCENTRATION

TRIBUTARIES TO THE SAGINAW RIVER

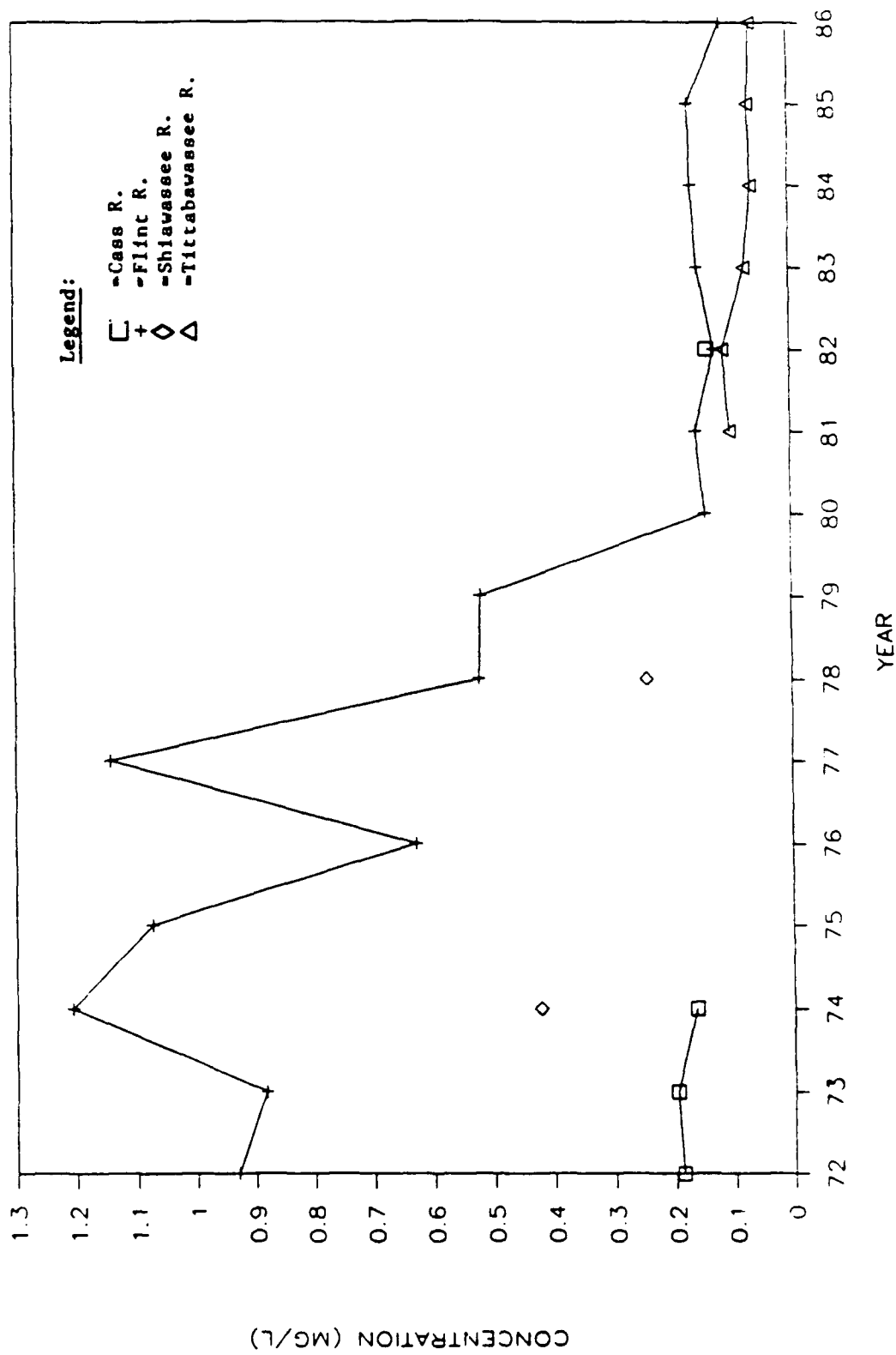


Figure 28b. Annual average total phosphorus concentrations in Saginaw River tributaries, 1972-1986

TOTAL PHOSPHORUS CONCENTRATION

WEST COASTAL BASIN TRIBUTARIES

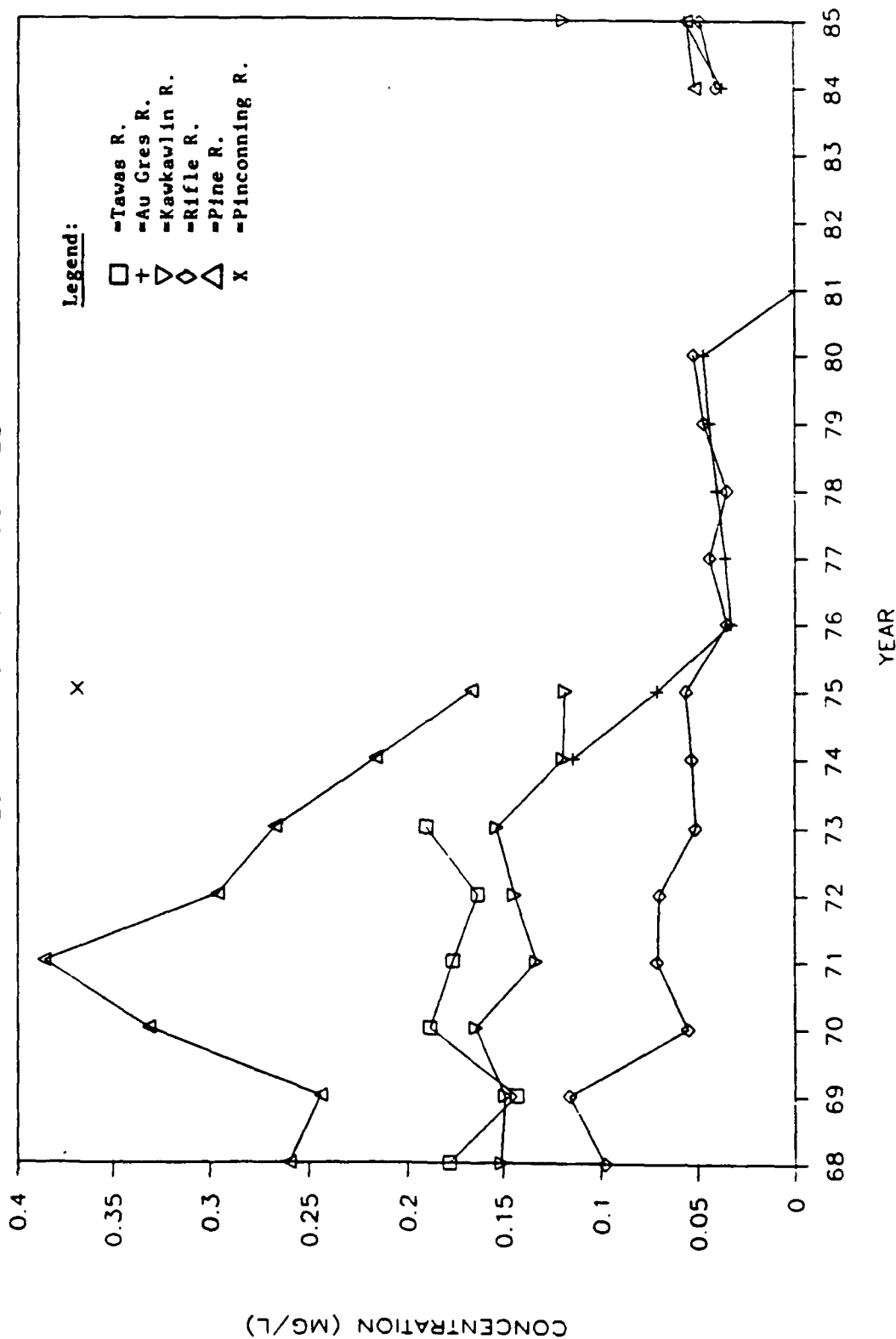


Figure 28c. Annual average total phosphorus concentrations in Saginaw Bay west coastal basin tributaries, 1968-1985

TOTAL PHOSPHORUS CONCENTRATION EAST COASTAL BASIN TRIBUTARIES

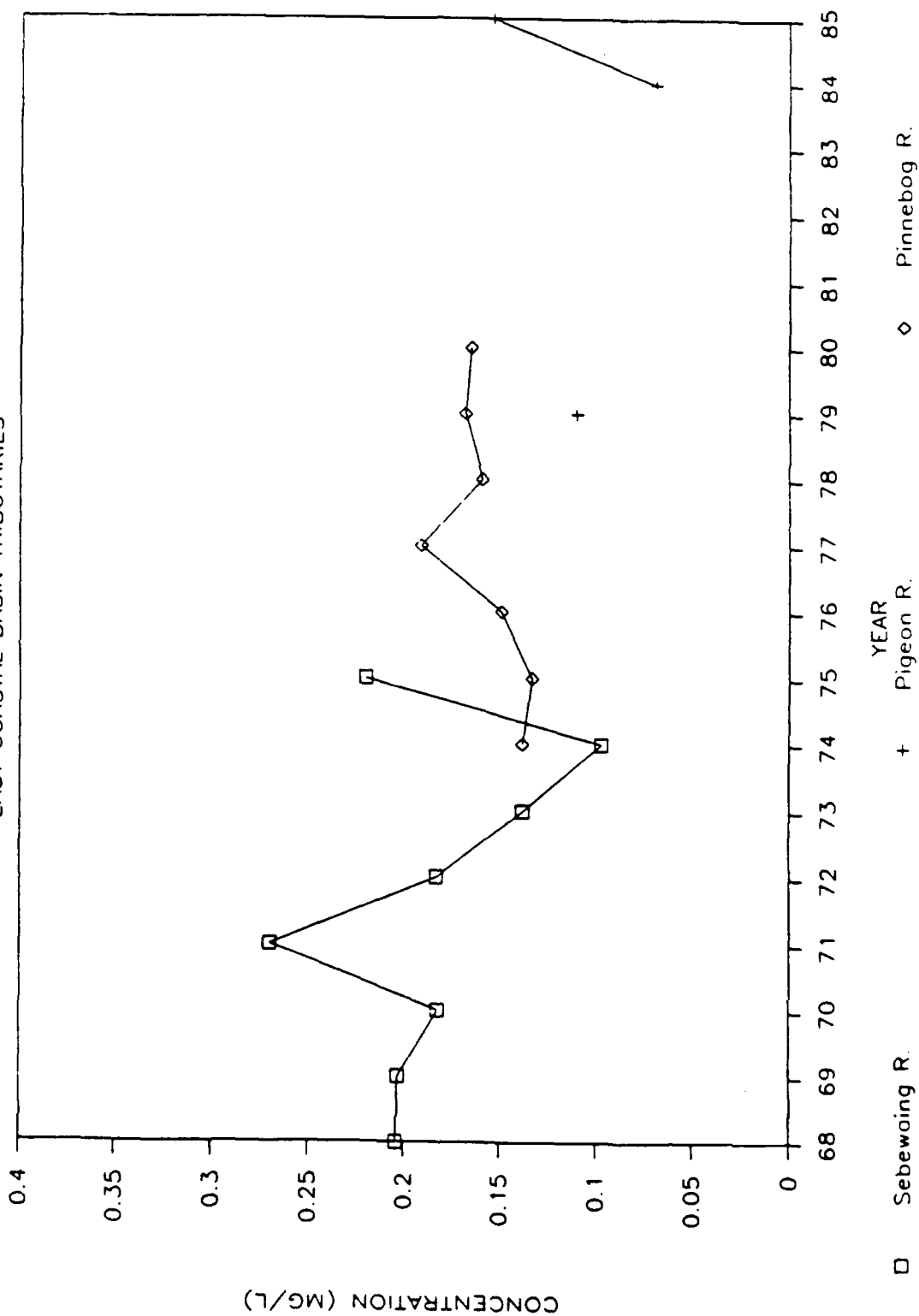


Figure 28d. Annual average total phosphorus concentrations in Saginaw Bay east coastal basin tributaries, 1968-1985

ORTHOPHOSPHORUS CONCENTRATION

SAGINAW RIVER

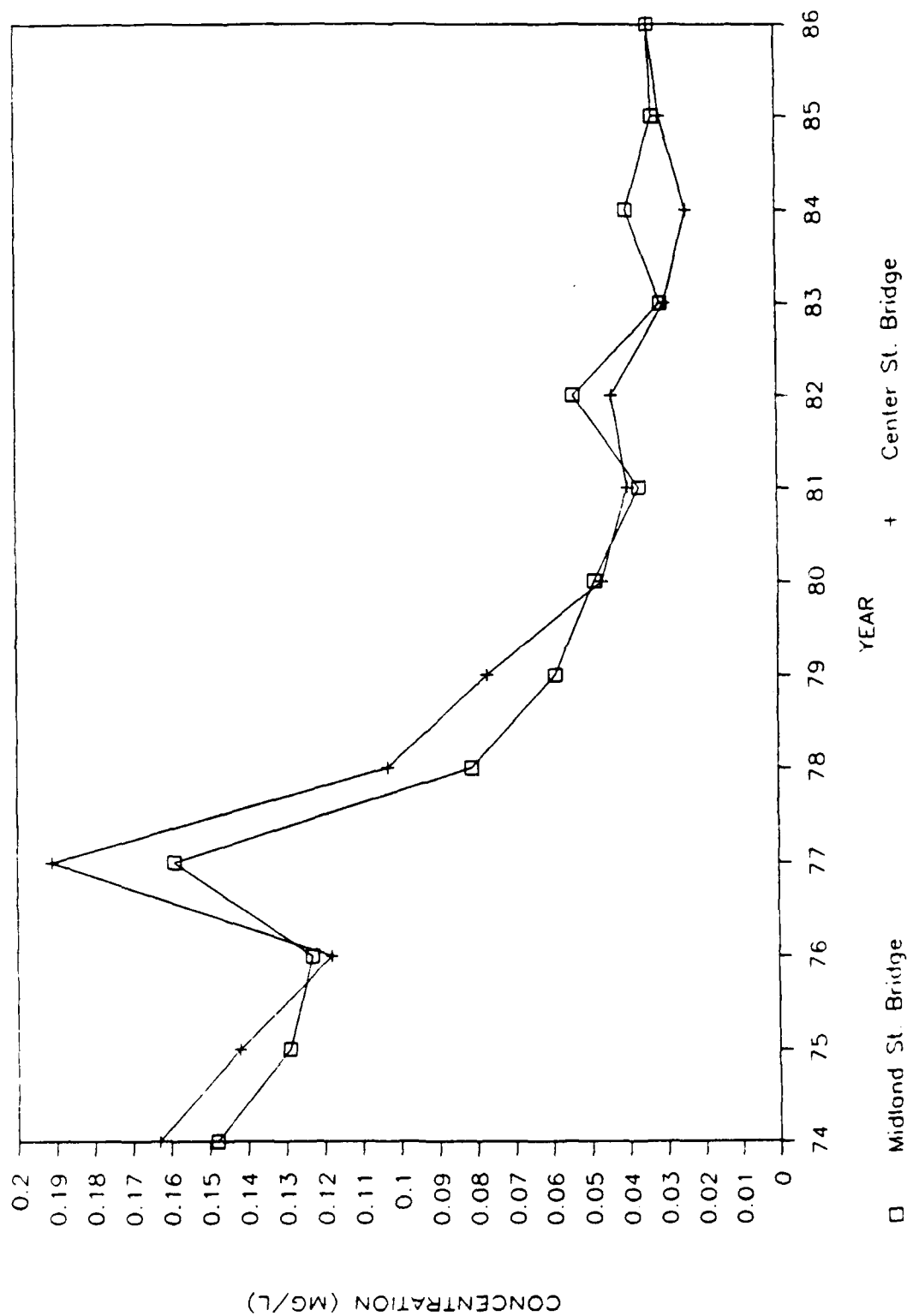


Figure 29a. Annual average orthophosphorus concentrations in Saginaw River water samples, 1974-1986

ORTHOPHOSPHORUS CONCENTRATION

TRIBUTARIES TO THE SAGINAW RIVER

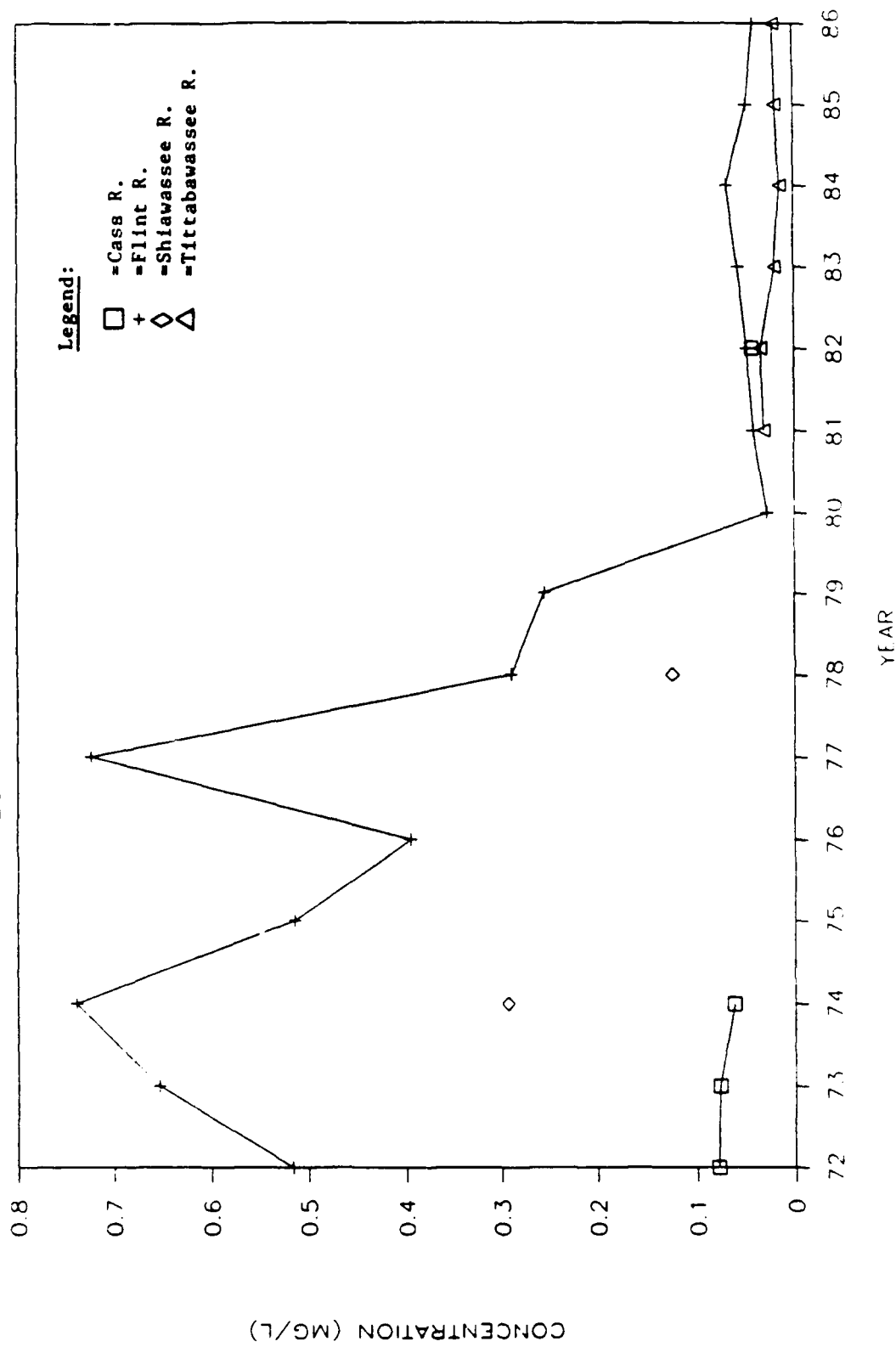


Figure 29b. Annual average orthophosphorus concentrations in Saginaw River tributaries, 1972-1986

ORTHOPHOSPHORUS CONCENTRATION

WEST COASTAL BASIN TRIBUTARIES

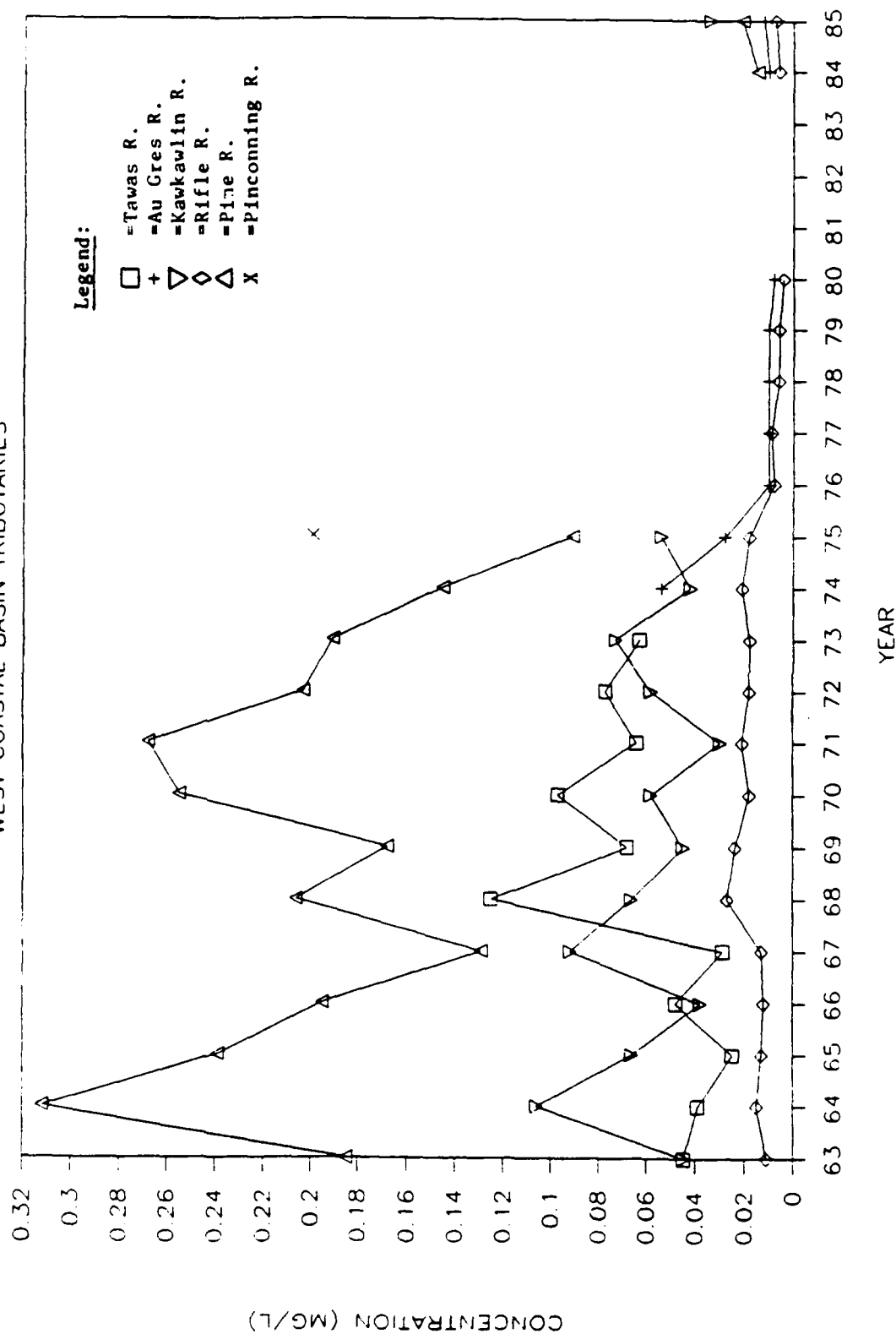


Figure 29c. Annual average orthophosphorus concentrations in Saginaw Bay west coastal basin tributaries, 1963-1985

