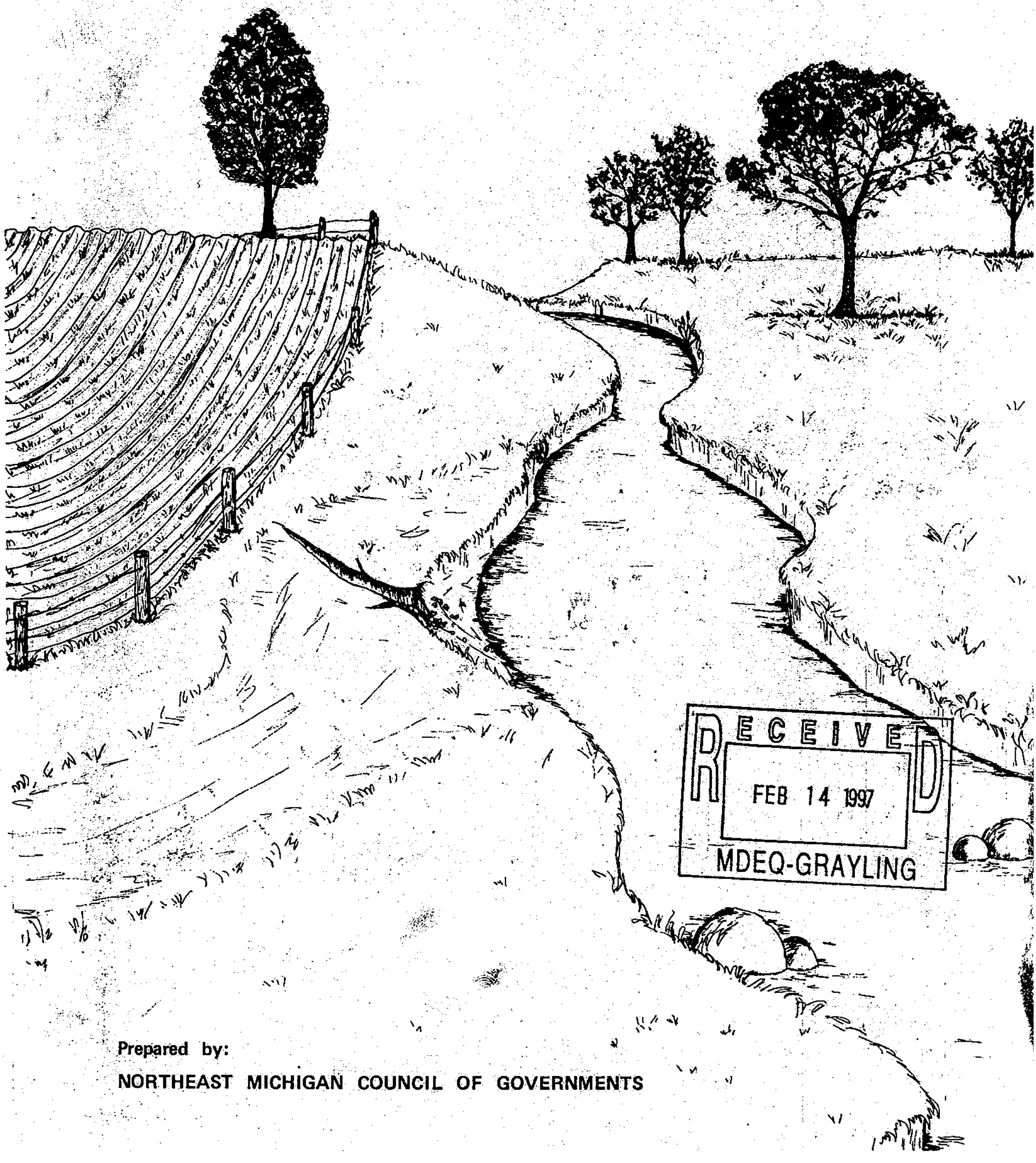
AGRICULTURAL AREAS OF WATER QUALITY CONCERN



Prepared by:
NORTHEAST MICHIGAN COUNCIL OF GOVERNMENTS

AGRICULTURAL AREAS OF WATER QUALITY CONCERN

December 1980

Prepared by:

Robert Wagner
Water Quality Specialist
Northeast Michigan Council of Governments

This project was funded, in part, by the U.S. Environmental Protection Agency (Grant # P005457), the State of Michigan, and members of the Northeast Michigan Council of Governments.