ORTHOPHOSPHORUS CONCENTRATION

EAST COASTAL BASIN TRIBUTARIES

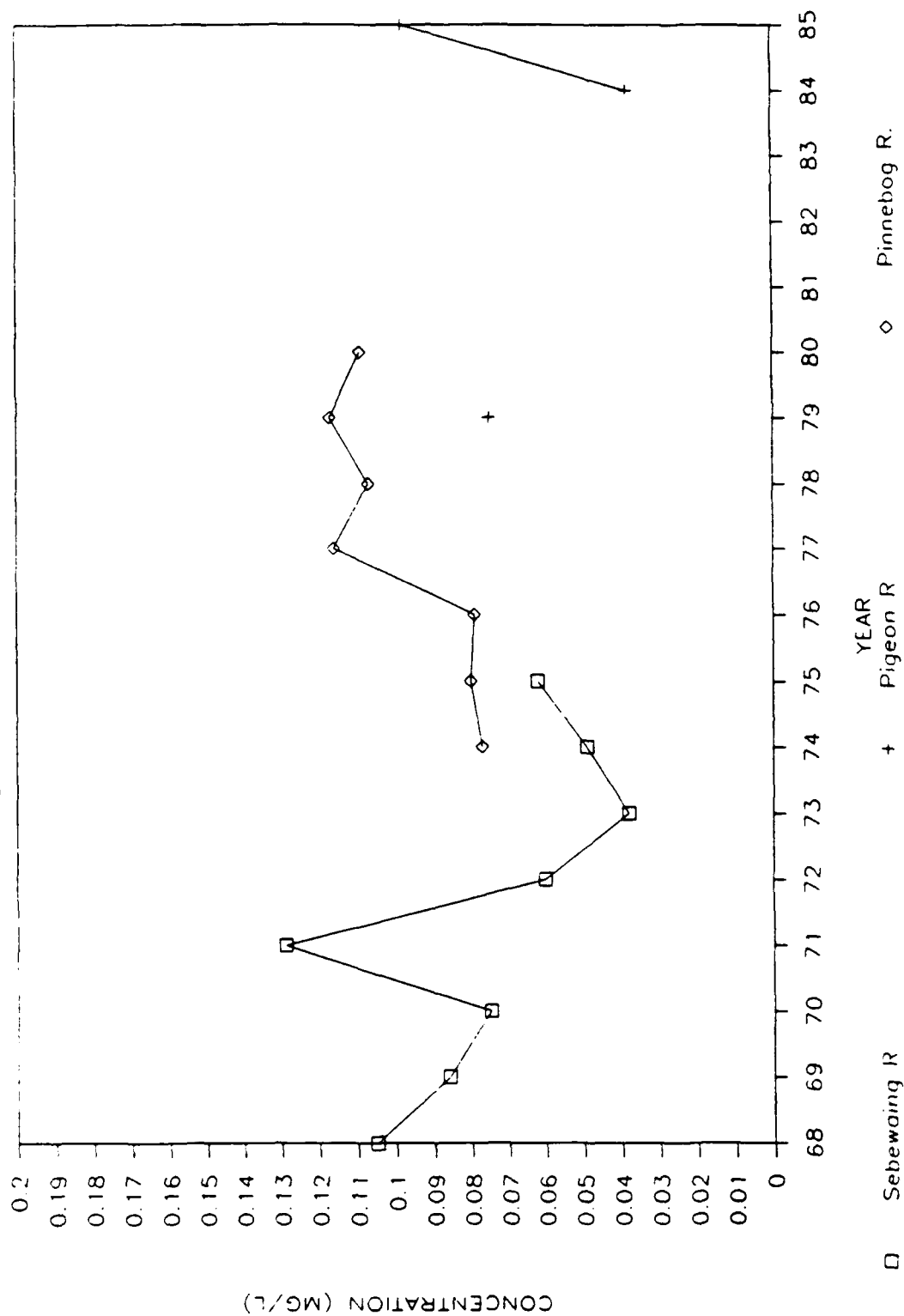


Figure 29d. Annual average orthophosphorus concentrations in Saginaw Bay east coastal basin tributaries, 1968-1985

NO2 + NO3 CONCENTRATION

*SAGINAW RIVER

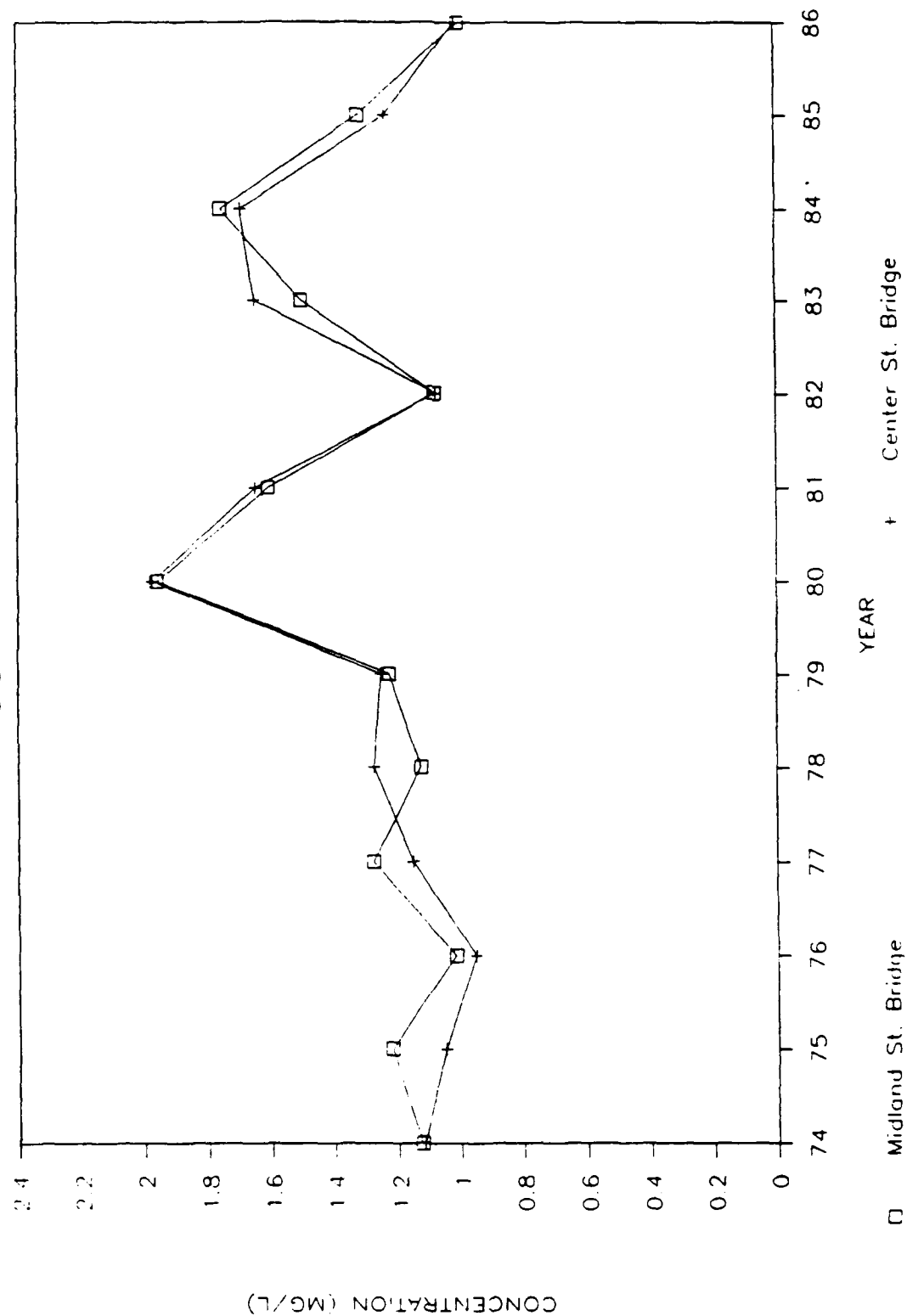


Figure 30a. Annual average nitrate-nitrite concentrations in Saginaw River water samples, 1974-1986

NO2 + NO3 CONCENTRATION

TRIBUTARIES TO THE SAGINAW RIVER

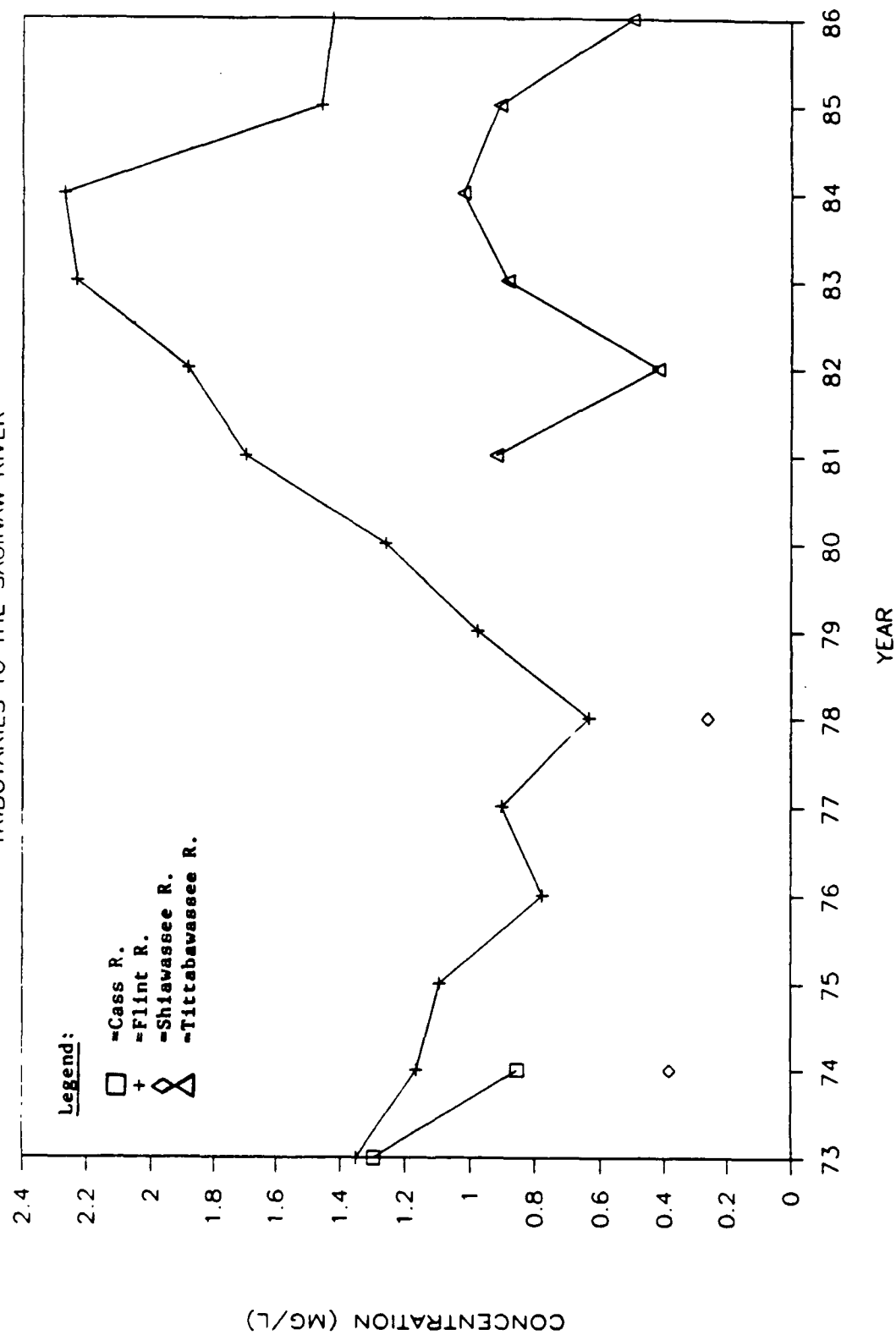


Figure 30b. Annual average nitrate-nitrite concentrations in Saginaw River tributaries, 1973-1986

NO₂ + NO₃ CONCENTRATION WEST COASTAL BASIN TRIBUTARIES

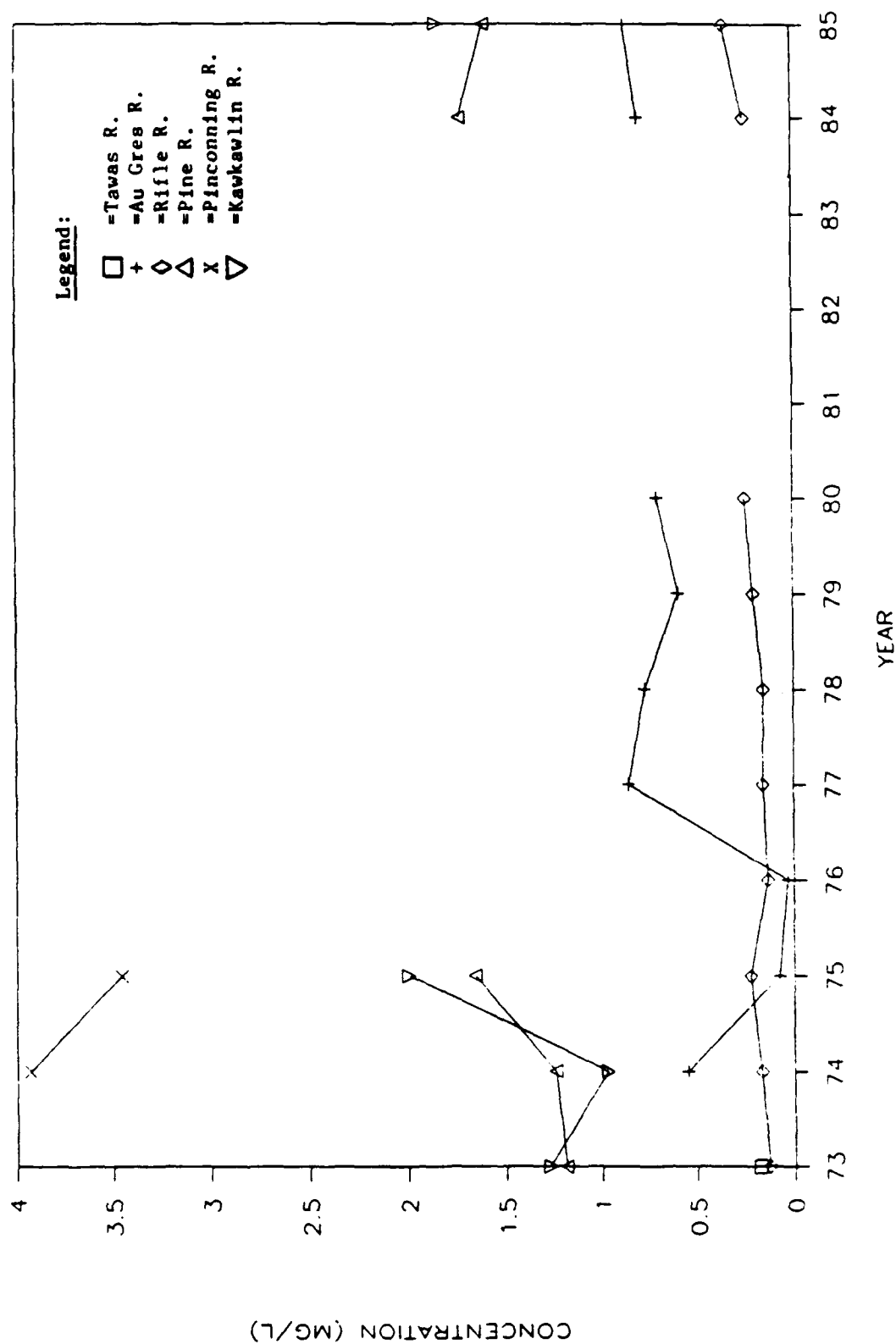


Figure 30c. Annual average nitrate-nitrite concentrations in Saginaw Bay
west coastal basin tributaries, 1973-1985

NO₂ + NO₃ CONCENTRATION EAST COASTAL BASIN TRIBUTARIES

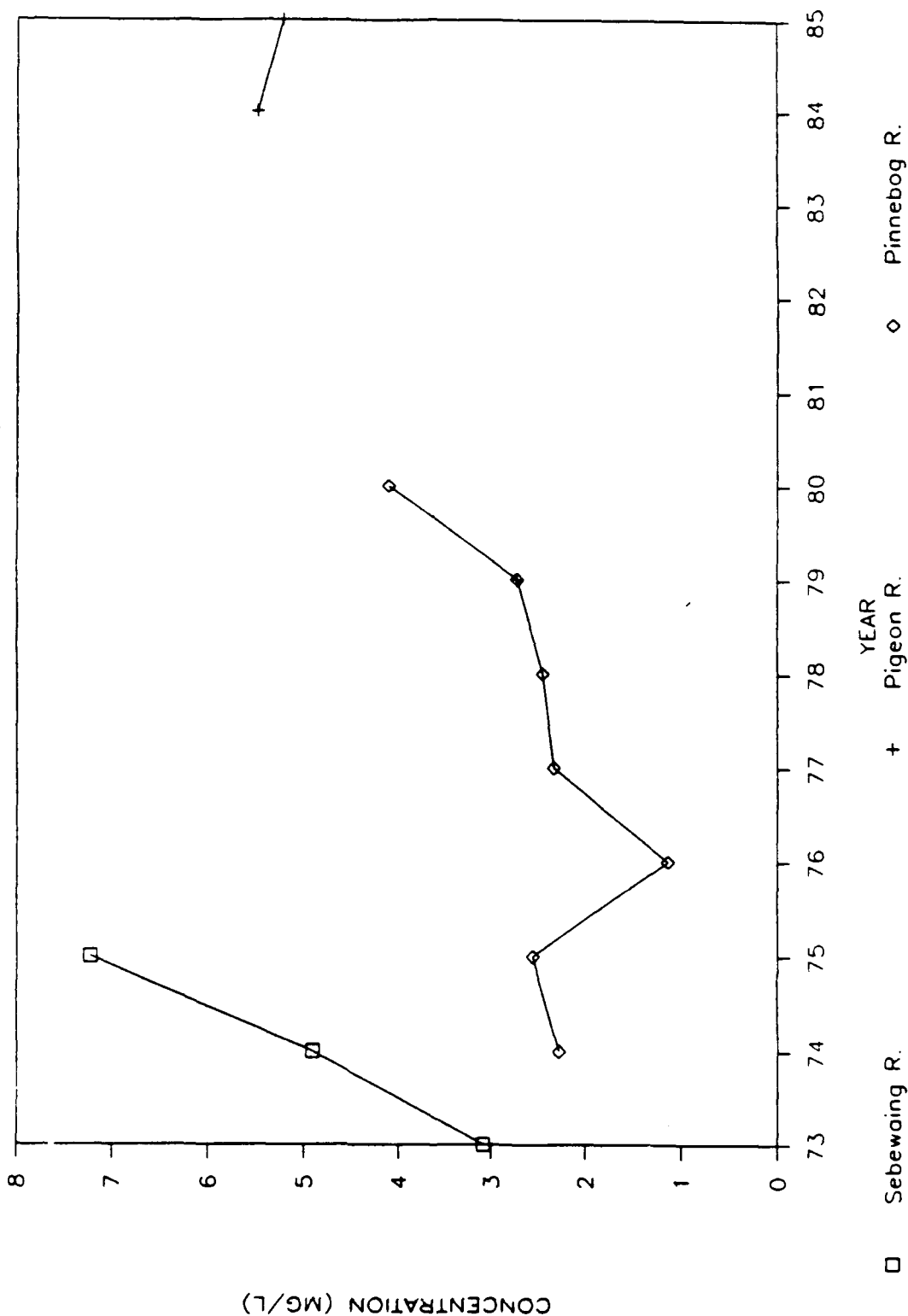


Figure 30d. Annual average nitrate-nitrite concentrations in Saginaw Bay east coastal basin tributaries, 1973-1985

CHLORIDE CONCENTRATION

SAGINAW RIVER

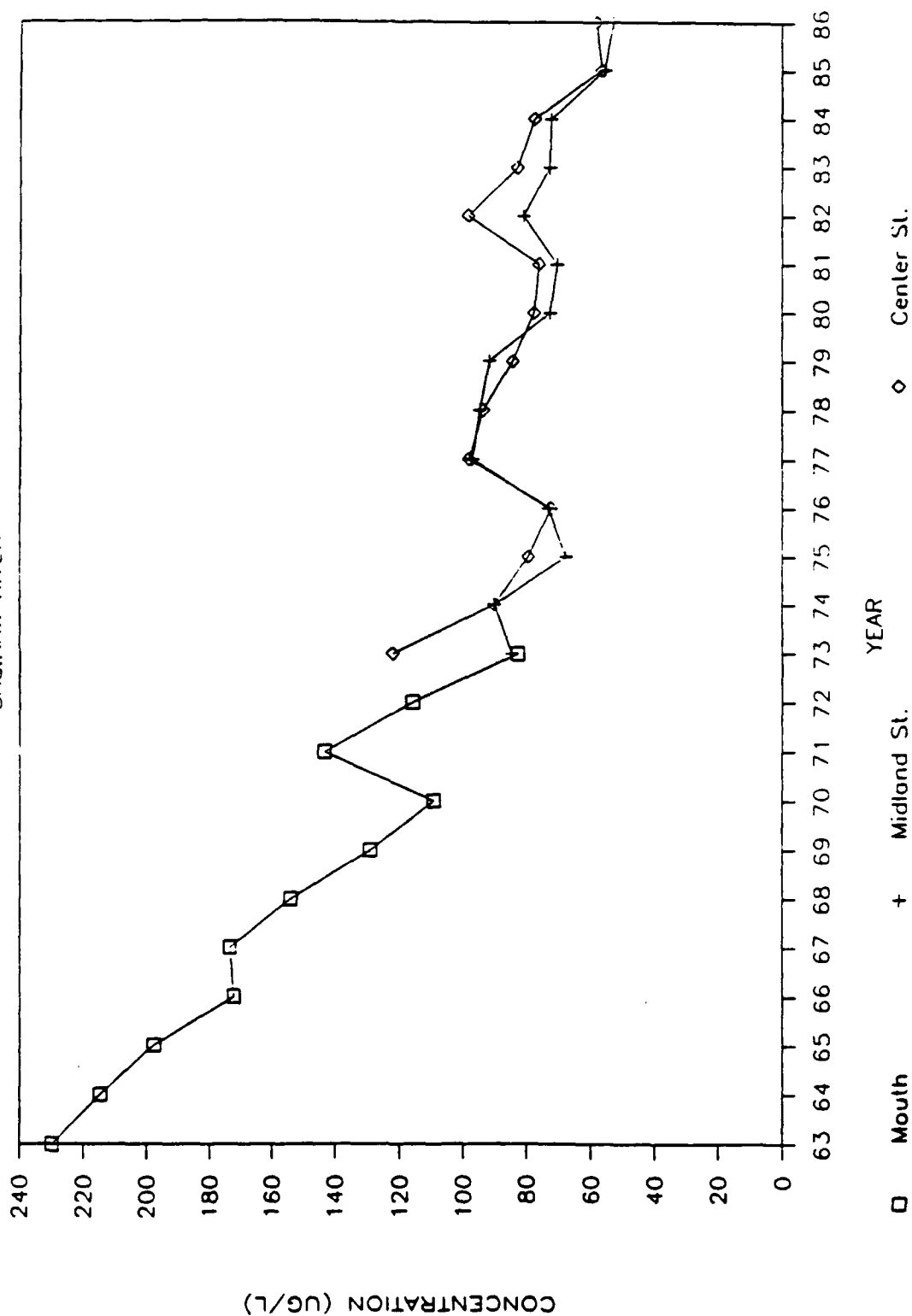


Figure 3la. Annual average chloride concentrations in Saginaw River water samples, 1963-1986

CHLORIDE CONCENTRATION

TRIBUTARIES TO THE SAGINAW RIVER

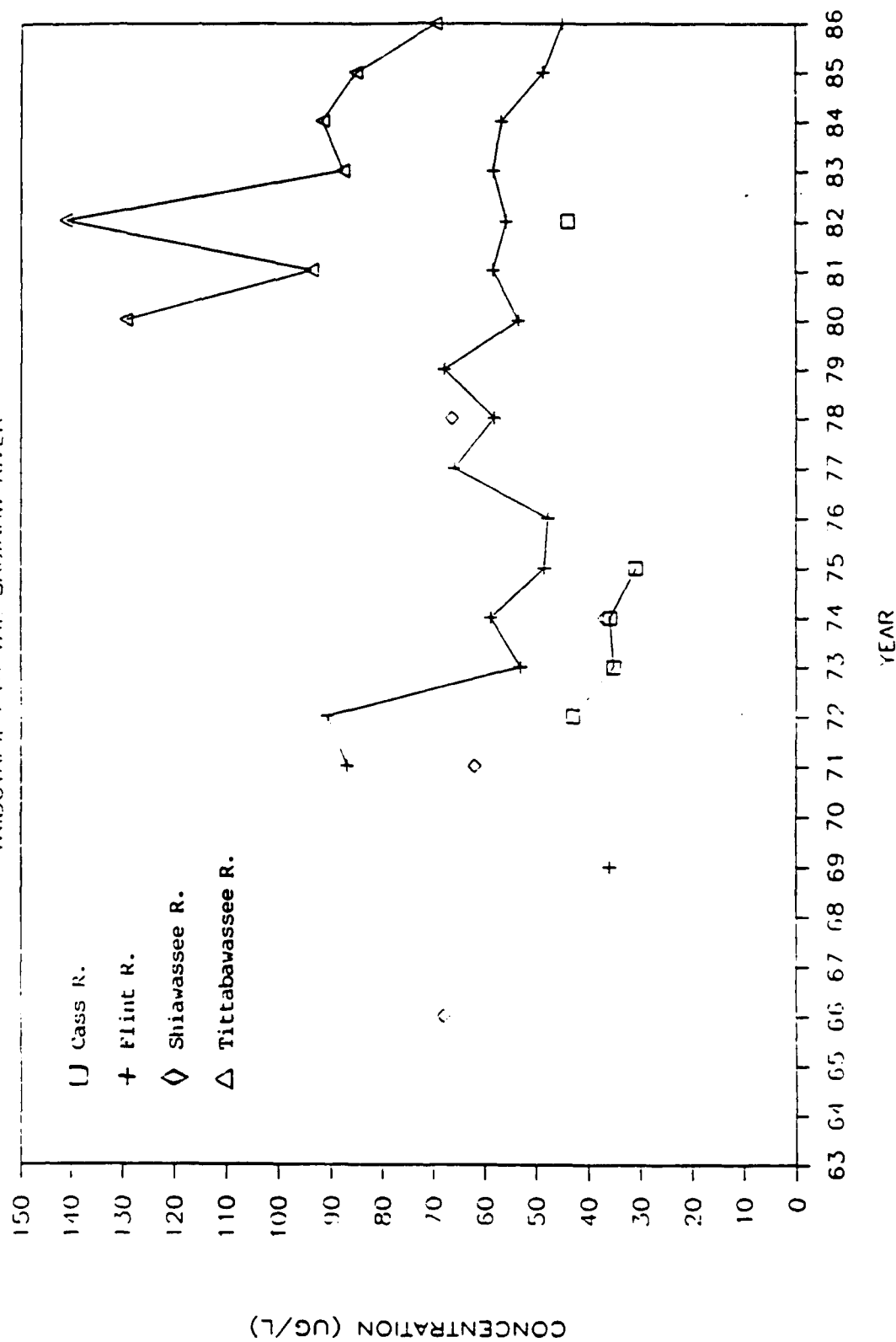


Figure 3lb. Annual average chloride concentrations in Saginaw River tributaries, 1963-1986

CHLORIDE CONCENTRATION WEST COAST BASIN TRIBUTARIES

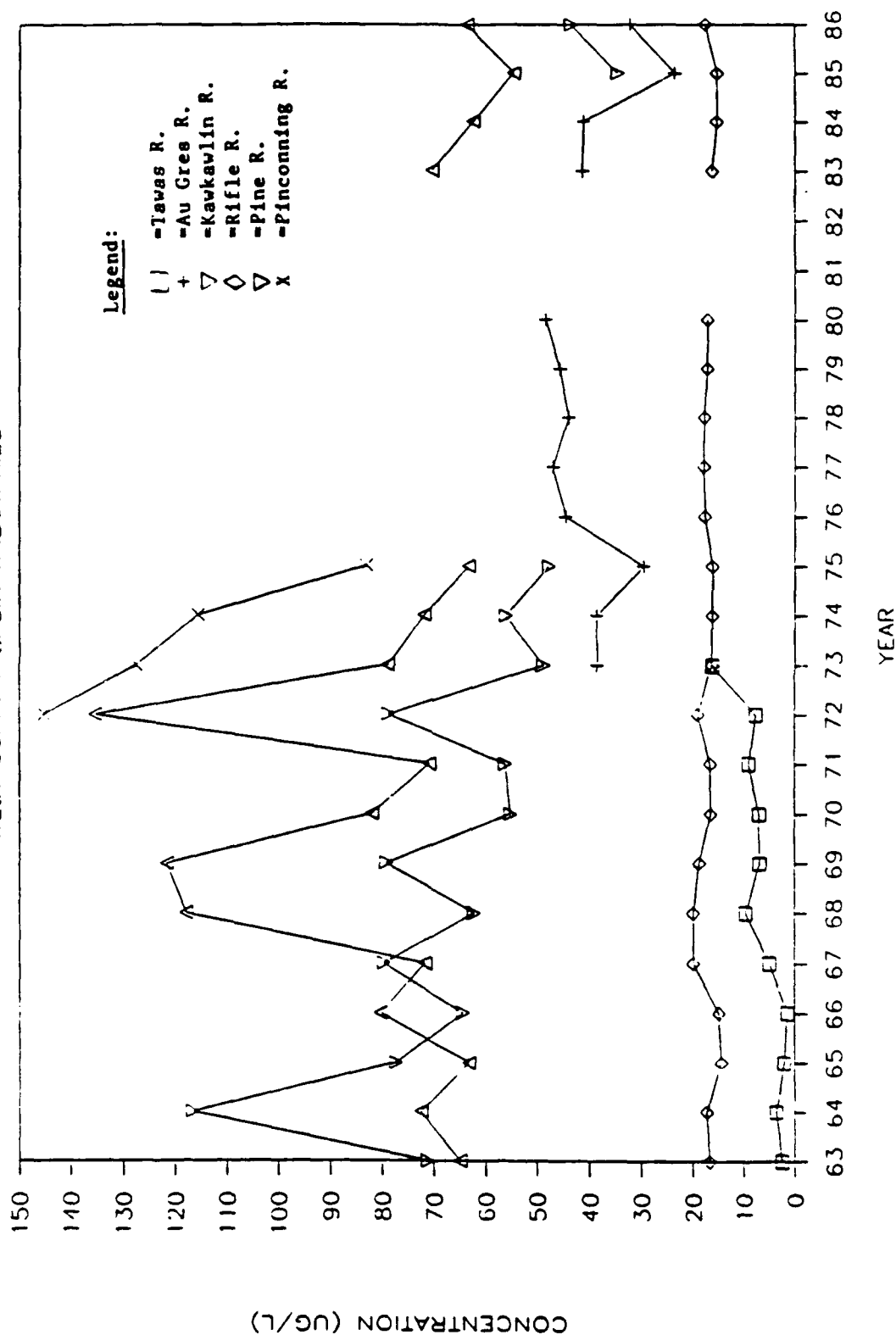


Figure 31c. Annual average chloride concentrations in Saginaw Bay west coastal basin tributaries, 1963-1986

CHLORIDE CONCENTRATION EAST COASTAL BASIN TRIBUTARIES

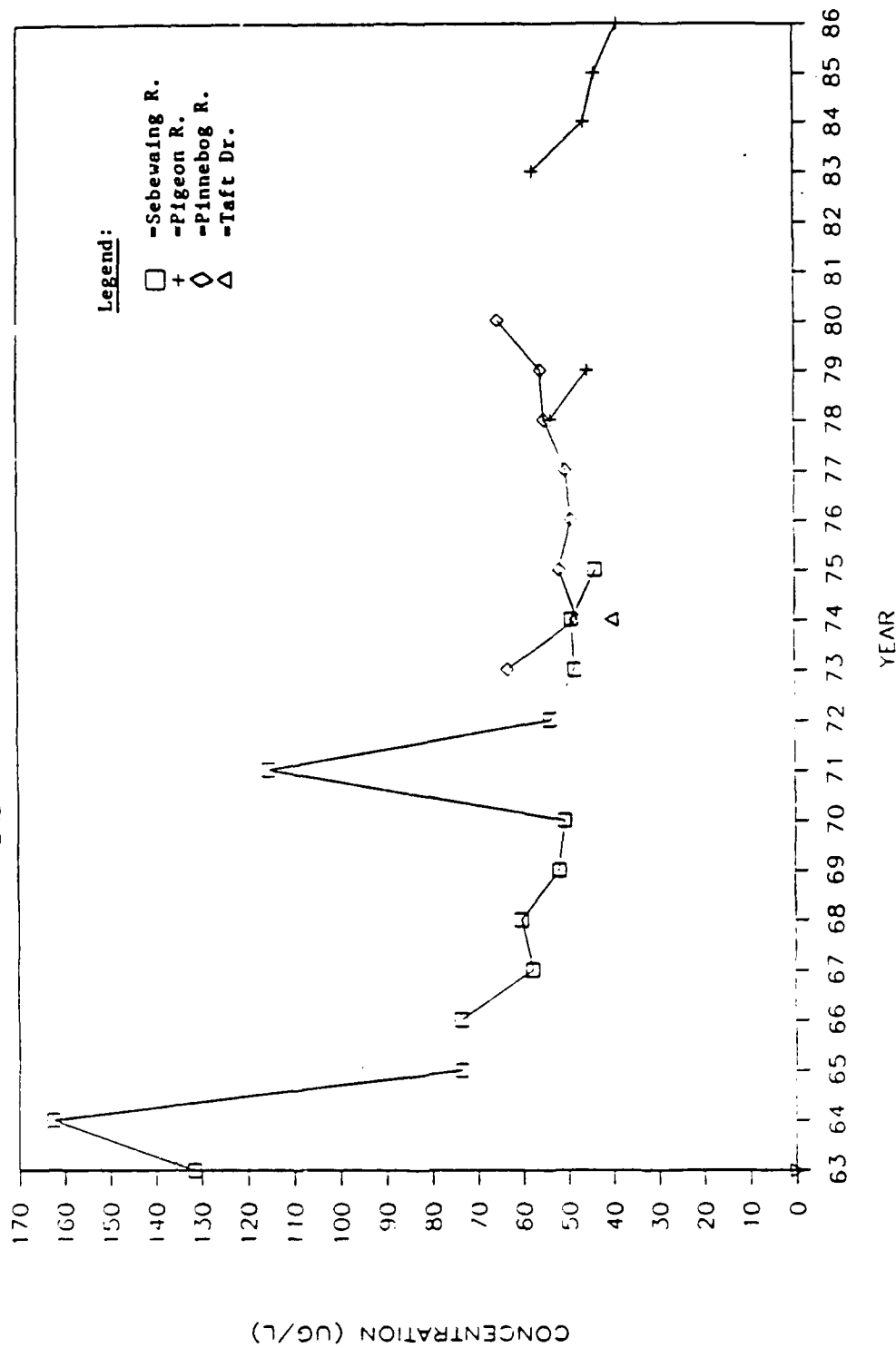


Figure 3ld. Annual average chloride concentrations in Saginaw Bay east coastal basin tributaries, 1963-1986

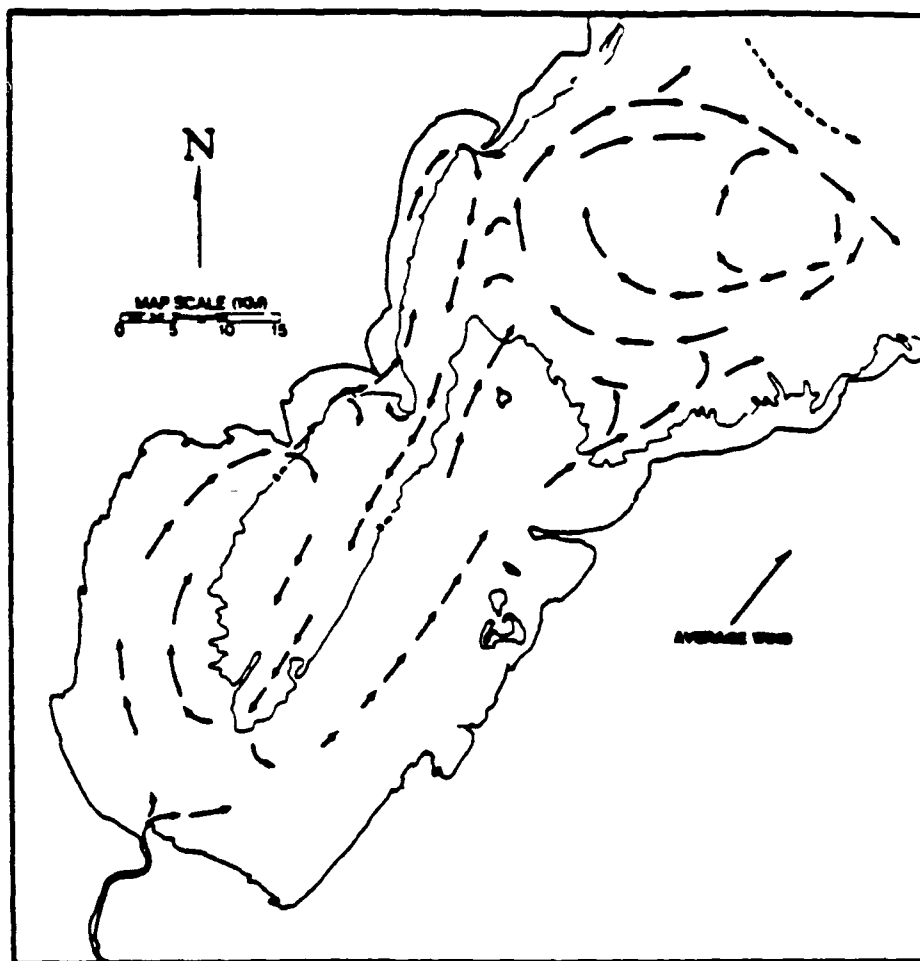


Figure 32a. Circulation pattern in Saginaw Bay for a southwest wind

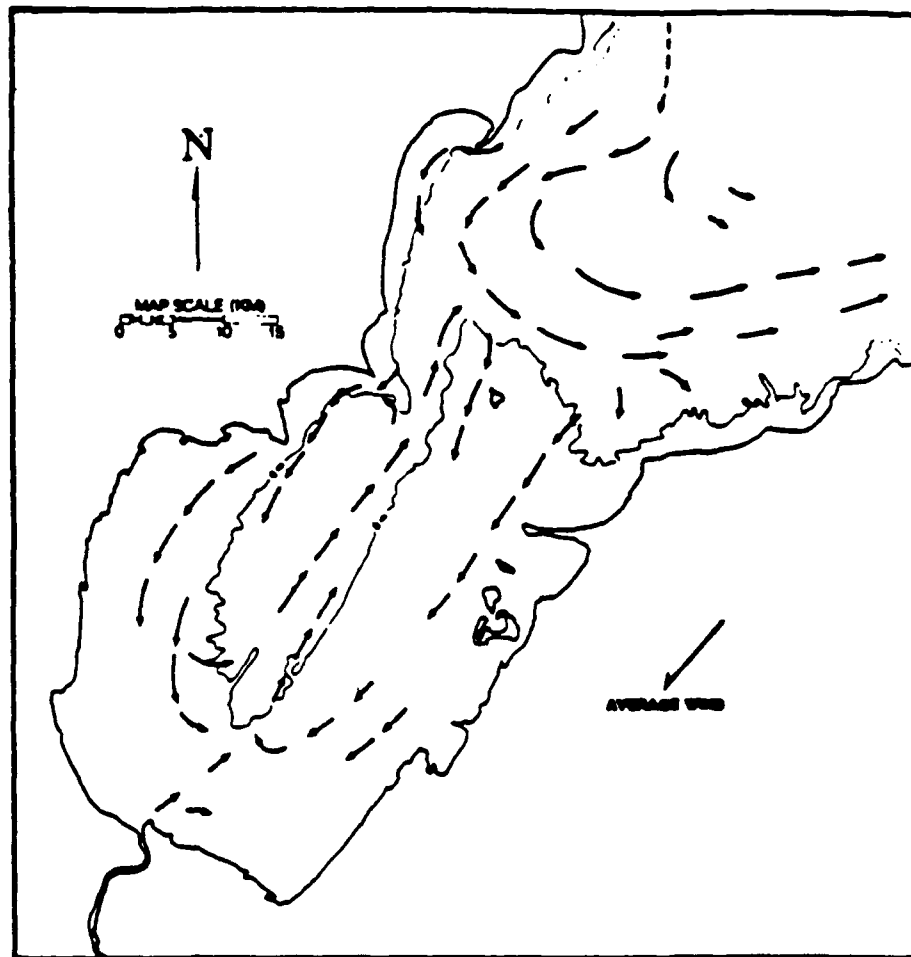


Figure 32b. Circulation pattern in Saginaw Bay for a northeast wind

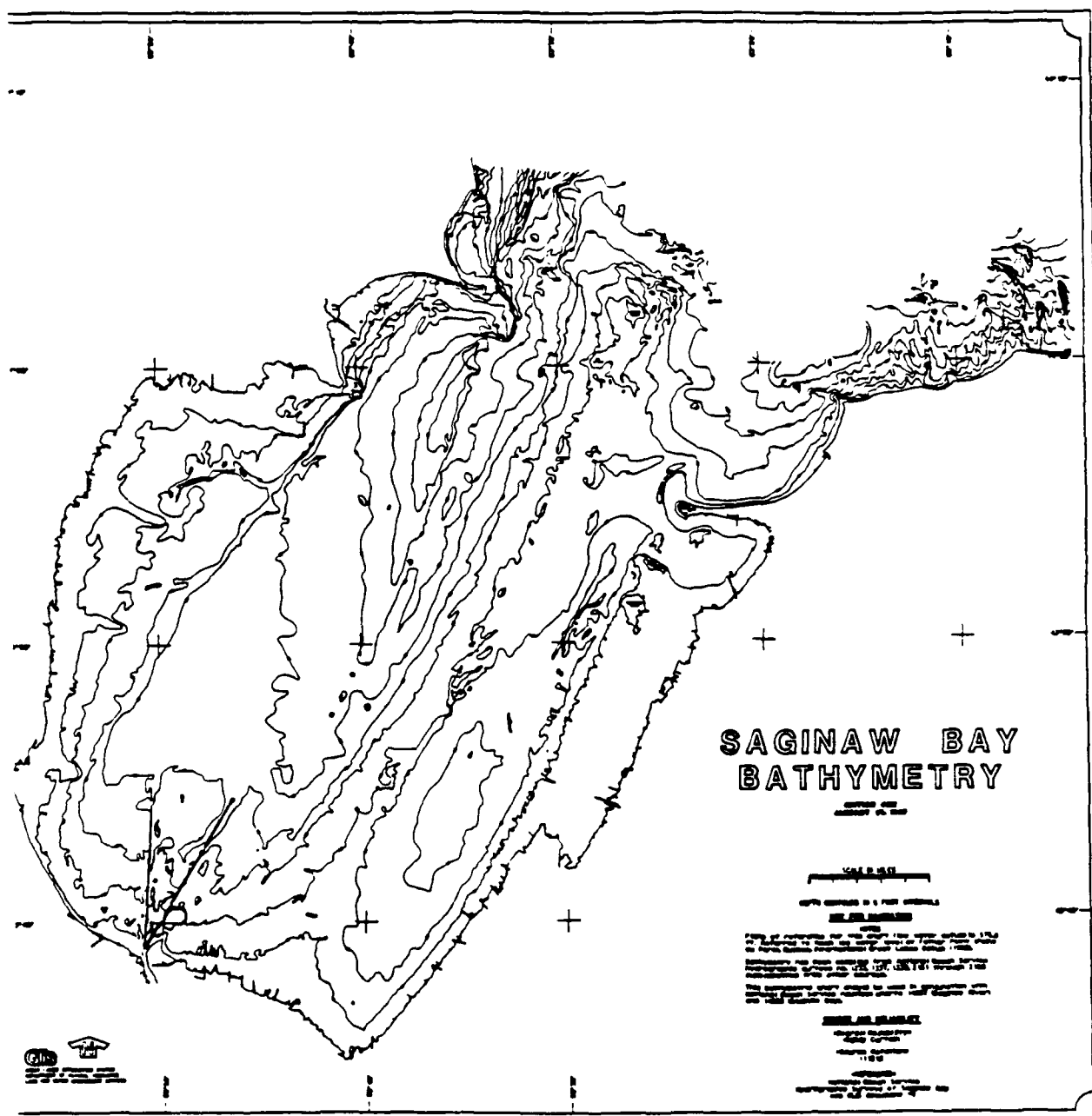


Figure 33. Saginaw Bay bathymetry (GLIS)

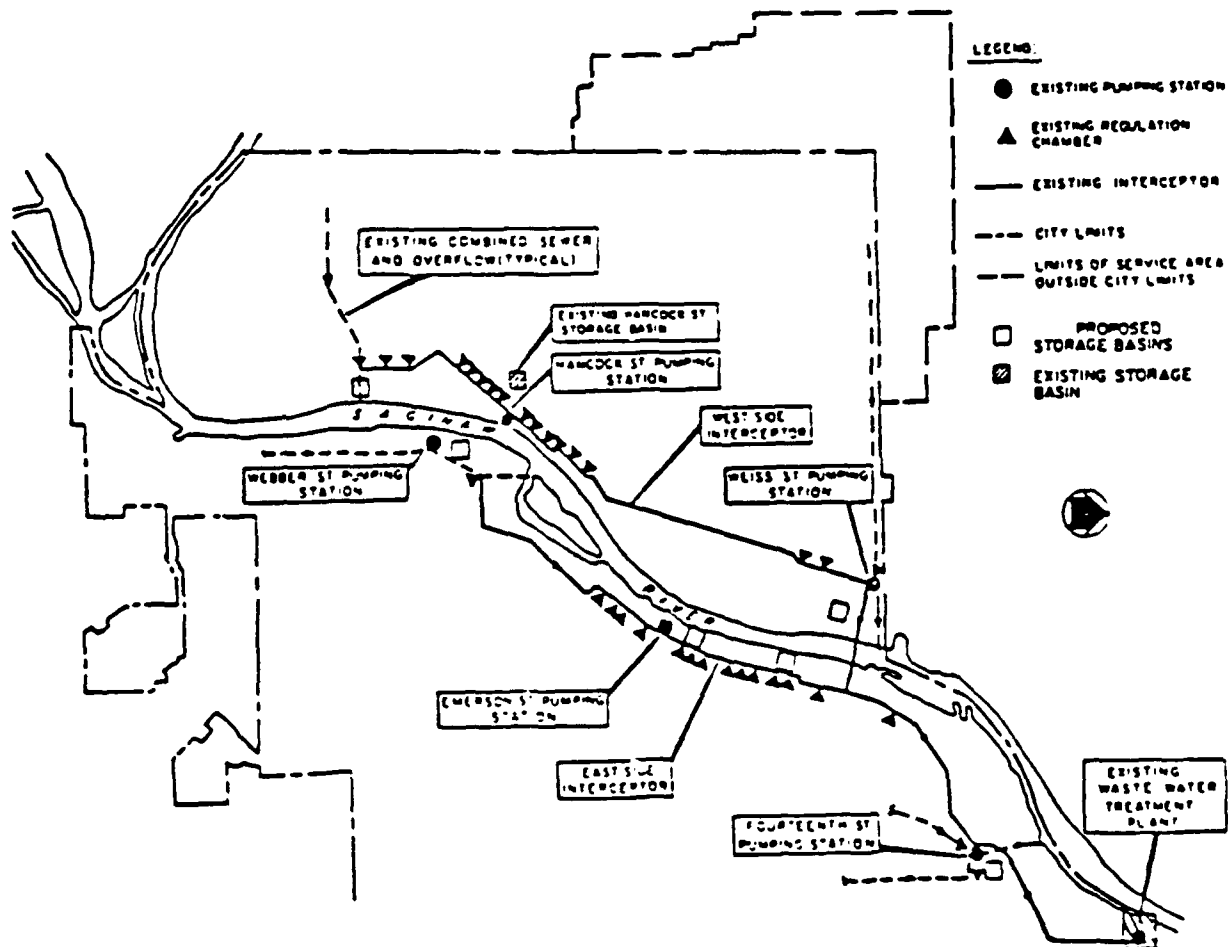


Figure 34. Combined sewer overflow storage and retention basins in the city of Saginaw (EDP 1981)

BANGOR TOWNSHIP
BAY COUNTY, MICHIGAN
WATER QUALITY INTAKE AND DISCHARGE
SITES AND SAMPLING STATIONS

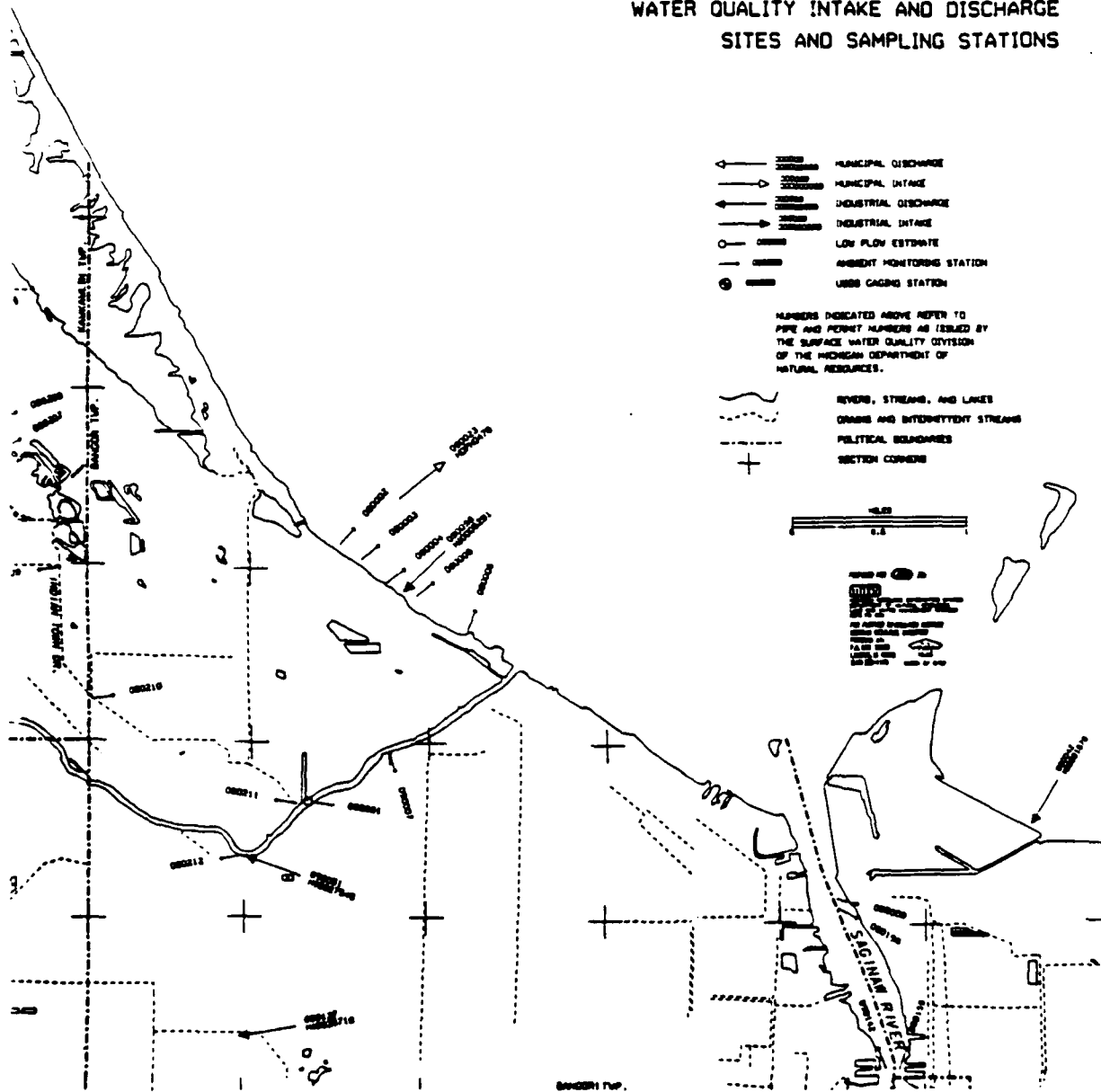


Figure 35. Water quality intake and discharge sites and sampling stations (GLIS)