ACKNOWLEDGMENTS

The Clean Water Program of NEMCOG would like to gratefully acknowledge the following individuals and organizations who made this report possible: to Becky Glover, for her midnight feedings of the auto analyzer; to the University of Michigan Biological Station for their cooperation and use of the wet chemistry lab; to the ASCS County Committees, ASCS County Executive Directors, Cooperative Extension Service Directors, Soil Conservation Districts and Soil Conservation Service, all of Northeast Michigan for their assistance and support; to Dr. Richard B. Moreau and students of Alpena Community College for their assistance in obtaining fisheries data; and finally to NATRAC and the Full Council of NEMCOG for their continued support and guidance of the Clean Water Program.

TABLE OF CONTENTS

FIGURES

TABLES

INTRODUCTION

INTRODUCTION

Agriculture is one of humanity's oldest and perhaps most important activities. It provides us with food to eat, clothes to wear and, depending on future technological advances, fuel to warm our homes or to aid in our increasing need for travel. The economic welfare of Michigan is to a large extent based on farming, and a large portion of the state's landscape is devoted to this activity. Yet by its very nature, the production of food and fiber has the potential to adversely affect the water we drink, use for recreation, and the aquatic plants and animals living in that water. In recent years, a concerned public, as well as governmental agencies, have realized that agriculture, as well as many other activities not previously thought of as having potential to adversely affect water quality, may in fact do so. Thus efforts to determine nonpoint sources of pollution and to control such pollution are now being broadened and expanded. Water pollution control, which was once a narrow examination of principally industrial discharges and sewage treatment plant discharges, has become a much more comprehensive approach.

Since 1976, the Northeast Michigan Council of Governments (NEMCOG) has been actively engaged in a water quality management planning program as part of the Clean Water Act passed by Congress in 1972. Initial efforts of the Region's water quality program were focused upon the compilation of existing data and the development of a Clean Water Management Plan for Northeast Michigan. The Plan, completed in January of 1978, was approved by all eight counties (Alcona, Alpena, Cheboygan, Crawford, Montmorency, Oscoda, Otsego and Presque Isle) in the NEMCOG Region and certified by Governor Milliken in October 1978.

During the preparation of the Plan it became quite obvious that the Region lacked sufficient water quality data to determine the extent and severity of water quality problems stemming from nonpoint sources and on which to base effective management recommendations. As a result, NEMCOG has pursued several projects in an effort to secure additional water quality data.

The Agricultural Nonpoint Source Project conducted this year by NEMCOG is an example of coupling existing information with new water quality data to aid the development of future water quality management strategies and priorities. The objectives of this project were: 1) to identify agricultural areas having the potential for creating water quality problems; 2) to document the impacts and severity of water quality problems for the three highest priority agricultural watersheds identified and; 3) to establish a regional priority for each identified agricultural watershed and develop management recommendations to control agricultural nonpoint source pollution in the region.

In the second section of this document is a discussion of the methods of investigation for the water quality surveys. Section three reviews the land use and water quality data examined by the water quality surveys for the Devils River, Ocqueoc River and Van Etten Creek. These three watersheds were identified as the three highest priority areas in the Region where agriculture may be degrading water quality. The process used to identify these three Agricultural Areas of Water Quality Concern (Agricultural AWQC) is described in section four which also includes a brief review of the other **nine** agricultural AWQC. Section five reviews current recommended best management practices and contained within section six is a discussion of the various types of assistance and incentive programs available to the landowner. Conclusions and Recommendations from the study are found in section seven.