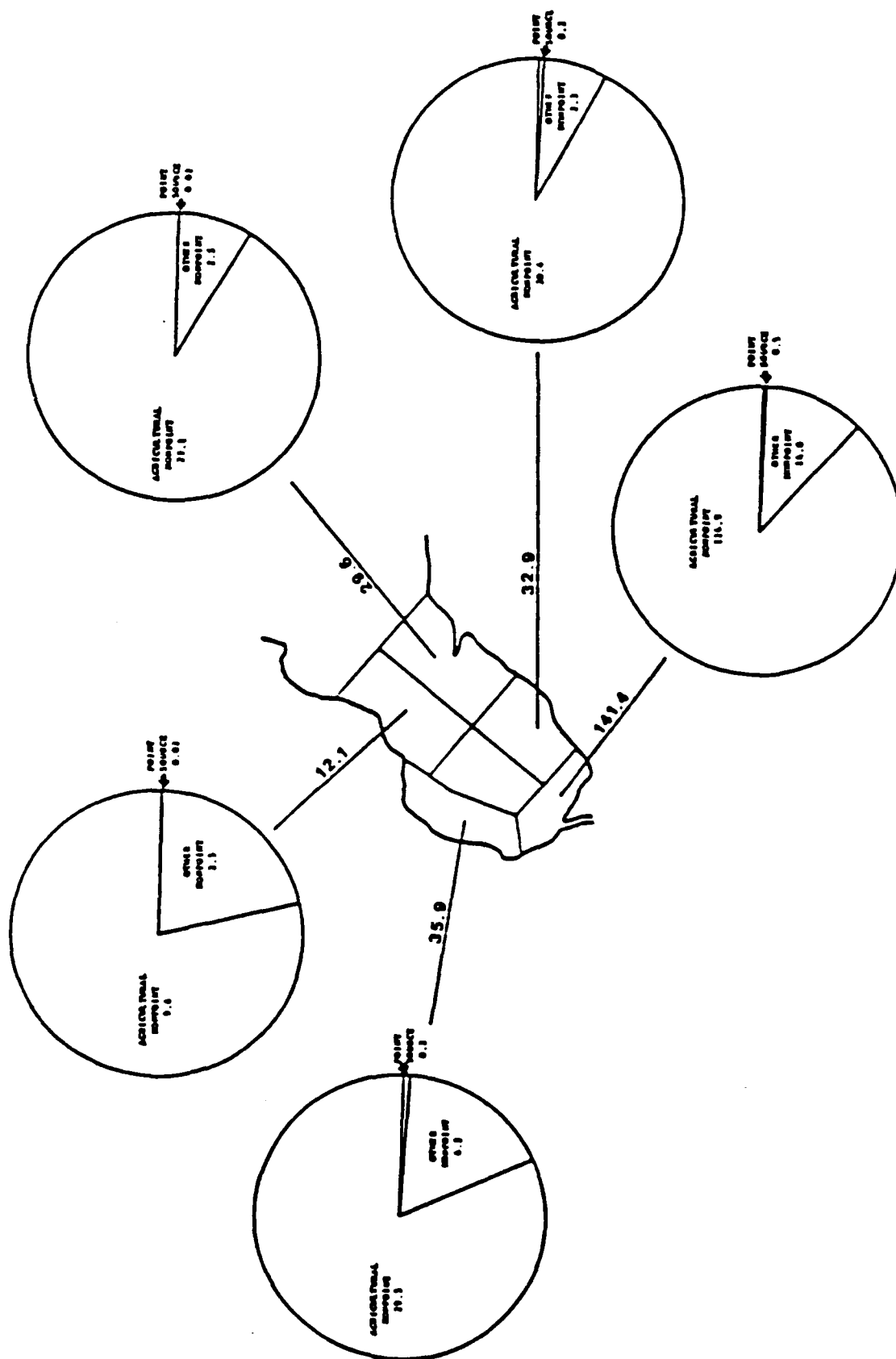


Figure 36. Distribution of annual suspended solid loads (1,000 metric tons) to inner Saginaw Bay in 1980 (I/TI 1983)

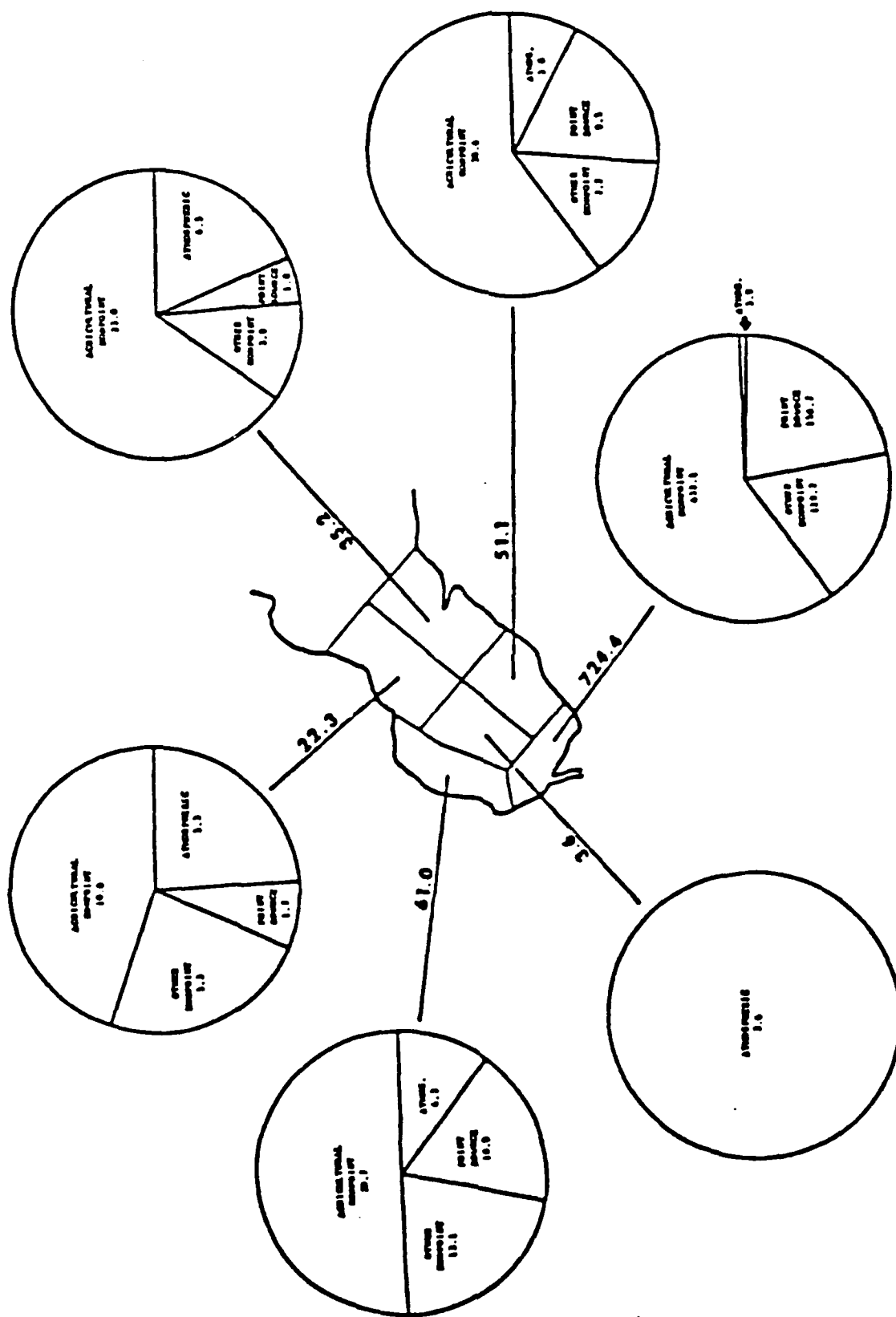


Figure 37. Source distribution of annual total phosphorus loads (metric tons) to inner Saginaw Bay in 1980 (LTI 1983)

BANGOR TOWNSHIP
BAY COUNTY, MICHIGAN
HIGH RISK EROSION AREAS
AND RECESSION RATES

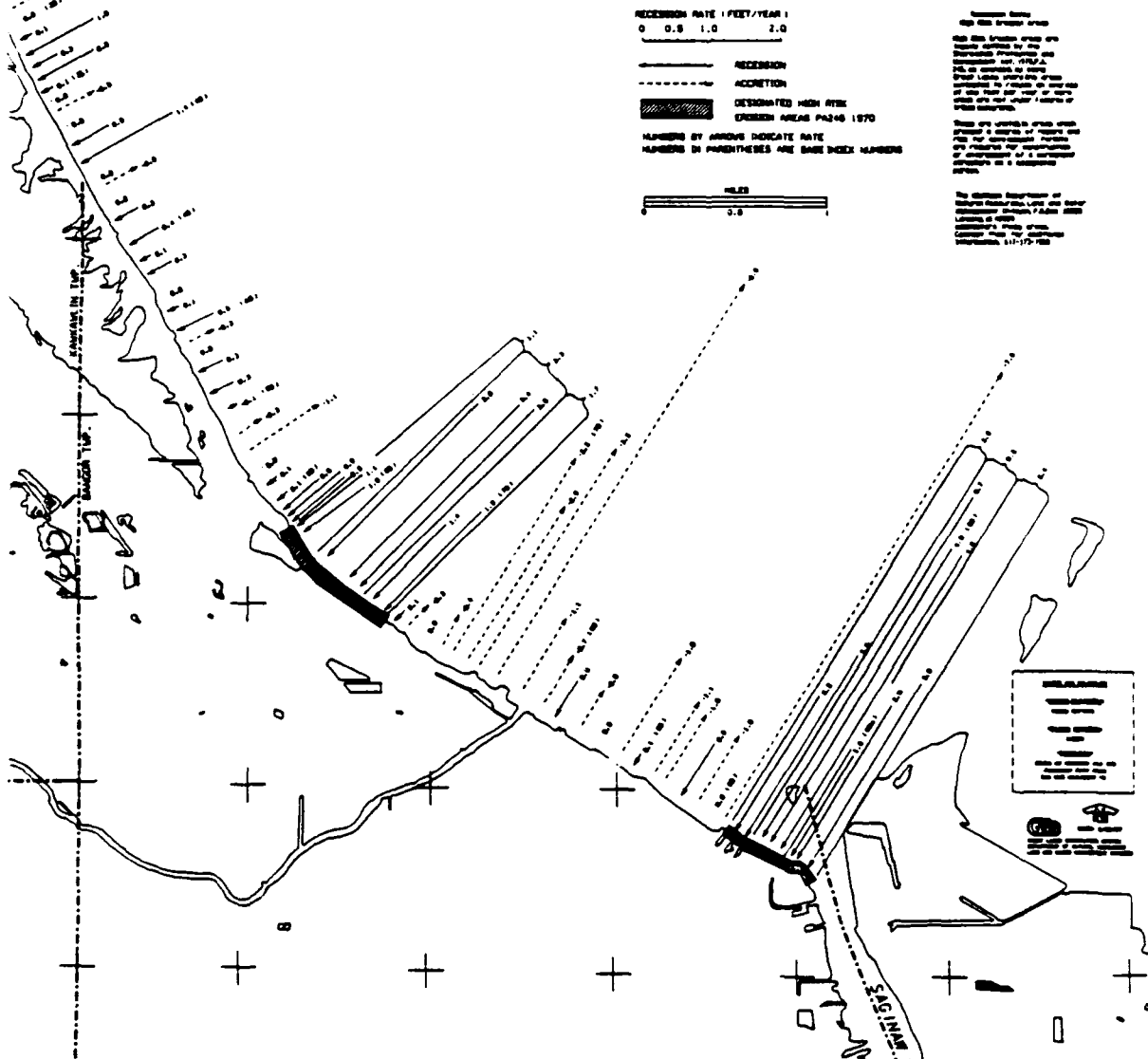
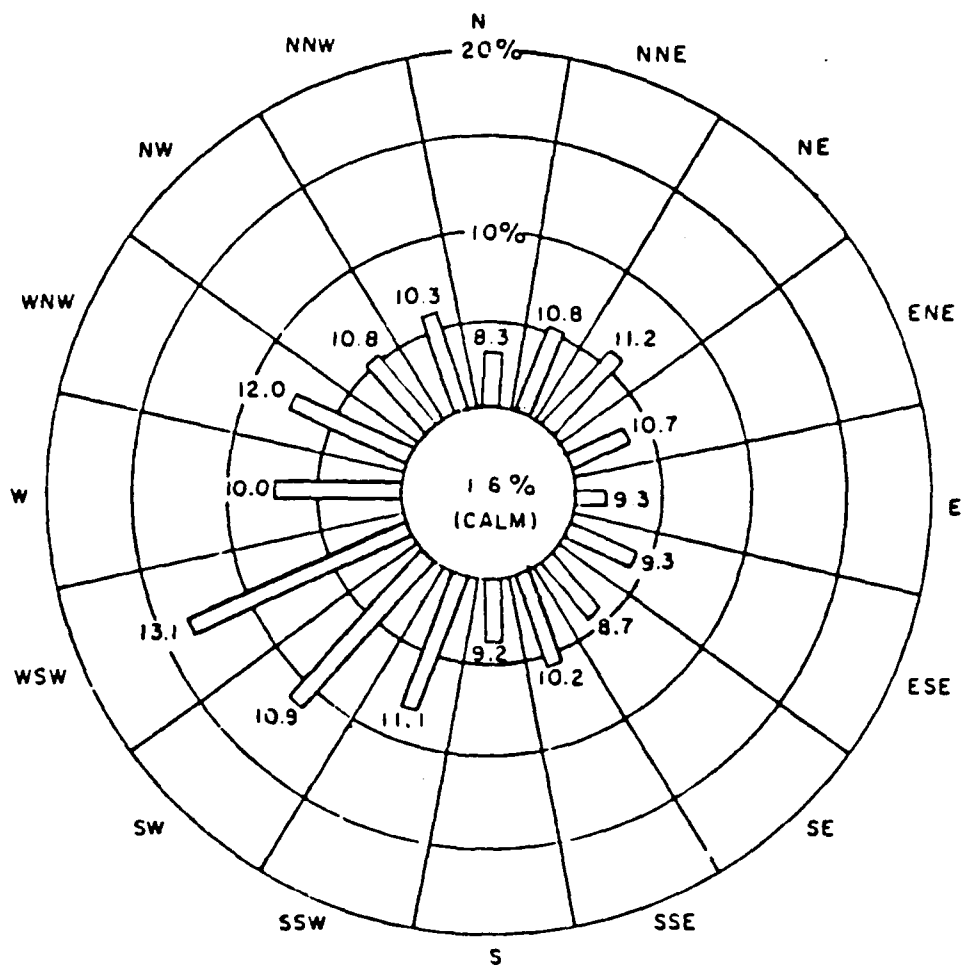


Figure 38. High risk erosion areas and recession rates (GLIS)



AVERAGE ANNUAL WIND SPEED: 10.6 M.P.H.

LEGEND

8.3 AVERAGE SPEED FOR SECTOR IN M.P.H.

VECTOR LENGTH INDICATES FREQUENCY OF OCCURRENCE IN SECTOR (PERCENT)

Figure 39. Annual wind vectors for the Saginaw Bay area (Consumers Power Company 1972)

LONG-TERM MODEL ADVECTION AND DISPERSION TRANSPORT

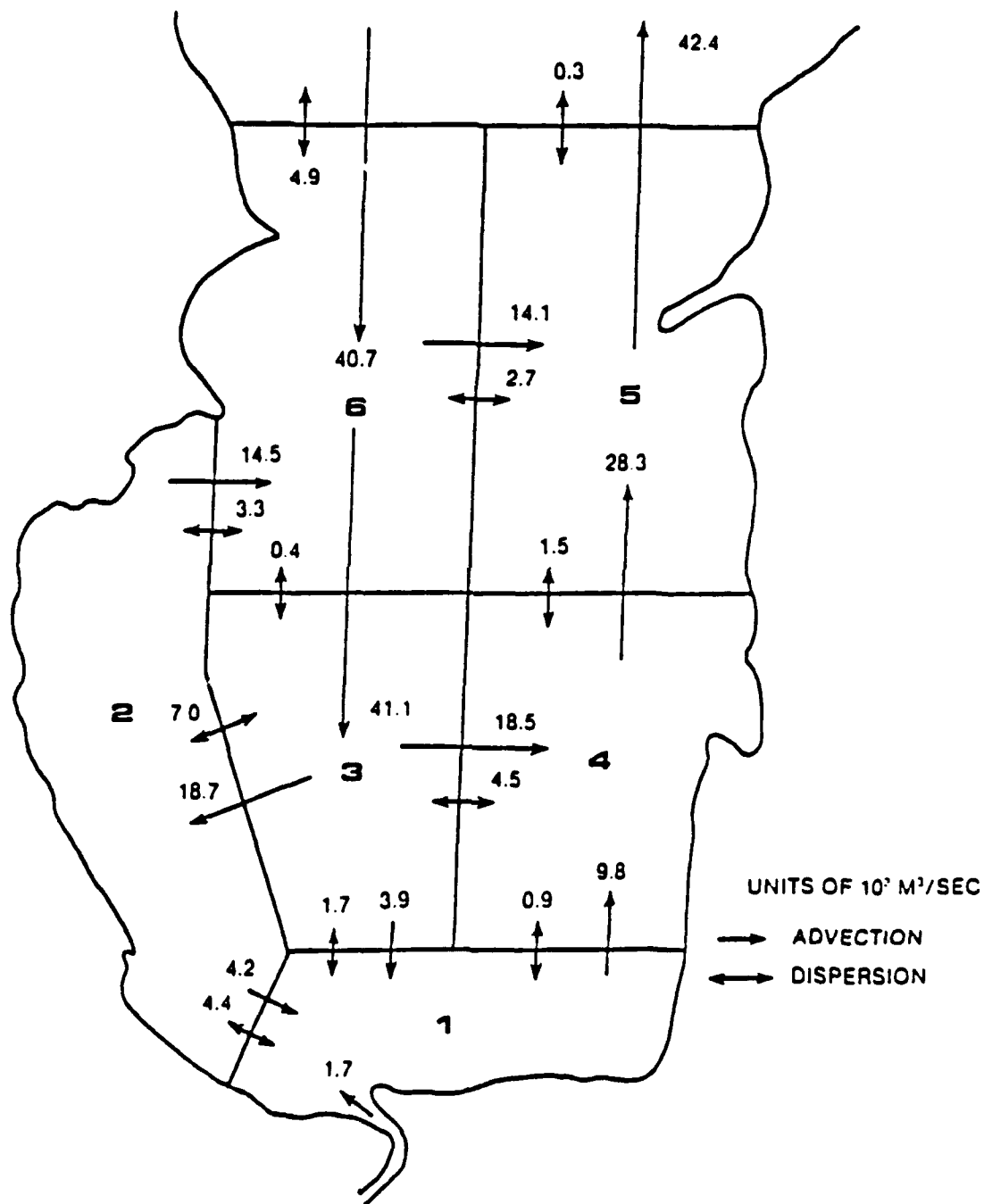


Figure 40. An advection and dispersion model for Saginaw Bay
(Limno-Tech 1977)

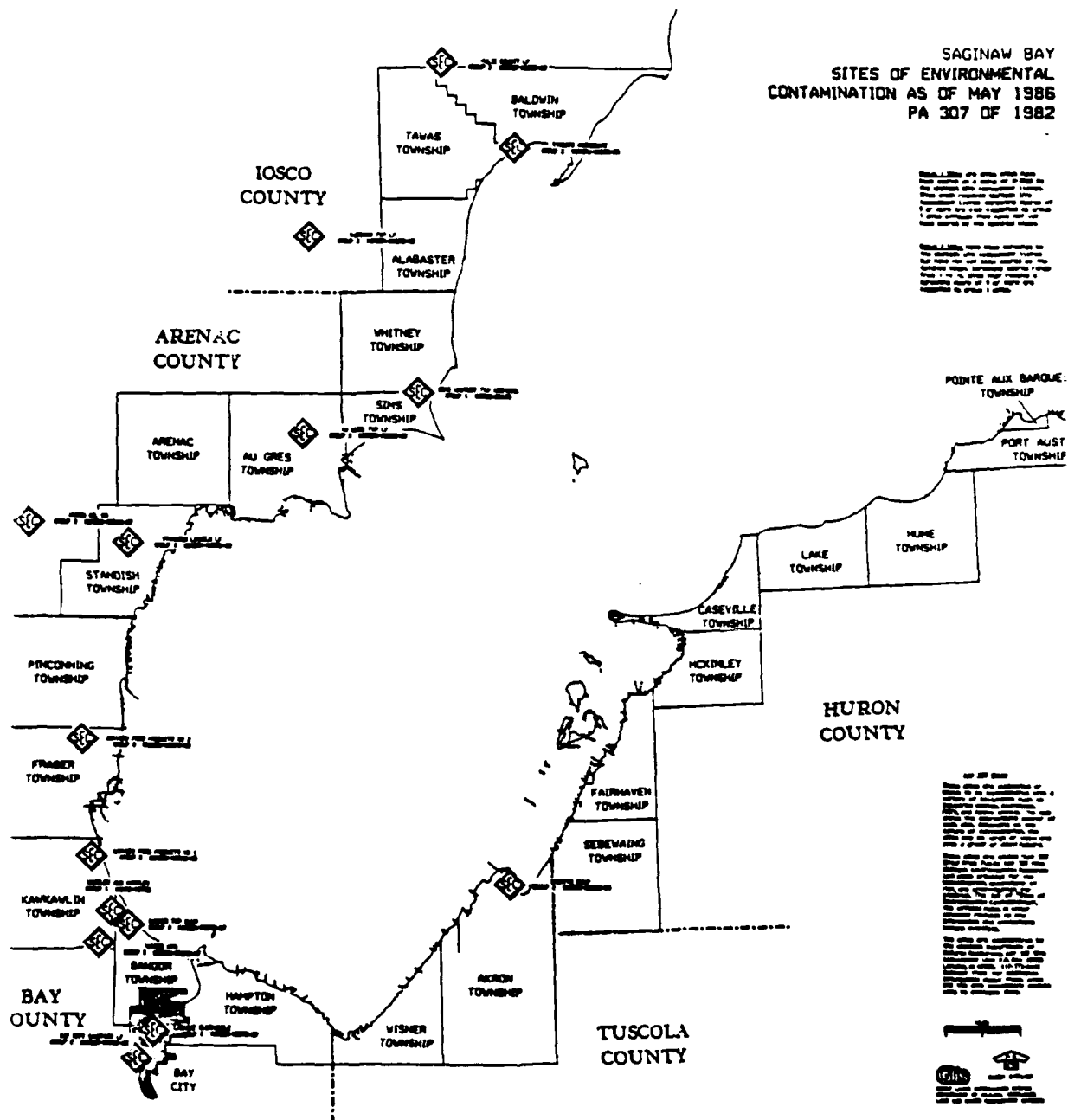


Figure 41. Sites of environmental contamination as of May 1986,
PA 307 of 1982 (GLIS)

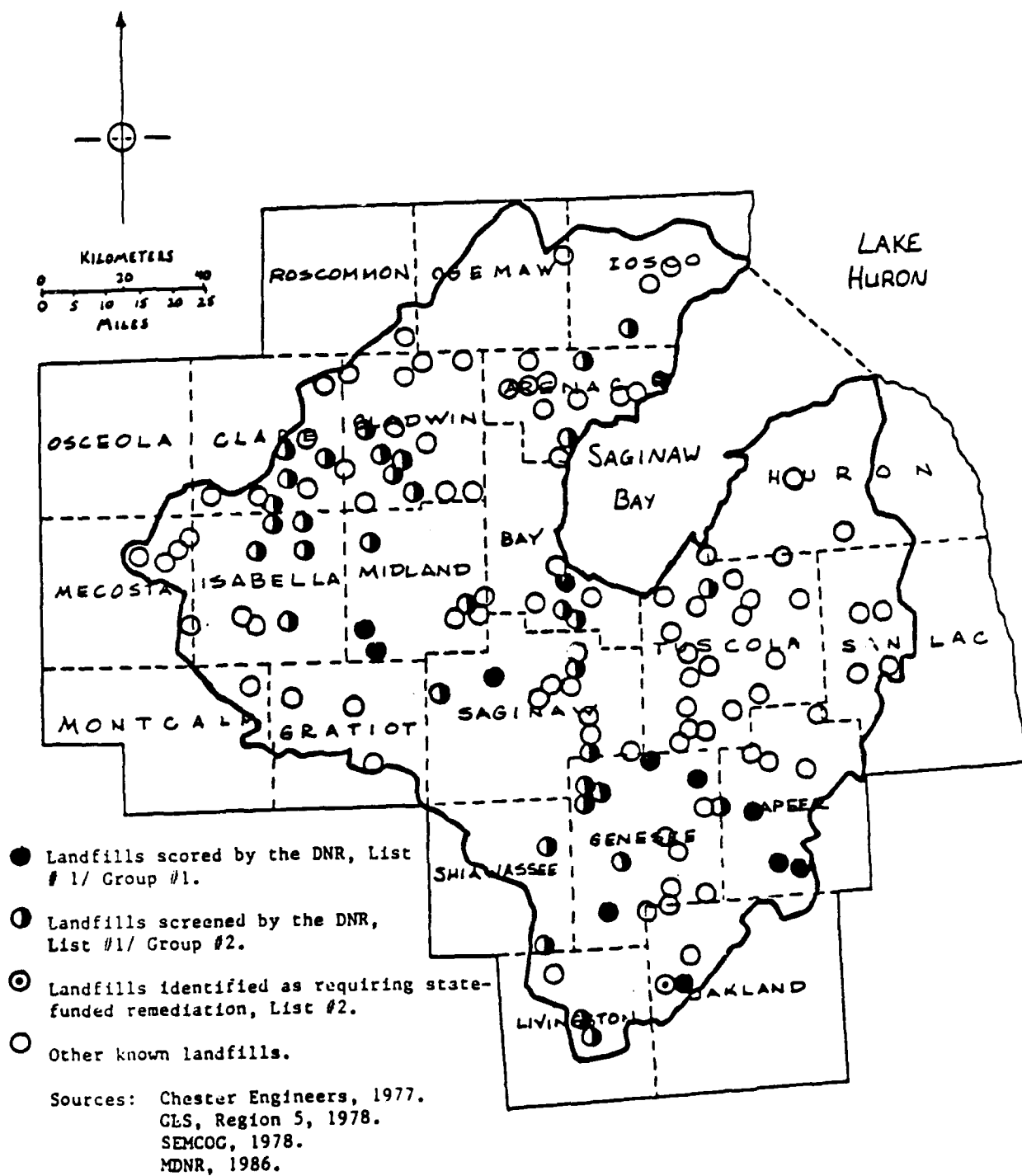


Figure 42. Landfills in the Saginaw Bay Basin

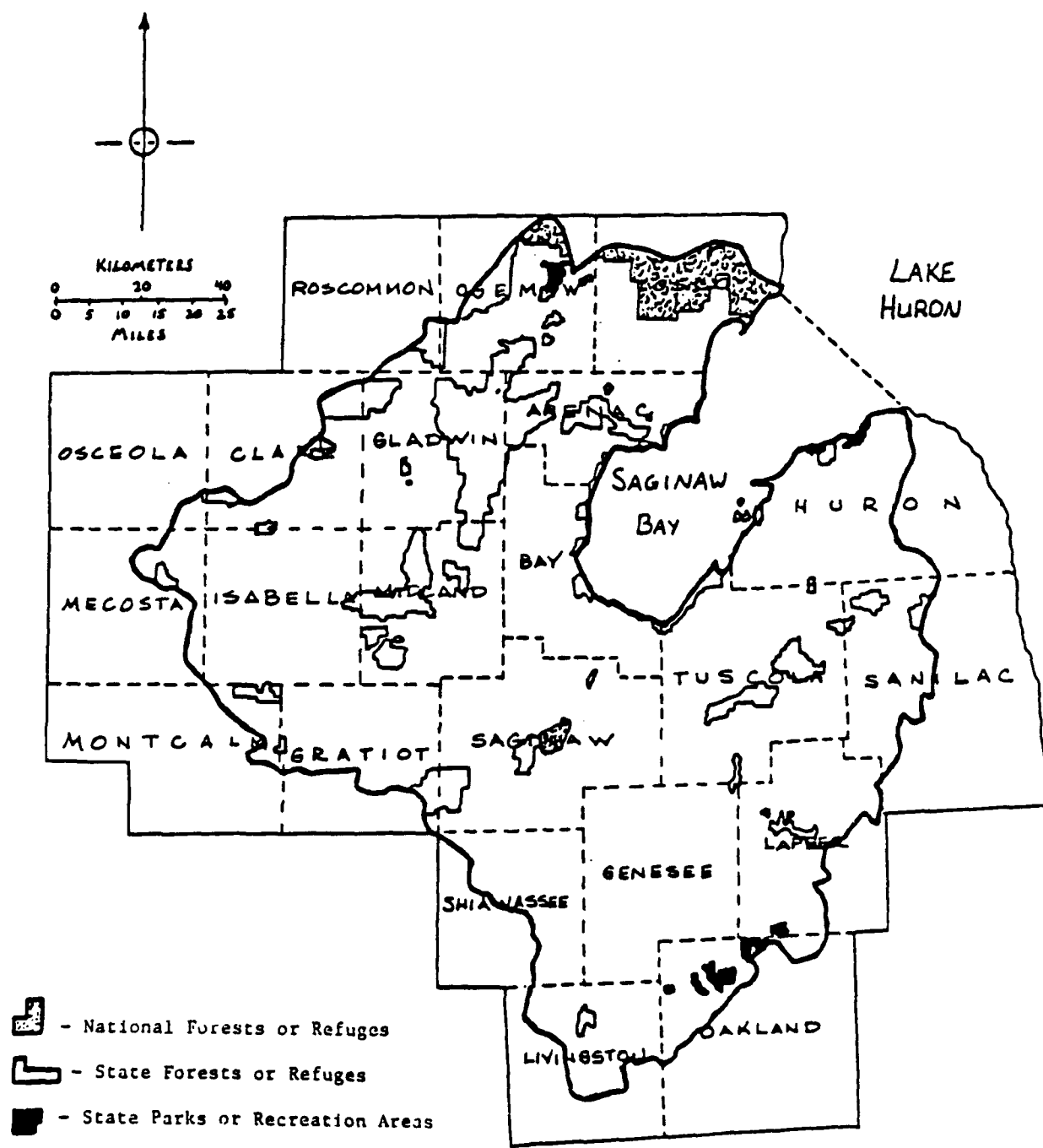


Figure 43. Public land in the Saginaw Bay drainage basin

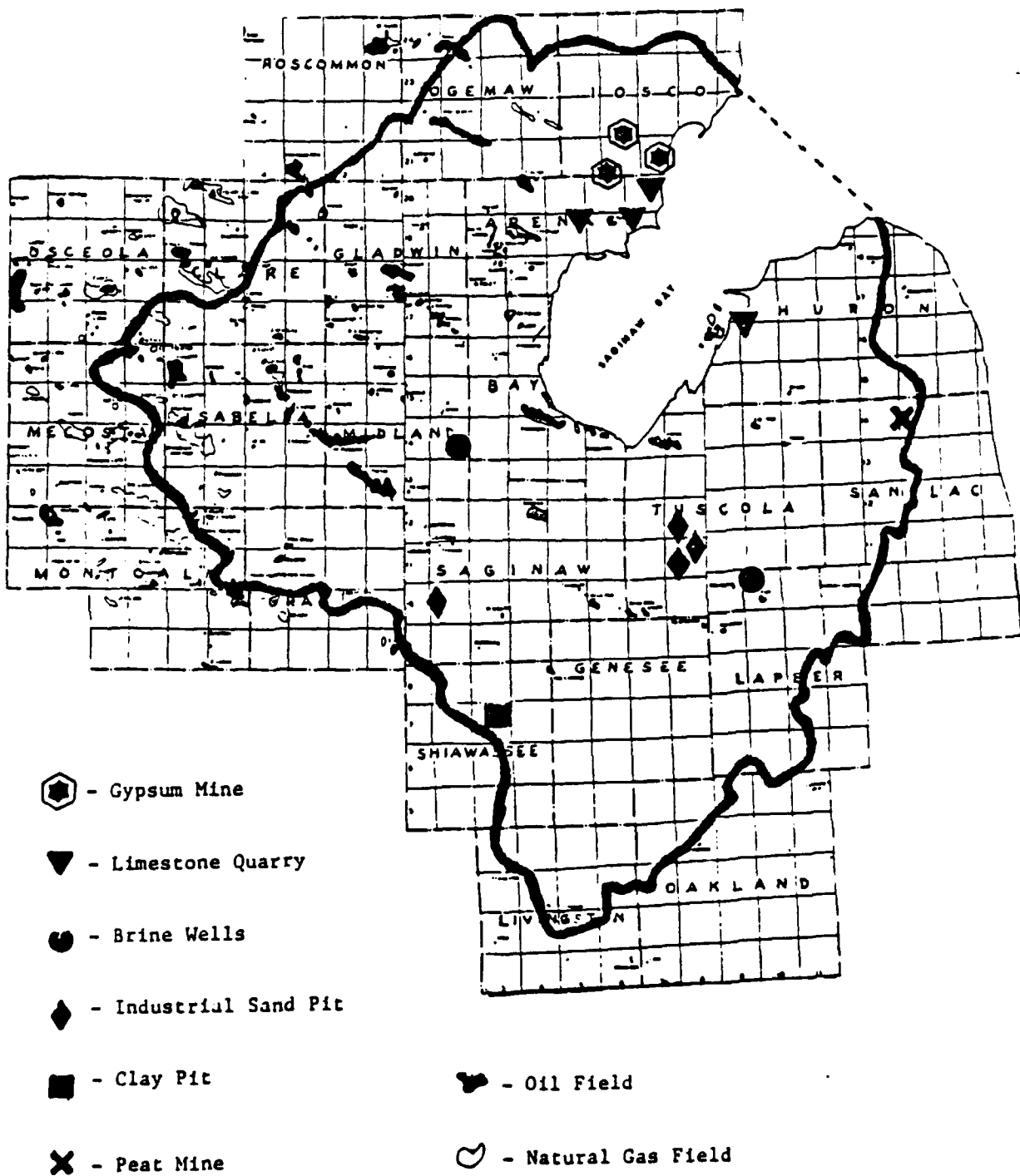


Figure 44. Extractive land uses in the Saginaw Bay drainage basin (MDNR 1978; 1982)

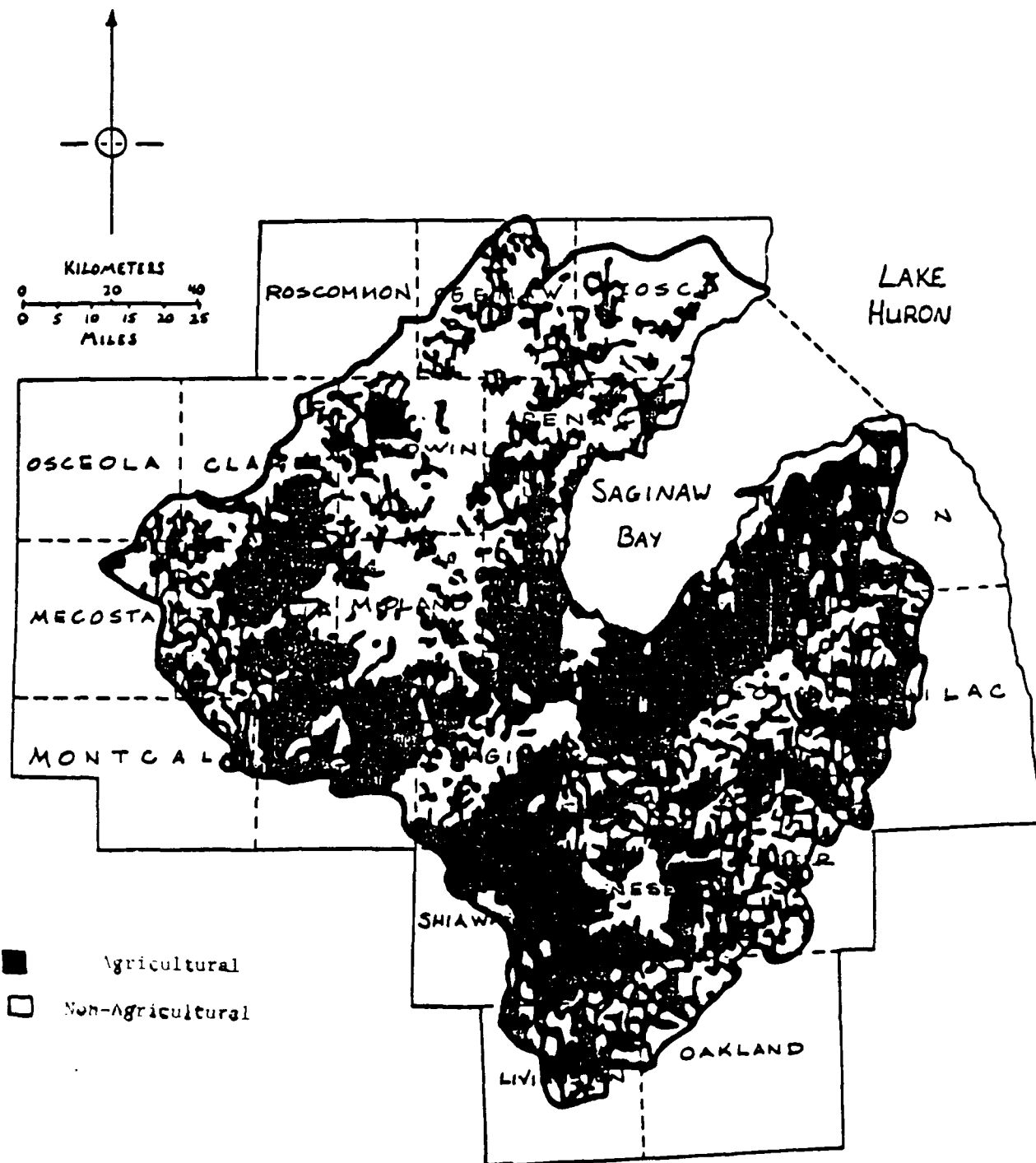


Figure 45. Agricultural land in the Saginaw Bay drainage basin
(ECMPDR 1987)

- 111 Agt. Sec. 4000-20
- 112 Ltr. Sec. 4000-20
- 113 Steps 1-4000, 4000-20
- 114 1-4000-20
- 115 General Sec. 4000-20
- 116 General Sec. 4000-20
- 117 1-4000-20
- 118 1-4000-20
- 119 1-4000-20
- 120 1-4000-20
- 121 1-4000-20
- 122 1-4000-20
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- 200 1-4000-20

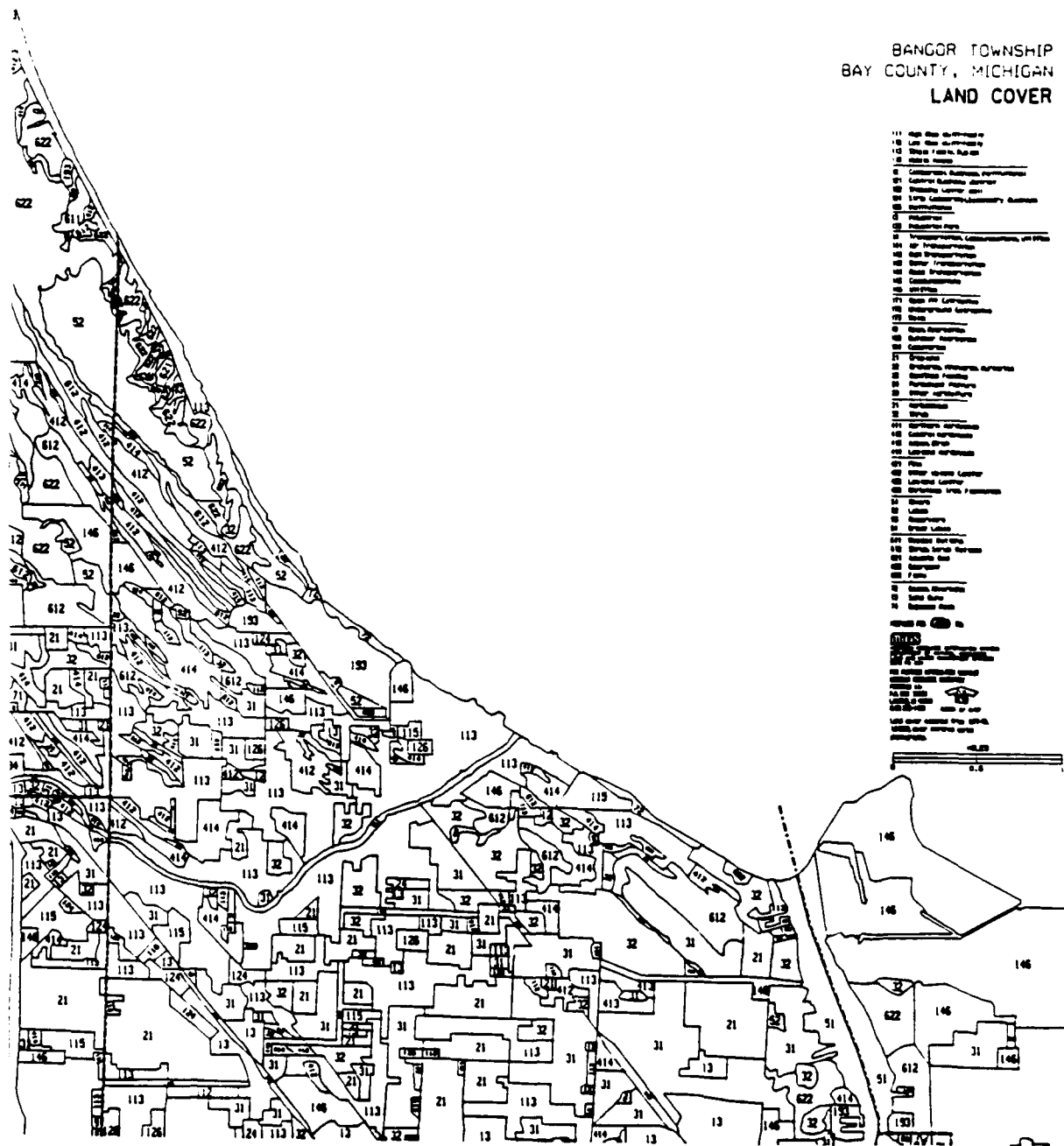


Figure 46. Land cover, Bay County, Michigan (GLIS)

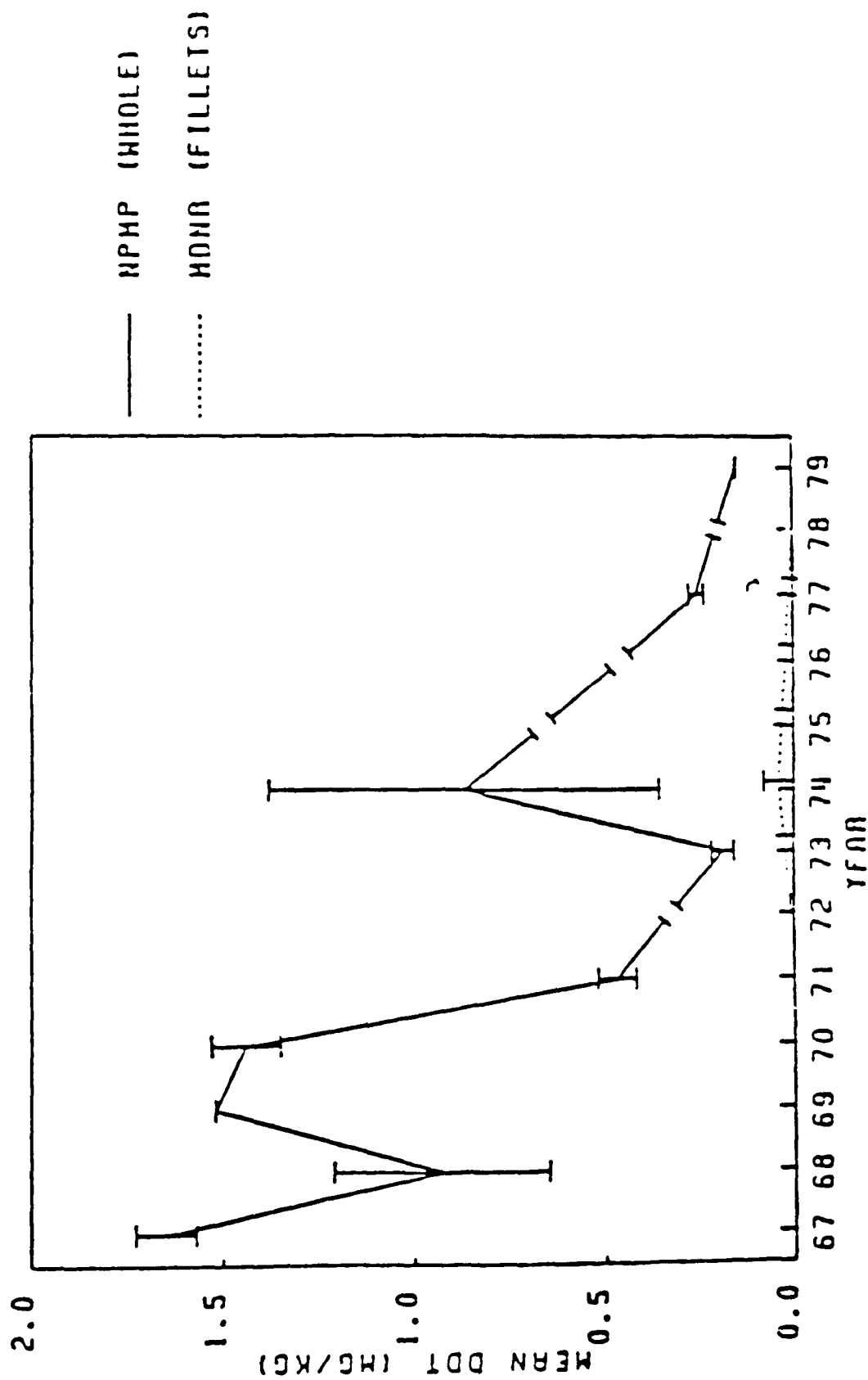


Figure 47. Yearly mean DDT-R concentrations for yellow perch from Saginaw Bay, 1967-1979 (Kreis and Rice 1985)

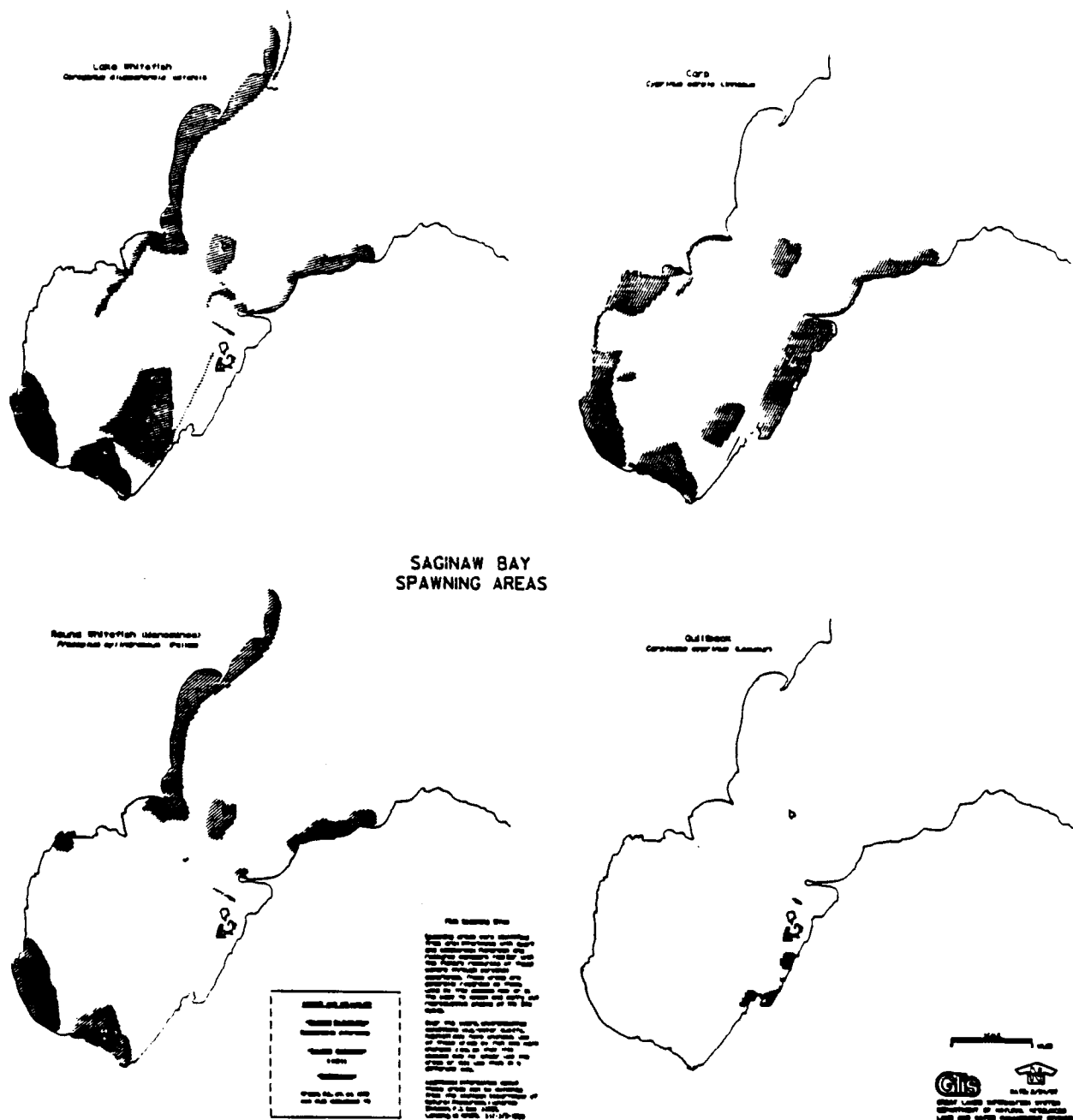


Figure 48a. Saginaw Bay spawning areas (GLIS)