This document can be an important tool in recognizing water quality problems at the local, regional and state level; securing additional funding for technical assistance and cost-sharing; and in fostering support and cooperation from various organizations and agencies. Through good stewardship of the land we can mitigate water quality problems arising from agricultural activities while continuing to produce the food, fiber and energy that we depend on.

METHODS OF INVESTIGATION

Water Quality Parameters

A multitude of tests may be performed on any water sample to characterize its quality. The parameters vary with regard to the value of the information they provide and the cost and effort involved in their analysis, and these criteria played a part in determining whether to include a parameter in this study. The parameters used in this study are each described briefly below.

Temperature - Temperature directly and indirectly affects many different aspects of the river ecosystem. Many organisms, from aquatic insects to fishes, may have specific temperature requirements for metabolism which can make them susceptible to variations or extremes in temperature. Temperature also affects many chemical and physical reactions, influencing among other factors, nutrient and dissolved oxygen concentrations, and rates of photosynthesis. This factor thus plays a central role in many processes of the aquatic system.

Dissolved Oxygen - The presence of dissolved oxygen in water is essential to most forms of life that make up healthy and productive aquatic systems. Aquatic organisms prefer certain ranges of dissolved oxygen levels outside of which they become unhealthy or restricted. The amount of dissolved oxygen water can hold is directly related to the temperature of the water: warm water holds less oxygen than cold water, underlining again the importance of water temperature. To compare dissolved oxygen concentrations, therefore, the values are also given as a percentage of the amount of dissolved oxygen the water could hold at that temperature if saturated with oxygen. The units are given as percent saturation.

Alkalinity - Alkalinity is the water's capacity to resist change in pH due to addition of acid, and is therefore a measurement of the buffering capacity of water. Abnormal or fluctuating alkalinity values indicate an upset in the chemical balance of the water.

Chlorophyll *a* - This photosynthetic pigment is present in all algae and is the substance which transforms solar energy into chemical energy, making algae the primary producers of organic material in the aquatic environment. Measuring the concentration of chlorophyll *a* can give an indication of the amount of algae, and thus productivity, of the water system.

Nitrogen - Nitrogen is considered an important factor regulating the algal productivity of fresh waters and can occur in numerous forms. The forms which are most easily used by algae and macrophytes are the oxidized forms, nitrite (NO_2) and nitrate (NO_3). Nitrate usually comprises most of the total oxidized nitrogen (NO_2+NO_3) since nitrite is so readily oxidized to nitrate. Ammonia (NH_3) can also act as a nutrient source and occurs primarily as a result of the decomposition of organic matter. In the presence of oxygen, this ammonia is usually transformed to nitrite and nitrate. Nitrogen can enter an aquatic system naturally from the atmosphere, precipitation and dryfall, groundwater, and decomposition of organic matter entering the water. Sources from human activities include wastewater discharges, urban and agricultural runoff, and septic tank seepage.

Phosphorus - This nutrient is essential to the growth of organisms, and has been the major topic of research relating nutrient concentrations to aquatic productivity. This is so because phosphorus has been implicated as the nutrient which most often limits growth in a body of water. Phosphorus in natural waters is found almost strictly as phosphate. The forms measured for the purposes of this study were the inorganic soluble fraction, or ortho-phosphate (ortho-PO_4) and total phosphorus (Total P) which includes phosphorus in organisms and phosphorus adsorbed to inorganic and organic matter, as well as dissolved inorganic phosphorus.

Biochemical Oxygen Demand - Biochemical Oxygen Demand (BOD) is a general measurement of the amount of dissolved oxygen consumed in water by microorganisms under specified laboratory conditions. Since it is primarily the decomposition of organic wastes that requires oxygen, this test gives an indication of the amount of oxygen-demanding wastes in water. Although it is questionable that BOD values represent actual stream oxygen demands, the test is useful as a relative measure of pollution. Any decomposing organic matter, including the remains of algae, aquatic macrophytes, zooplankton, etc. can consume and reduce the amount of dissolved oxygen available to aquatic life.