Saginaw Bay Commercial Fisheries

Total Production 1916-1986

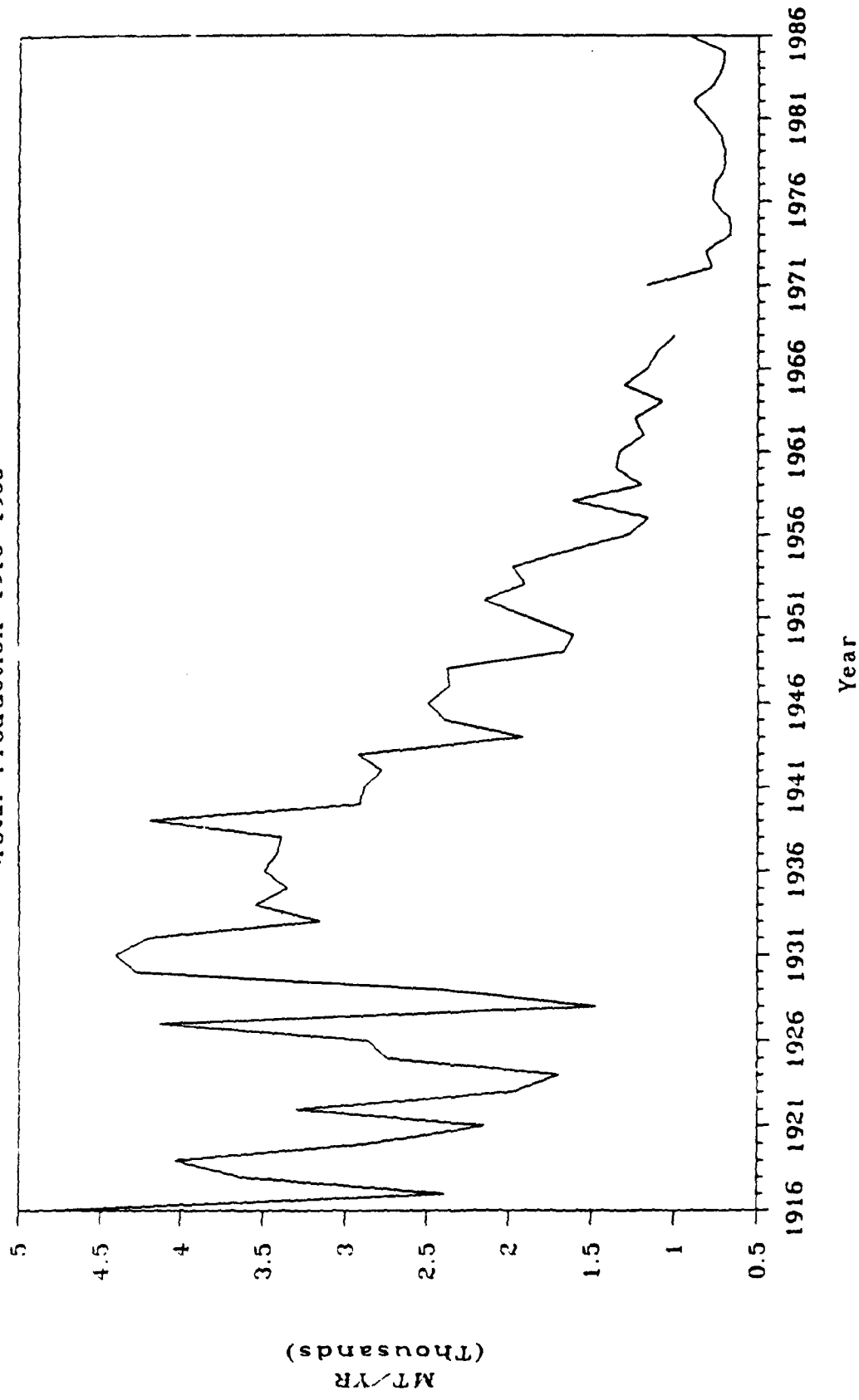


Figure 48b. Total commercial fisheries catch in Saginaw Bay, 1916-1986
(MDNR unpublished)

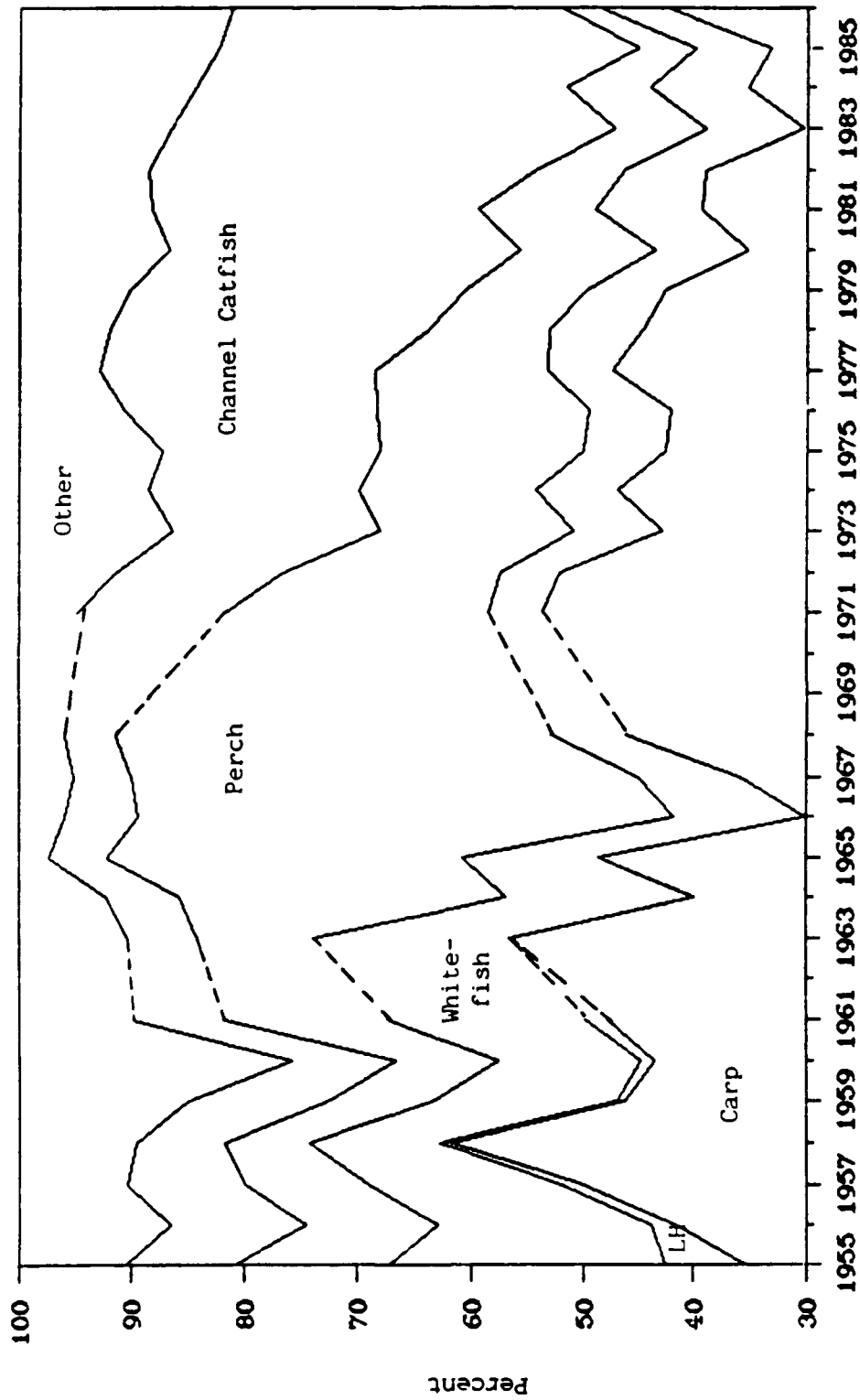


Figure 48c. Fish species composition of the commercial catch in Saginaw Bay, 1955-1986 (MDNR unpublished)

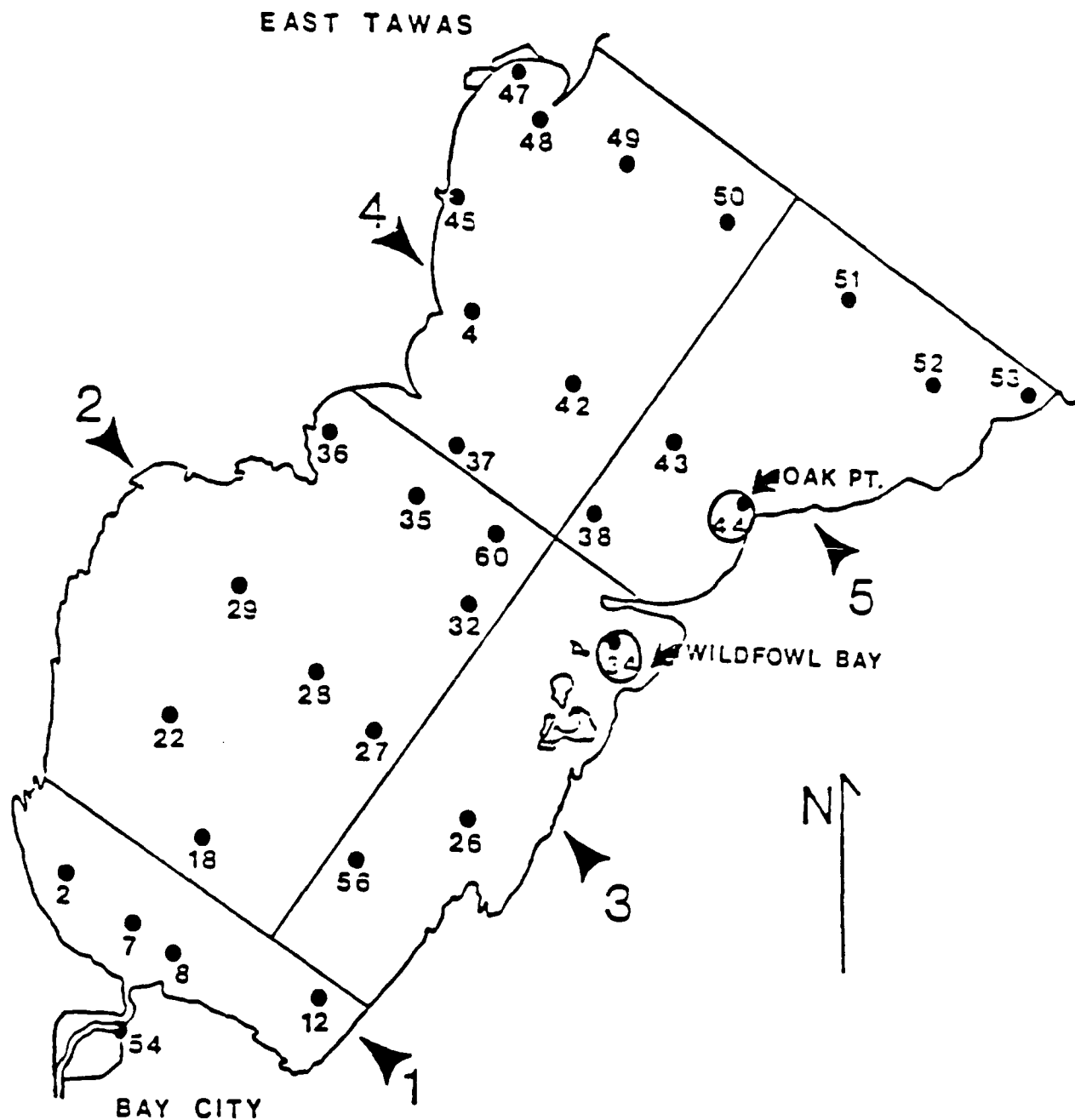


Figure 49. Plankton station locations in Saginaw Bay, 1980
(Stoermer and Theriot 1983)

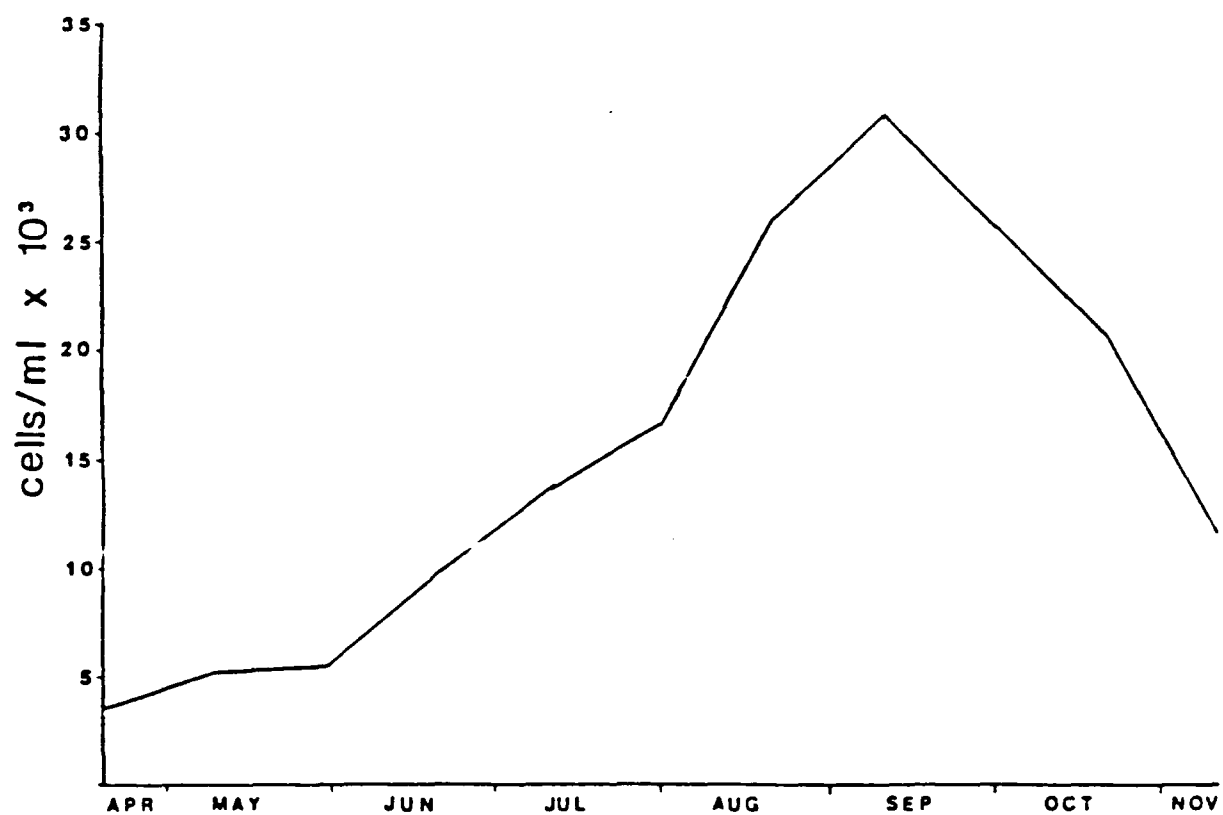


Figure 50. Seasonal variation of mean total phytoplankton cell abundance in Saginaw Bay, April-November, 1980 (Stoermer and Theriot 1983)

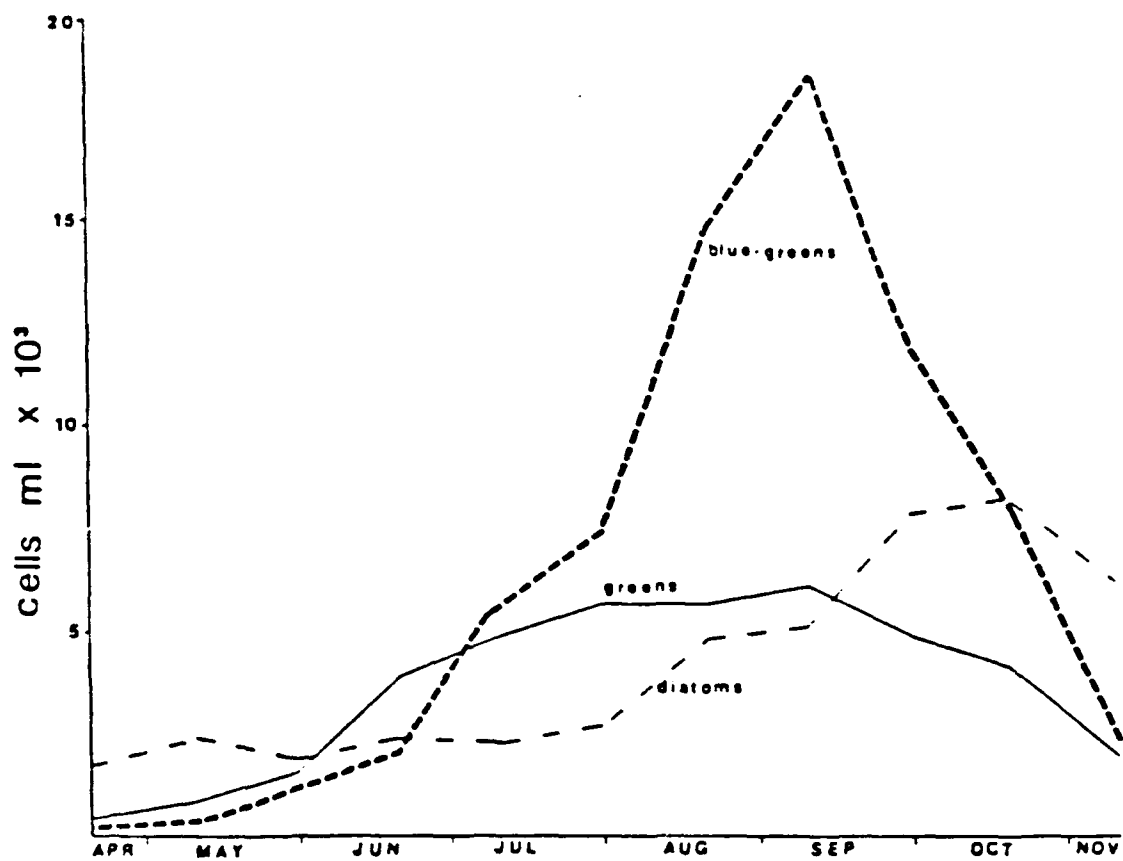


Figure 51. Seasonal variation of abundance of the three dominant algal divisions in Saginaw Bay, April-November, 1980 (Stoermer and Theriot 1983)

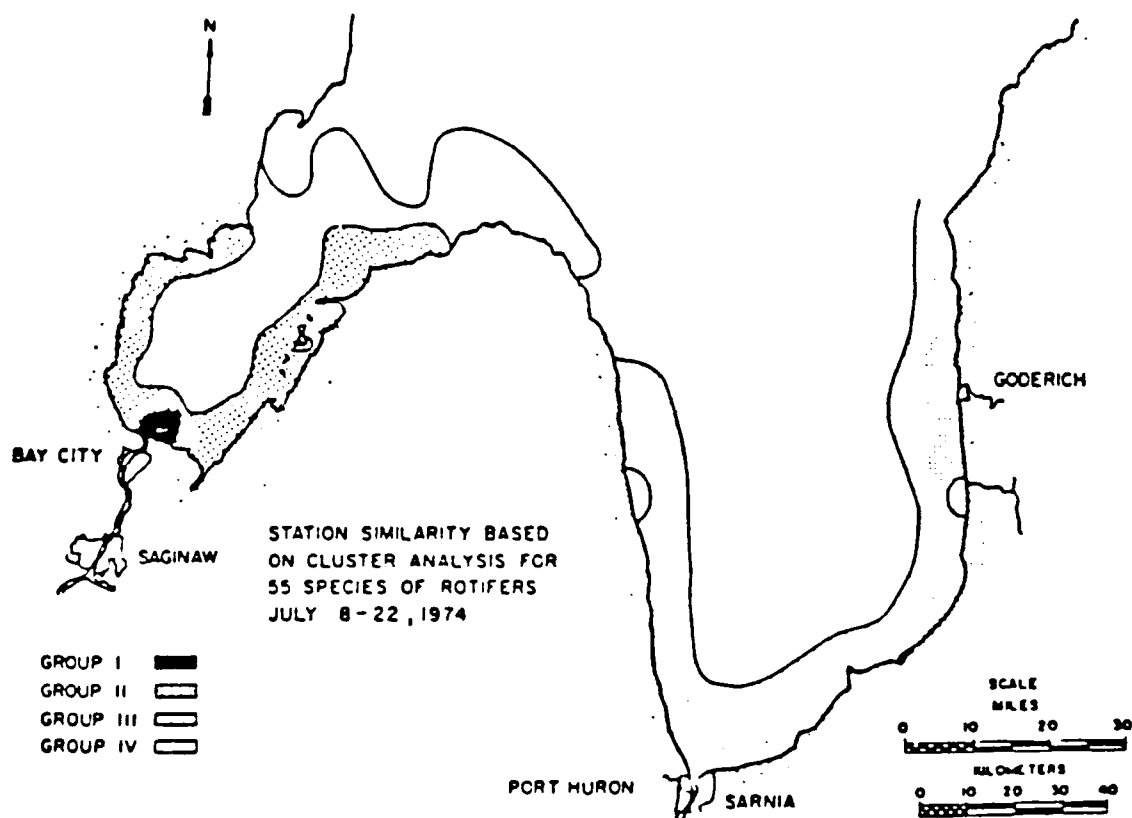


Figure 52. Grouping of 78 stations determined by cluster analysis of rotifer data for Saginaw Bay and Southern Lake Huron during July 1974 (Stemberger and Gannon 1977)

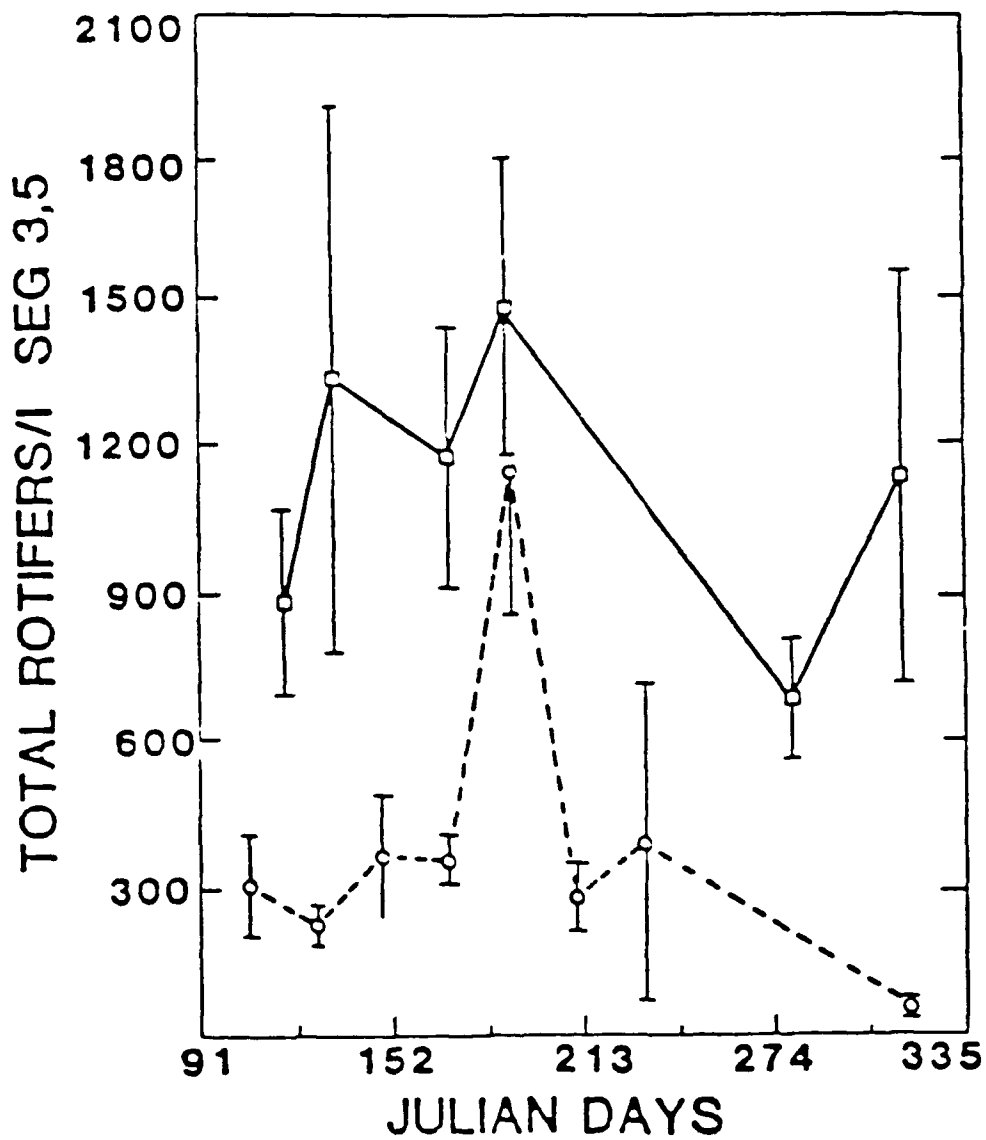


Figure 53. Numbers of rotifers (#1) found in segments 3 and 5 in 1974 (□) contrasted to 1980 (○) (McNaught et al. 1983; see Figure 49)

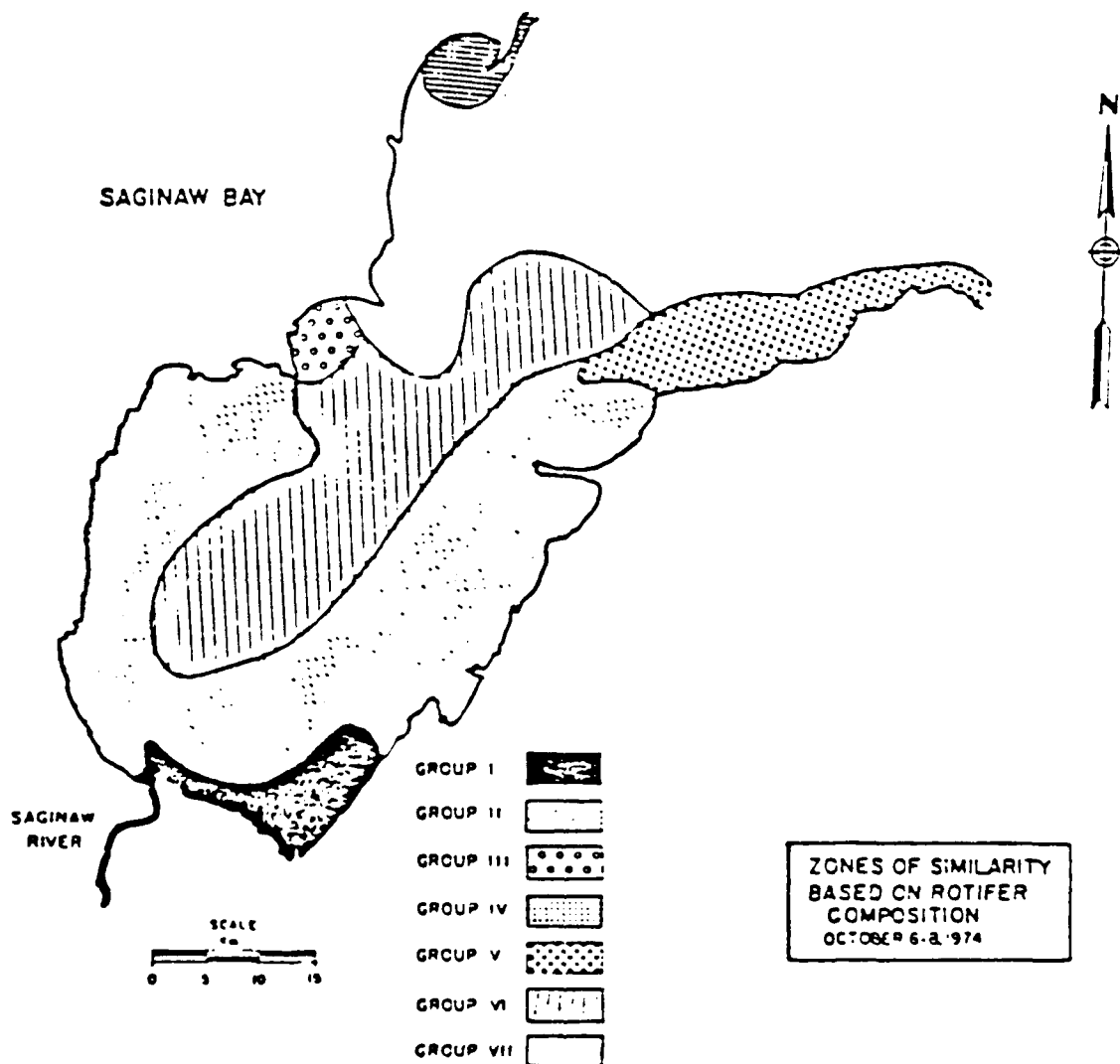


Figure 54. Grouping of 38 stations determined by cluster analysis of rotifer data for Saginaw Bay during October, 1974 (Gannon 1981)

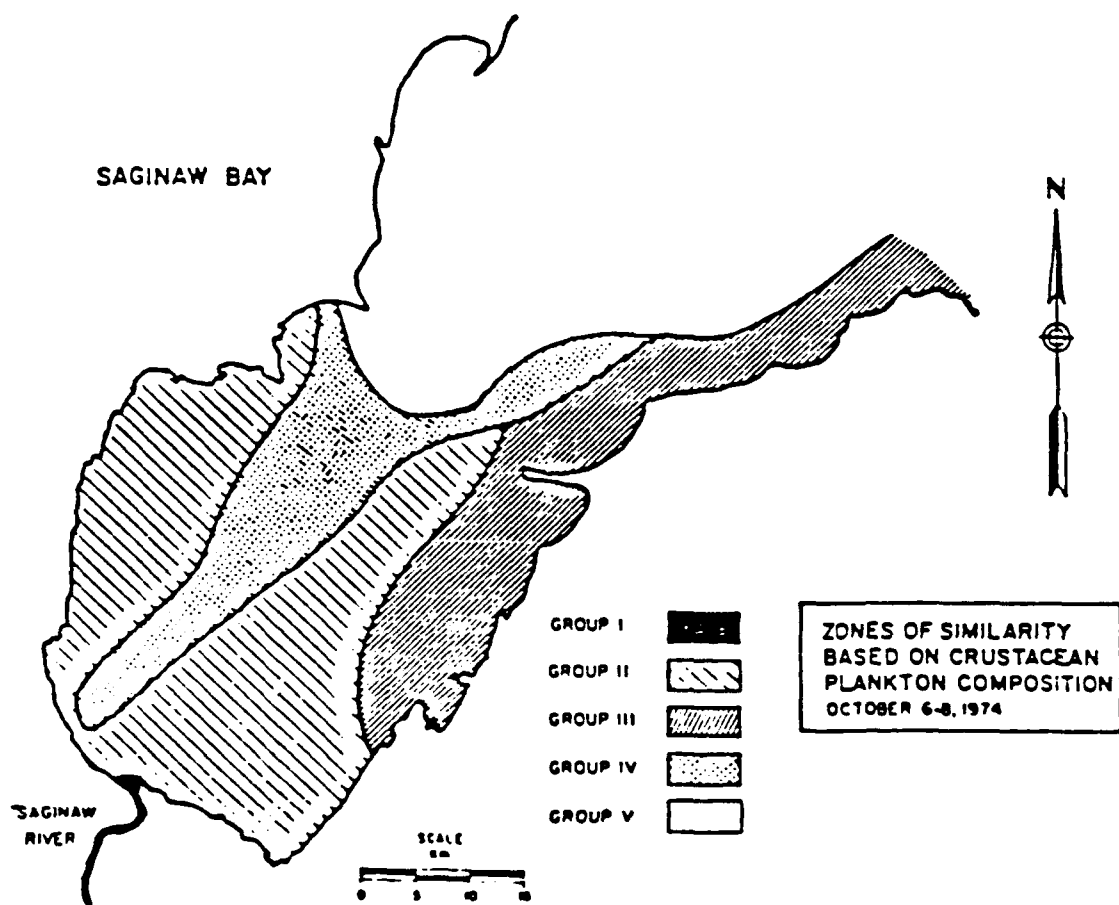


Figure 55. Grouping of 38 stations determined by cluster analysis of crustacean plankton data for Saginaw Bay during October, 1974 (Gannon 1981)

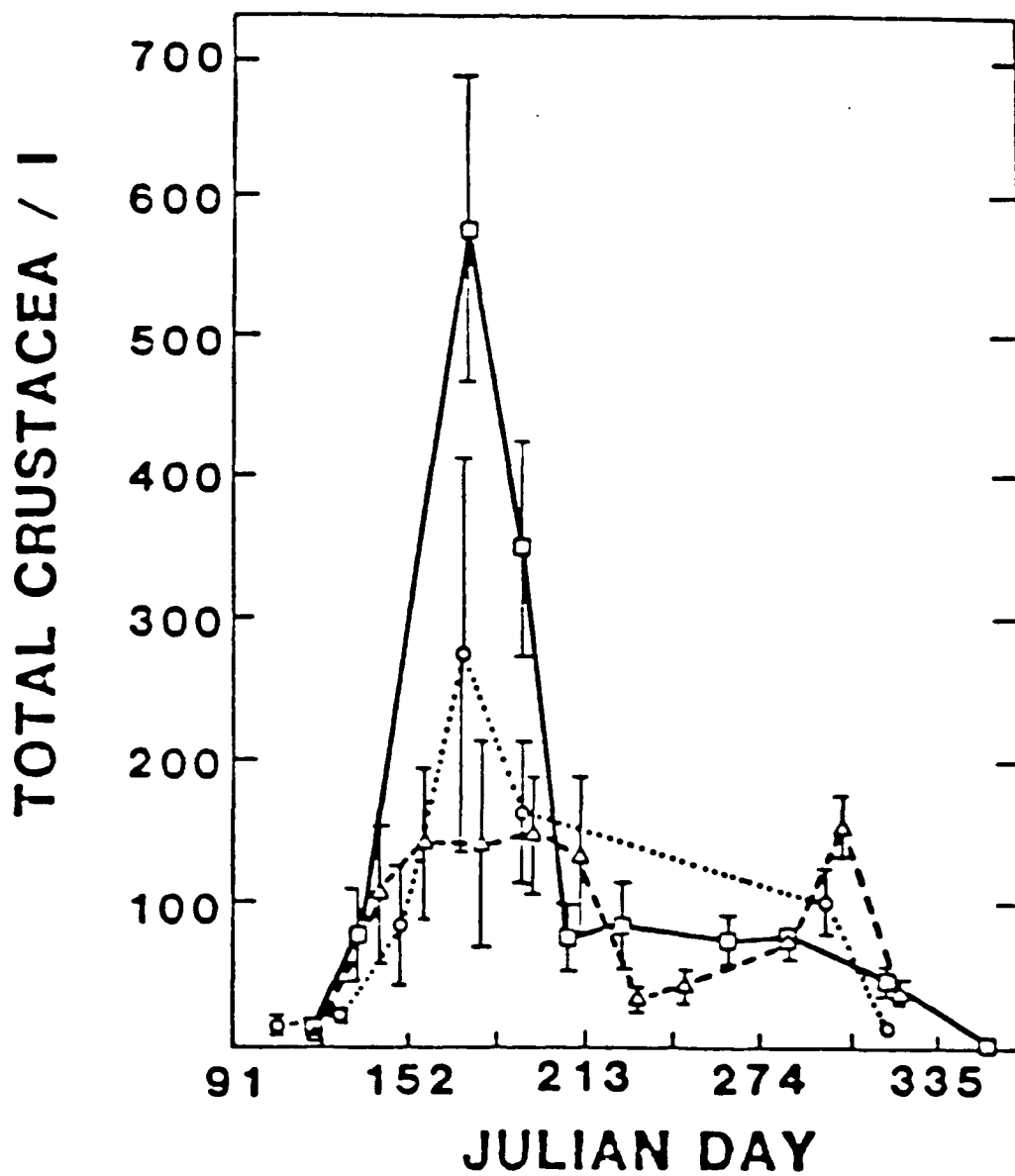


Figure 56. Numbers of crustacean zooplankton (#/l) found in Segments 3 and 5 during 1974, 1975, and 1980 (McNaught et al. 1983; see Figure 49)

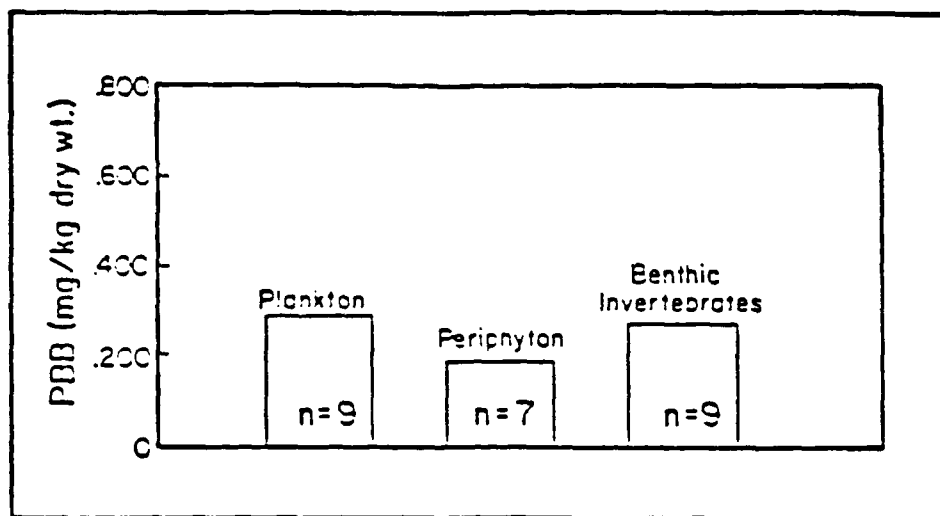


Figure 57a. Average PBB concentrations (mg/kg dry weight) in Pine River plankton, periphyton, and benthic invertebrates (LTI 1983)

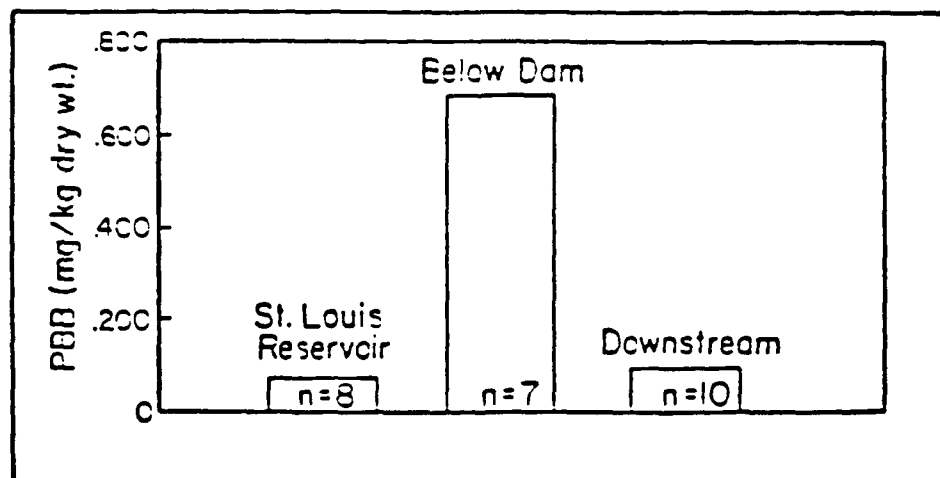


Figure 57b. Average PBB concentrations (mg/kg dry weight) in plankton, periphyton, and benthic invertebrates collected in the Pine River from the St. Louis Reservoir, below the dam, and downstream from the dam (LTI 1983)

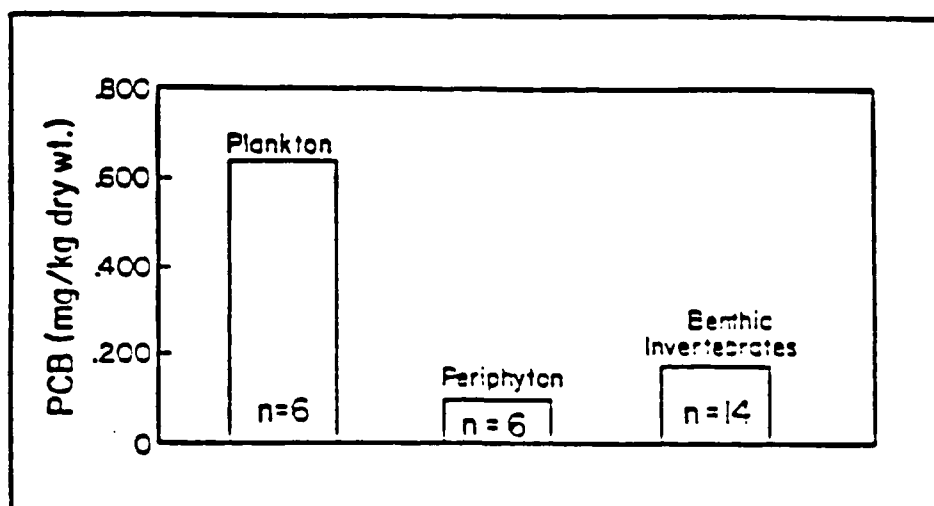


Figure 58a. Average PBB concentrations (mg/kg dry weight) in Saginaw River plankton, periphyton, and benthic invertebrates (figure from LTI 1983)

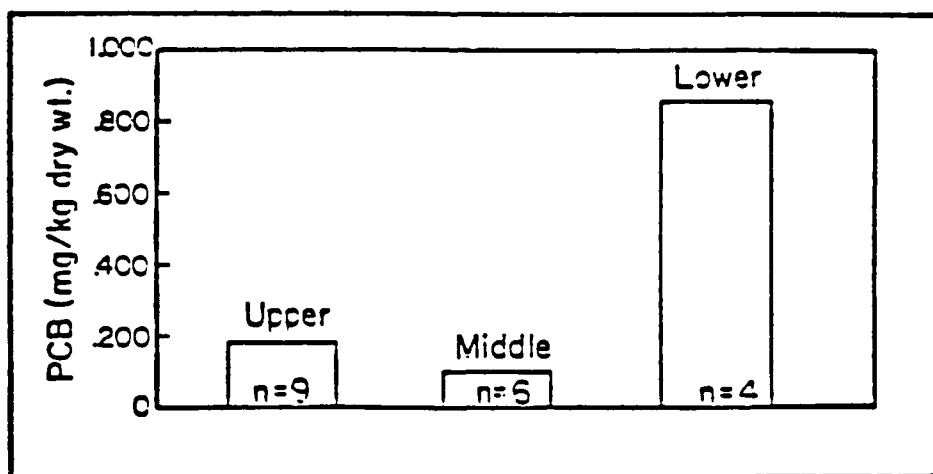


Figure 58b. Average PBB concentrations (mg/kg dry weight) in plankton, periphyton, and benthic invertebrates collected from the Upper, Middle, and Lower Saginaw River

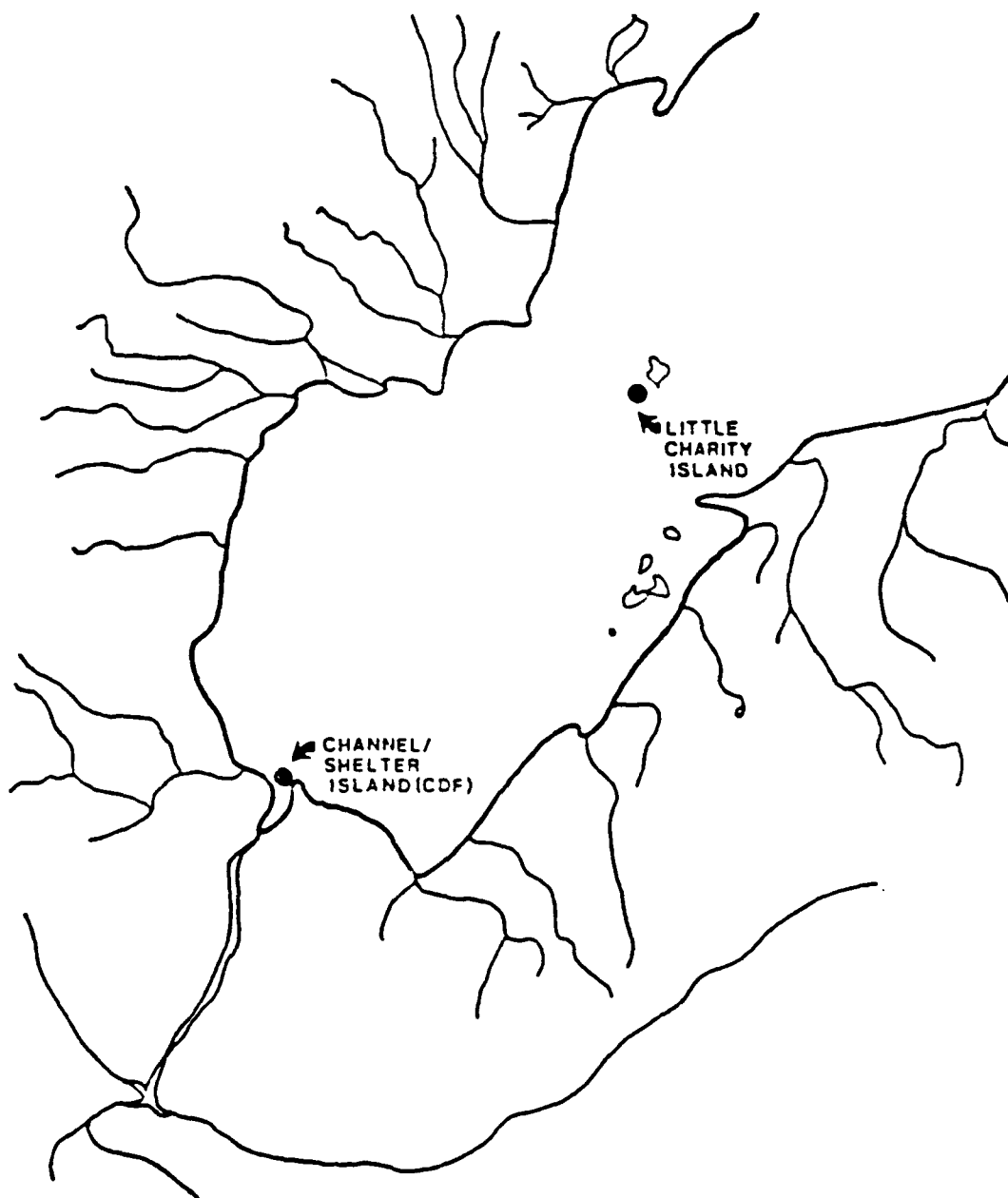


Figure 59. Locations of two herring gull colonies in Saginaw Bay monitored for organochlorine and other toxic organic contamination