Conductivity - Conductivity is a measure of the ability of water to carry an electric current. This ability is determined by the concentrations of ions present (such as calcium, magnesium, chloride, and carbonate ions) and by temperature. For ease of comparison, conductivity values are all corrected to 25°C, and are reported as umhos/cm (micromhos per centimeter). While the conductivity of most surface waters ranges generally from 50 to 1,500 umhos/cm, certain contaminated waters may exhibit much higher values. High or widely fluctuating conductivity values may therefore indicate a pollution problem.

Turbidity - Turbidity is caused by suspended organic and inorganic particulate matter and by microscopic organisms, and is a measure of the opaqueness or cloudiness of a water sample. Although high turbidity values generally indicate pollution or contamination, it is a nonspecific test, and the cause of a high value may be sedimentation from surface runoff, wastewater loading, or a dense population of algae.

pH - pH is formally defined as the logarithm of the reciprocal of the hydrogen ion concentration and describes water as being acidic or alkaline. The scale ranges generally from 0 (very acidic) to 14 (very alkaline), with 7 representing neutrality. The pH of most natural water falls within the range of 4 to 9. pH changes can strongly affect the chemistry in water as well as the organisms in it, and can indicate changes in the water system due to waste discharges, acid rain, etc.

One drawback to characterizing a river based on the periodic chemical analysis of water samples is that the analysis reflects water quality as it exists only at the moment of sampling. There are other techniques designed to assess the condition, over a larger period of time, of a river's aquatic environment. Two of these techniques were used in order to complement the water quality data collected in this study. One technique concerns the fish community and the other concerns the macroinvertebrate animals.

Macroinvertebrates - Aquatic macroinvertebrates are animals which live at least part of their lives on or in various surfaces in lakes or streams, and which, by definition, can be retained by a U.S. Standard No. 30 sieve. This community of animals is composed by insects, annelids, molluscs, flatworms, roundworms and crustaceans, and is very sensitive to stress caused by organic pollution, sedimentation, temperature fluctuation, oxygen depletion, etc. Since these animals remain relatively immobile in the stream, and they may live for weeks or months, their community structure is a function of, and reflects the continuous or long-term conditions of the stream over a period of time. Sampling this community, therefore, can provide information which is not available through periodic physical-chemical sampling, and which can give a more integrated picture in describing the river environment.

Fish - In the aquatic ecosystem fish are at the top of the food chain and therefore can reflect the type and productivity of plant and animal communities they feed on. Additionally, many species of fish are sensitive to temperature (brook trout) or sedimentation (rainbow darter).

Sampling Methods

Each of the three watersheds was assigned an upstream sampling site (location above intensive agricultural area) and a downstream sampling site (location below intensive agricultural area) except the Ocqueoc River which had three sites because of the watershed size and number of tributaries.

Sampling took place June 5 and July 16 on the Ocqueoc River and June 6 and July 10 for the Devils River and Van Etten Creek. While spring runoff sampling is very desirable, it was not feasible because of the unavailability of a water chemistry lab and the timing of this project. Therefore, summer storm sampling was planned and prepared. Between June 1 and August 22, Northeast Michigan experienced unseasonably dry weather, reducing the opportunity to obtain storm event samples.

Upon arrival at each sampling site, the date, time and location were recorded. A composite water sample for chlorophyll *a* was then taken by submerging a 100 ml polyethylene bottle just below the surface across the width of the stream. Immediately after securing the sample, $MgCO_3$ was added to buffer chlorophyll *a* against decomposition to phaeophytin by acid. Composite water samples for general chemical analysis were collected in the same manner and contained in a 1 liter acid washed polyethylene bottle. All samples were placed in a cooler with ice where sample temperatures were maintained at 2°-6°C until they reached the lab. Dissolved oxygen and temperature profiles were taken using a YSI Model 57 dissolved oxygen meter. The DO meter was wet-air calibrated before each use. Samples for the biochemical oxygen demand test were collected in 300 ml glass incubation bottles with ground glass stoppers. A Surber stream bottom sampler was used for collecting triplicate benthic macroinvertebrate samples at each site during the first sampling run. Organisms were preserved in 70% ethanol. Additionally, two students under the supervision of Dr. Richard B. Moreau of Alpena Community College provided valuable fisheries information by shocking each area in August utilizing a portable Coffett shocker.