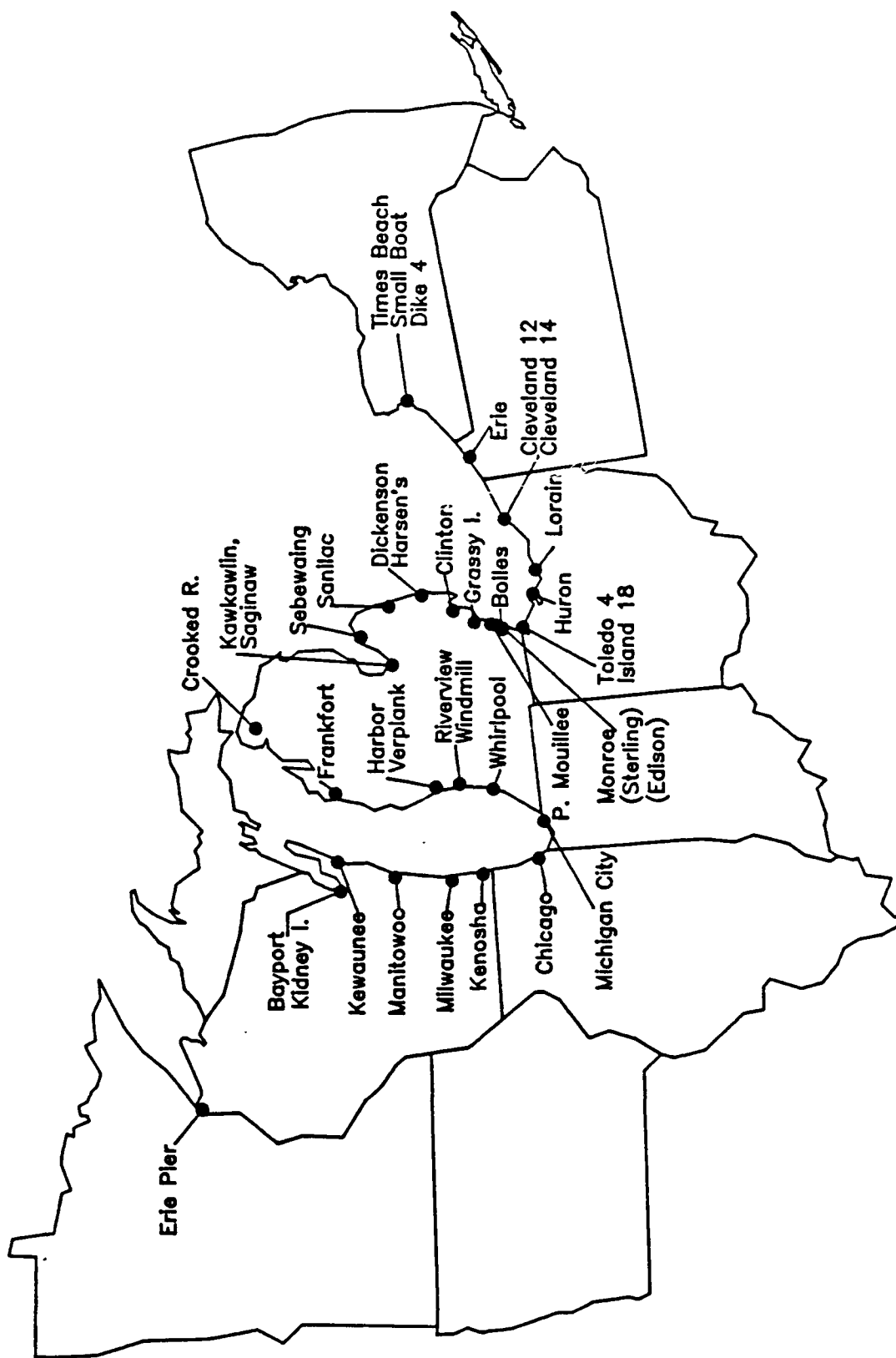


Figure 60. Locations of confined disposal facilities, US Great Lakes

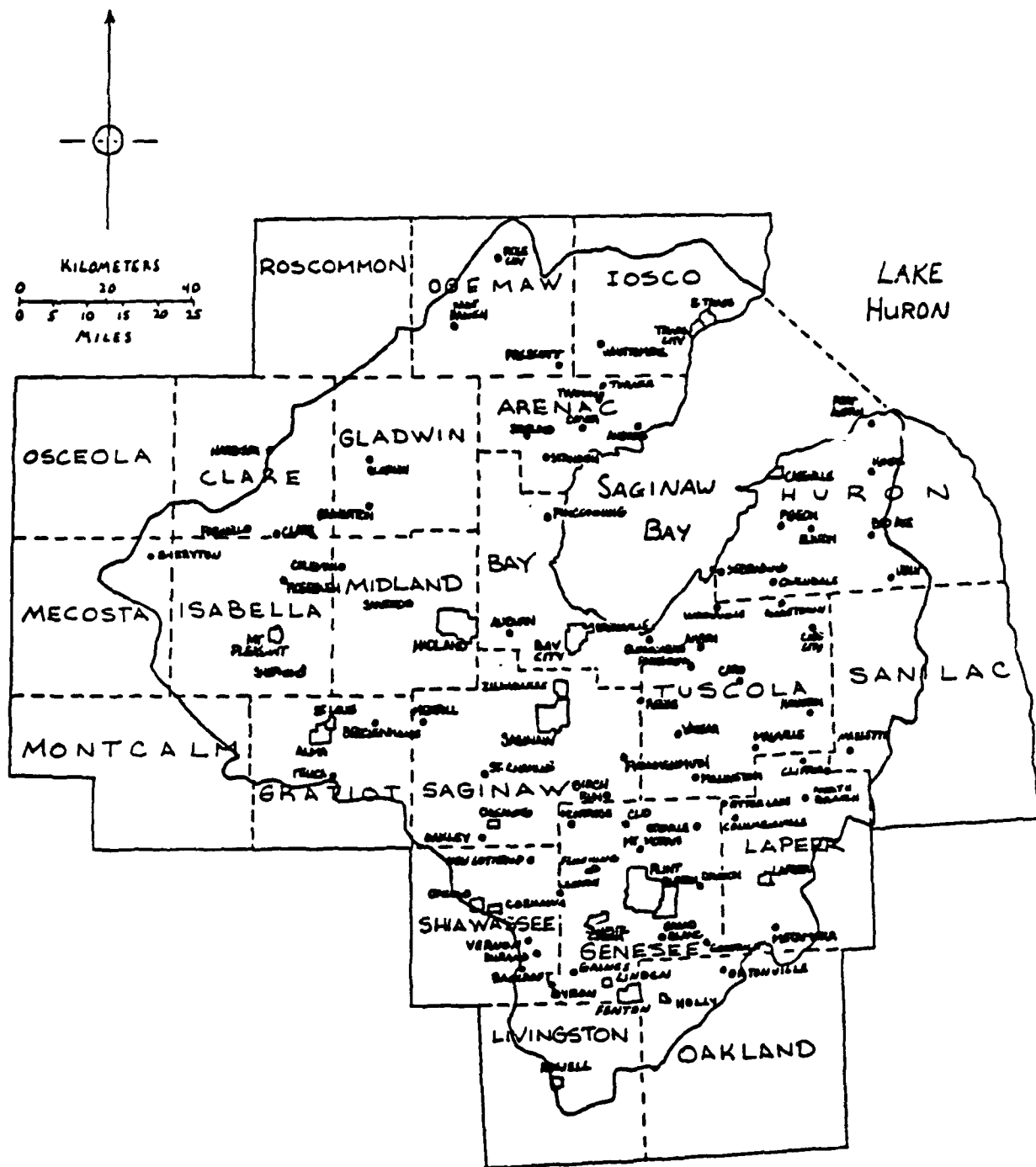


Figure 61. Cities and villages located in the Saginaw Bay drainage basin

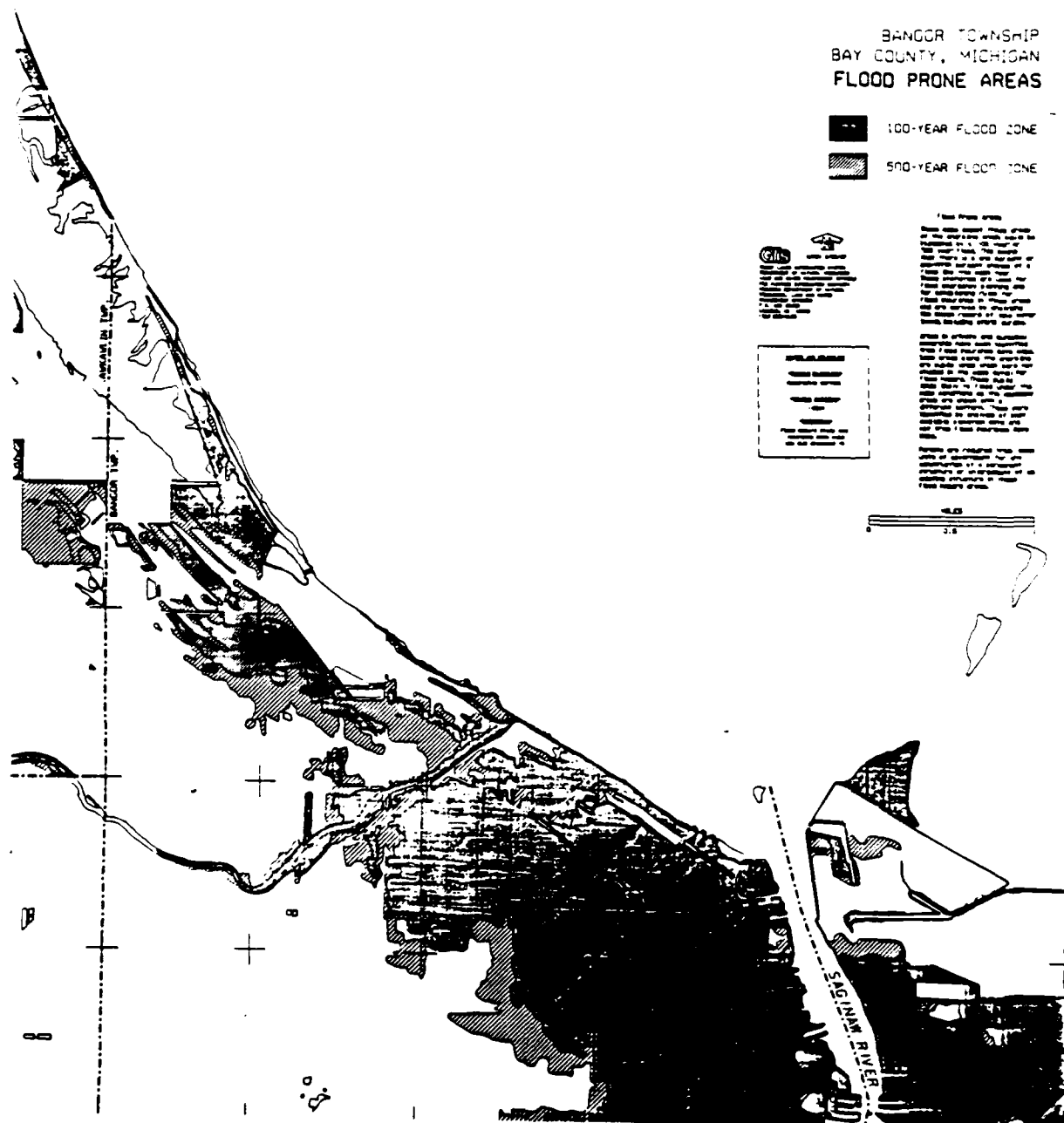


Figure 62. Flood-prone areas, Bay County, Michigan (GLIS)

APPENDIX 1: RECENT AND PROJECTED POPULATIONS FOR TOWNSHIPS,
VILLAGES AND CITIES WITHIN THE SAGINAW BAY DRAINAGE BASIN

Location	Population	
	1980	2000
<u>Arenac Co.</u>		
Townships		
Adams	457	582
Arenac	892	1,198
Au Gres	907	1,301
Clayton	967	1,237
Deep River	1,874	2,479
Lincoln	1,090	1,497
Mason	852	1,074
Moffatt	657	906
Sims	695	1,011
Standish	2,011	2,802
Turner	791	933
Whitney	1,078	1,526
Villages		
Sterling	457	608
Turner	187	215
Twining	196	234
Cities		
Au Gres	768	1,085
Omer	403	495
Standish	1,264	1,675
<u>Bay Co.</u>		
Townships		
Banor	17,494	18,293
Beaver	3,027	3,129
Frankenlust	2,525	2,595
Fraser	3,954	4,135
Garfield	1,810	1,846
Gibson	1,068	951
Hampton	10,418	10,894
Kawkawlin	5,077	5,309
Merritt	1,676	1,521
Monitor	10,143	10,606
Mt. Forest	1,444	1,462

Bay Co. cont.

Pinconning	2,984	3,093
Portsmouth	4,291	4,385
Williams	4,414	4,465
Cities		
Auburn	1,921	1,919
Bay City	41,593	34,843
Essexville	4,378	4,146
Pinconning	1,430	1,411

Clare Co.

Townships		
Arthur	562	755
Franklin	631	987
Freeman	437	582
Frost	852	1,252
Garfield	1,416	2,283
Grant	2,227	3,252
Hamilton	1,595	2,343
Hatton	638	937
Hayes	3,609	5,819
Lincoln	974	1,431
Sheridan	1,033	1,408
Surrey	3,101	4,845
Villages		
Farwell	804	1,144
Cities		
Clare	3,300	4,738
Harrison	1,700	2,538

Genesee Co.

Townships		
Argentine	4,180	4,534
Atlas	4,891	5,401
Clayton	7,269	8,074
Davison	13,708	15,301
Fenton	11,744	12,774
Flint	35,405	34,369
Flushing	9,246	10,273
Forest	4,255	4,718
Gaines	5,209	5,839

Genesee Co. cont.

Genesee	25,065	24,312
Grand Blanc	24,413	26,644
Montrose	6,164	6,719
Mt. Morris	27,928	27,121
Mundy	10,786	11,750
Richfield	6,895	7,658
Thetford	8,499	9,548
Vienna	12,914	14,082
Cities		
Burton	29,976	28,965
Clio	2,669	2,844
Davison	6,087	6,761
Fenton	8,098	8,729
Flint	159,611	145,598
Flushing	8,624	9,378
Grand Blanc	6,848	8,159
Montrose	1,706	1,855
Mt. Morris	3,246	3,465
Swartz Creek	5,013	5,826
Villages		
Gaines	440	433
Goodrich	795	790
Lennon	114	115
Linden	2,174	2,191
Otisville	682	670
Otter Lake	14	14

Gladwin Co.

Townships		
Beaverton	1,612	2,727
Bentley	771	1,164
Billings	2,076	3,412
Bourret	315	517
Buckeye	970	1,522
Butman	834	1,192
Clement	781	1,371
Gladwin	743	907
Grim	115	151
Grout	1,542	2,424
Hay	1,056	1,834
Sage	2,049	3,325
Secord	850	1,353
Sherman	773	1,212
Tobacco	1,966	3,152

Gladwin Co. cont.

Cities

Beaverton	1,025	1,392
Gladwin	2,479	3,444

Gratiot Co.

Townships

Arcadia	1,784	1,797
Bethany	1,526	1,432
Elba	1,537	1,400
Emerson	1,092	958
Hamilton	530	435
Lafayette	776	627
Newark	1,097	1,009
New Haven	1,021	913
North Star	1,171	993
Pine River	1,939	1,866
Seville	2,091	2,150
Sumner	1,897	1,982
Wheller	3,219	3,276

Villages

Breckenridge	1,495	1,584

Cities

Alma	9,652	9,548
Ithaca	2,950	2,868
St. Louis	4,107	4,115

Huron Co.

Townships

Bingham	1,679	1,768
Brookfield	998	896
Caseville	2,067	2,381
Chandler	555	460
Colfax	1,907	2,284
Dwight	1,145	1,111
Fairhaven	1,292	1,325
Grant	819	806
Hume	753	701
Lake	822	920
Lincoln	1,042	1,053
McKinley	555	540
Meade	789	766
Oliver	1,756	1,743
Paris	732	613
Pte Aux Barques	6	6

Huron Co. cont.

Port Austin	1,570	1,734
Sebewaing	3,259	3,417
Sheridan	812	763
Verona	1,122	1,284
Winsor	2,140	2,164
Villages		
Caseville	851	924
Elkton	953	1,010
Kinde	600	635
Owendale	308	311
Pigeon	1,247	1,372
Port Austin	839	883
Sebewaing	2,046	2,201
Ubyly	862	966
Cities		
Bad Axe	3,184	3,427

Iosco Co.

Townships		
Alabaster	371	406
Au Sable	2,198	2,699
Baldwin	1,393	1,697
Burleigh	761	789
Grant	1,043	1,281
Oscoda	11,386	13,155
Plainfield	3,160	3,862
Reno	566	581
Sherman	465	481
Tawas	1,463	1,678
Wilber	554	635
Cities		
East Tawas	2,584	2,964
Tawas City	1,967	2,222
Whittemore	438	451

Isabella Co.

Townships		
Broomfield	1,246	1,625
Chippewa	3,784	5,160
Coe	3,141	4,162
Coldwater	714	882
Deerfield	2,160	2,930
Denver	1,059	1,321

Isabella Co. cont.

Fremont	1,215	1,579
Gilmore	966	1,202
Isabella	1,916	2,375
Lincoln	1,698	2,262
Nottawa	2,042	2,706
Rolland	1,105	1,326
Sherman	1,405	1,709
Union	5,306	7,633
Vernon	1,389	1,654
Wise	1,218	1,540
Villages		
Shepherd	1,534	2,158
Rosebush	336	N.A.
City		
C.M.U. ^a	16,912	13,500
Bal. of City	6,834	8,833
Mt. Pleasant	23,746	22,333

Lapeer Co.

Townships		
Arcadia	2,347	3,109
Attica	3,642	4,987
Burlington	1,562	1,774
Burnside	1,772	2,192
Deerfield	4,672	6,346
Dryden	2,977	4,056
Elba	4,604	5,007
Goodland	1,534	1,799
Hadley	3,331	4,843
Lapeer	4,261	5,948
Marathon	4,336	5,335
Mayfield	7,098	9,787
Metamora	3,220	4,459
North Branch	2,721	3,518
Oregon	5,652	7,862
Rich	1,249	1,422
City		
Lapeer	6,198	6,363
Villages		
Clifford	406	543
Columbiaville	953	982
Metamora	552	564
North Branch	896	1,143
Otter Lake	442	499

Livingston Co.

Townships		
Cohoctah	2,436	4,365 ^b
Conway	1,722	2,488 ^b
Deerfield	2,611	3,645 ^b
Genoa	9,261	17,388 ^b
Hartland	6,034	14,558 ^b
Howell	3,999	8,288 ^b
Marion	4,754	9,723 ^b
Oceola	4,175	8,935 ^b
Tyrone	6,077	12,231 ^b
City		
Howell	6,976	9,269 ^b

Mecosta Co.

Townships		
Chippewa	1,009	1,400
Fork	1,348	1,900
Martiny	1,210	1,800
Millbrook	947	1,280
Sheridan	1,007	1,200
Wheatland	1,424	1,870
Village		
Barryton	422	N.A.

Midland Co.

Townships		
Edenville	2,029	2,180
Geneva	1,157	1,205
Greendale	1,244	1,315
Homer	4,477	5,195
Hope	1,249	1,320
Ingersoll	3,011	3,375
Jasper	1,129	1,152
Jerome	4,171	4,840
Larkin	3,303	3,832
Lee	3,325	3,858
Lincoln	1,643	1,906
Midland	2,389	2,346
Mills	1,461	1,695
Mount Haley	1,586	1,840
Porter	1,113	1,089
Warren	1,846	2,131

Midland Co. cont.

Villages		
Sanford	864	N.A.
Cities		
Coleman	1,429	1,602
Midland	37,250	42,418

Montcalm Co.

Townships		
Crystal	2,224	2,700
Ferris	1,133	1,400
Home	2,614	2,850
Richland	2,421	3,300

Oakland Co.

Townships		
Addison	4,184	8,636 ^b
Brandon	8,336	16,720 ^b
Groveland	4,114	8,595 ^b
Highland	16,958	29,918 ^b
Holly	3,612	5,027 ^b
Oxford	7,823	15,236 ^b
Rose	4,465	9,290 ^b
Springfield	8,295	16,097 ^b
Village		
Ortonville	1,190	1,316 ^h
City		
Holly	4,874	6,263 ^b

Ogemaw Co.

Townships		
Churchill	1,058	1,507
Cumming	675	921
Edwards	1,036	1,470
Goodar	374	476
Hill	1,301	1,745
Horton	729	1,034
Klacking	386	504
Logan	567	718
Mills	2,624	4,042
Ogemaw	814	1,189

Ogemaw Co. cont.

Richland	803	966
Rose	1,085	1,630
West Branch	2,075	3,054
Village		
Prescott	322	367
Cities		
Rose City	661	938
West Branch	1,785	2,092

Osceola Co.

Townships		
Evart	1,029	1,300
Orient	635	900
Sylvan	657	700

Roscommon Co.

Townships		
Backus	213	302
Nester	245	331
Richfield	2,926	4,786

Saginaw Co.

Townships		
Albee	2,642	2,814
Birch Run	5,488	5,838
Blumfield	2,047	2,137
Brady	2,498	2,536
Brant	1,849	1,800
Bridgeport	13,978	14,781
Buena Vista	12,768	12,587
Carrollton	7,482	7,262
Chapin	1,054	1,020
Cheasaning	5,317	5,354
Frankenmuth	2,389	2,497
Fremont	2,087	2,066
James	2,168	2,293
Jonesfield	1,920	1,854
Kochville	2,828	3,012
Lakefield	960	949
Maple Grove	2,994	3,189

Saginaw Co. cont.

Marion	913	878
Richland	4,402	4,689
Saginaw	38,668	41,190
St. Charles	3,689	3,580
Spaulding	3,164	3,109
Swan Creek	2,530	2,745
Taymouth	4,581	4,770
Thomas	11,184	11,875
Tittabawassee	4,908	5,228
Zilwaukee	89	N.A.
Villages		
Birch Run	1,196	1,266
Cheasining	2,656	2,531
Merrill	851	786
Oakley	412	407
St. Charles	2,276	2,364
Cities		
Frankenmuth	3,753	3,994
Saginaw	77,508	67,969
Zilwaukee	2,201	N.A.

Sanilac Co.

Townships		
Argyle	912	905
Austin	802	807
Custer	1,122	1,202
Elmer	829	826
Evergreen	1,042	1,046
Flynn	963	1,058
Greenleaf	746	772
Lamotte	1,065	1,145
Marlette	2,029	2,476
Minden	710	700
Moore	1,318	1,393
Wheatland	582	583
City		
Marlette	1,761	2,034

Shiawassee Co.

Townships

Antrim	1,752	2,421
Burns	3,273	4,098
Caledonia	4,785	5,404
Fairfield	904	984
Hazelton	2,411	2,762
New Haven	1,425	1,522
Owosso	4,530	5,188
Rush	1,500	1,585
Shiawassee	2,709	3,161
Venice	3,063	3,416
Vernon	5,003	5,678

Cities

Corunna	3,206	3,668
Durand	4,241	4,099
Owosso	16,455	17,531

Villages

Bancroft	618	614
Byron	689	656
Lennon	486	482
New Lothrop	646	716
Vernon	1,008	977

Tuscola Co.

Townships

Akron	1,811	1,855
Almer	2,720	3,179
Arbela	3,192	3,856
Columbia	1,428	1,390
Dayton	1,728	2,027
Denmark	3,615	4,313
Elkland	3,449	4,044
Ellington	1,214	1,351
Elmwood	1,337	1,427
Fairgrove	1,946	2,125
Fremont	2,871	3,349
Gilford	915	857
Indianfields	7,037	8,059
Juniata	1,619	2,018
Kingston	1,539	1,667
Koylton	1,339	1,581
Millington	4,429	5,434
Novesta	1,482	1,632
Tuscola	2,255	2,719

Tuscola Co. cont.

Vassar	3,709	4,631
Watertown	2,122	2,575
Wells	1,501	1,695
Wisner	916	1,043
Villages		
Akron	538	617
Caro	4,317	5,079
Cass City	2,258	2,716
Fairgrove	691	823
Gagetown	482	481
Kingston	417	457
Mayville	958	1,082
Millington	1,237	1,442
Reese	1,645	2,057
Unionville	578	625
City		
Vassar	2,727	3,075
Saginaw Bay Drainage		
Drainage Basin Total	1,458,339	1,648,036

Sources: - Bureau of the Census. 1983
- ECMPDR Region 7
- GLS Region 5
- SEMCOG Region I
- WMRPC Region 8

^a Central Michigan University figures supplied by Mt. Pleasant Department of Community Affairs.

^b Projected to the year 2005 by SEMCOG.

APPENDIX 2: DISTRIBUTION OF ESTABLISHMENTS BY MAJOR INDUSTRIAL GROUP AND EMPLOYMENT RANGE
FOR COUNTIES IN THE SAGINAW BAY DRAINAGE BASIN

Major group descriptions are: 20-food and kindred products; 22-textile mill products; 23-apparel and other textile products; 24-lumber and wood products; 25-furniture and fixtures; 26-paper and allied products; 27-printing and publishing; 28-chemicals and allied products; 29-petroleum and coal products; 30-rubber and misc. plastics products; 31-leather and leather products; 32-stone, clay, and glass products; 33-primary metal industries; 34-fabricated metal products; 35-machinery, except electrical; 36-electric and electronic equipment; 37-transportation equipment; 38-instruments and related products; 39-miscellaneous manufacturing industries (Bureau of the Census, 1985).

	20	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	Auxil- aries
Arenac																				
1 to 19 employees	3			6			2						1	5	3		1	1		
20 to 99 employees														1	3					
Bay																				
1 to 19 employees	4	1		6	3	2	12	2	1	6		13	3	13	21	4	3		2	2
20 to 99 employees	1					1	2	1		0		2	2	5	6	1	0		1	1
100 to 249 employees	3					1	2			1		1	1	1	0	2	2			0
250 employees or more		1													1	1	1			1
Clare																				
1 to 19 employees	2			5			3				4		1	2	2				1	1
20 to 99 employees	2			1						2										
Genesee																				
1 to 19 employees	8	1	3	7	4	4	42	7		11	1	12	3	28	46	6	5	8	9	3
20 to 99 employees	7	1				1	8	0		8		4	1	10	12	1	3	1	2	2
100 to 249 employees	2					1	0	0						0	3	1	0			
250 employees or more							1	1						2			6			
Gladwin																				
1 to 19 employees				3			1	2		0				4	8		2			
20 to 99 employees										2					3		1			
100 to 249 employees																				

	20	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	Auxil- aries
<u>Gratiot</u> ^a																				
1 to 19 employees	2			5		1	4	0	0	0	0	3	0	1	3	1	0	1	2	
20 to 99 employees				1			2	1	0	2	0		1	2	3		3		1	
100 to 249 employees									1	1	0			0			0		1	
250 employees or more											1			1			1			
<u>Huron</u> ^a																				
1 to 19 employees	5	1	2				9	2	3			6	1	5	8		1			
20 to 99 employees	3						1	1	2			2	2	3	4		1			
100 to 249 employees	1												1	0						
250 employees or more														1						
<u>Iosco</u> ^a																				
1 to 19 employees	1		1	10			1					3		1	5		1		2	
20 to 99 employees							1					0		2	3		1		2	
100 to 249 employees												1		2						
<u>Isabella</u>																				
1 to 19 employees	2		1	4	1	2	7					3		0	7			3	1	
20 to 99 employees	1						3							0	2					
100 to 249 employees														1	2					
<u>Lapeer</u> ^a																				
1 to 19 employees	1		1	2			5		3			3	2	10	15	1	7	0	3	0
20 to 99 employees	0			1			1		2				2	4	4		3	1		1
100 to 249 employees	1								1					1						
250 employees or more																				
<u>Livingston</u> ^a																				
1 to 19 employees	2	1		2		1	10	6	3	9		3	2	15	25	9	1	0	2	0
20 to 99 employees	1			1		1	1		0	6		1	4	6	10	3	6	1		1
100 to 249 employees							1		1					0	2		1			
250 employees or more														1						

	20	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	Auxiliary
McCosta ^a																				
1 to 19 employees	3			6	1		4	1			1	2		0	3		0			
20 to 99 employees					1		1			0				2	4		1			
100 to 249 employees										1	1			2						
250 employees or more										1										
Midland																				
1 to 19 employees	1			3	1		6	0	2			3	3	0	5	1		1	3	0
20 to 99 employees				1	1		1	0	1			1		1	1				1	0
100 to 249 employees							2	0	1											1
250 employees or more								3												1
Montcalm ^a																				
1 to 19 employees	1		1	9	1	0	8	2	0	4	1	7		6	8	0	1		1	0
20 to 99 employees	1					2	2	1	1	4				0	2	0	0			1
100 to 249 employees	0						1							1		1	0			
250 employees or more	1													1		1	1			
Oakland ^a																				
1 to 19 employees	20	5	16	51	26	11	240	45	12	84	2	60	41	232	617	63	36	28	62	52
20 to 99 employees	4	1	4	2	2	5	19	14	2	35		10	17	114	225	36	16	18	10	58
100 to 249 employees	4			1	1	1	3	1		8		1	3	17	23	13	4	4	2	17
250 employees or more							1	2					3	3	9	3	8	1	1	13
Ogemaw ^a																				
1 to 19 employees				15	0		1		1			4	2	3	4	2			1	
20 to 99 employees					1								1	2	4					
100 to 249 employees														1						
Osceola ^a																				
1 to 19 employees	0			7			3			1	0	1		4	3	0	0		1	
20 to 99 employees	0									0	0			1	1	2	1			
100 to 249 employees	2									0	1		1	0						
250 employees or more										1										

	20	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	Auxil- aries
<u>Roscommon</u> ^a																				
1 to 19 employees				4			4					4		2				1	1	
20 to 99 employees							1							2						
<u>Saginaw</u>																				
1 to 19 employees	7	2	1	12	4	0	26	4		3		13	5	14	34	1	2	5	1	2
20 to 99 employees	4		1	1	0	3	3	2		3		1	1	7	22	3	1	1	1	3
100 to 249 employees	5				1		0			1			1		2	0	0			
250 employees or more	1						1						2		3	1	3			
<u>Sanilac</u> ^a																				
1 to 19 employees	5		2	2	1		5	1		3		4	0	10	9	0	2	1		
20 to 99 employees	0			1						5		2	1	6	2	2	2			
100 to 249 employees	1									1				3			1			
250 employees or more	1									1										
<u>Shiawassee</u> ^a																				
1 to 19 employees	3		1	3	1	0	7			5	1	4	0	6	15	0	0		1	0
20 to 99 employees					2	1	1			3		2	1	.3	5	0	1			2
100 to 249 employees						1						1			1	3	2			0
250 employees or more																2	1			1
<u>Tuscola</u>																				
1 to 19 employees	1			4			6	1		0		5	0	3	9		1	2	1	1
20 to 99 employees	2						2			7			1	2	2		3			
100 to 249 employees	1												0		0					
250 employees or more													2		1					

^a Only a portion of county is within the Saginaw Bay drainage basin.

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