Analytical Methods

All water samples arrived at the lab of the University of Michigan Biological Station within 10 hours of actual sampling. Water samples were immediately analyzed for conductivity, total alkalinity, turbidity, pH, NO_3, NO_2-N, NH_3N, and total ortho - PO_4. At least a 200 ml aliquot of each water sample was quickly frozen for future total phosphorus analysis. Chlorophyll *a* samples were filtered through Millipore 0.45 um HAWP filters which were then frozen in capped centrifuge tubes for later fluorometric analysis. The following analytical methods were used in this study:

Dissolved Oxygen - Field measurement using YSI Model 57 dissolved oxygen meter with automatic stirrer; reported as mg/l. (Standard Methods, 14th ed., Method 422F).

Temperature - Field measurement using YSI Model 57 dissolved oxygen meter.

Biochemical Oxygen Demand - Five day incubation period; reported as mg/l. (Standard Methods, 14th ed., Method 507)

Conductivity - Laboratory measurement using an Industrial Instruments Model RC-16B2 Conductivity Bridge; reported as umhos/cm corrected to 25°C.

Turbidity - Laboratory measurement; absorptometric method using Hach DR-EL/2 test kit; reported in formazin turbidity units (FTU).

pH - Laboratory measurement using a Beckman Selectmeter pH meter.

Total Alkalinity - Titration using bromcresol green-methyl red indicator; reported as mg/l $CaCO_3$. (Standard Methods, 14th ed., Method 403)

Chlorophyll *a* - Samples filtered through Millipore 0.45 um HAWP filters, frozen in capped centrifuge tubes; fluorometric determination using a Turner Model 111 Fluorometer; corrected for phaeophytin *a*; reported as ug/l. (Standard Methods, 14th ed., Method 1002G)

Total Orthophosphate - Ascorbic acid reduction method using a Technicon dual channel Auto-Analyzer 11; reported as mg/l total orthophosphate (T ortho-PO_4). (Standard Methods, 14th ed., Method 606)

Total Phosphorus - Modification of the persulfate digestion method of Gales *et al.* (1966), followed by ascorbic acid reduction method (see Total Orthophosphate); reported as mg/l total phosphorus (Total P).

Nitrite - Cadmium reduction method with copper-cadmium reduction tube removed, using a Technicon dual channel Auto-Analyzer 11; reported as mg/l NO_2. (Standard Methods, 14th ed., Method 605)

Nitrite & Nitrate - Cadmium reduction method using a Technicon dual channel Auto-Analyzer 11; reported as mg/l NO_3+NO_2. (Standard Methods, 14th ed., Method 605).

Ammonia - Phenate method using a Technicon dual channel Auto-Analyzer 11; reported as mg/l NH_3. (Standard Methods, 14th ed., Method 604).

WATER QUALITY SURVEY OF THE

Devils River

Ocqueoc River

and

Van Etten Creek

DEVILS RIVER WATERSHED

Background

The south branch of the Devils River is located in Ossineke and Sanborn Townships, Alpena County and Caledonia Township, Alcona County. This coastal watershed encompasses approximately 9600 acres, of which 70 percent of the land is in agricultural production.

The northern half of the watershed, drained by Holcomb Creek, is dominated by undulating to rolling, well drained sandy and loamy soils on uplands. Drainage ways and swales are occupied by somewhat poorly drained loamy and organic soils. Major soils in this area have medium to moderately high natural fertility and water holding capacity. Permeability ranges from moderately rapid to moderately slow. The southern half of the watershed is characterized by numerous small finger drainages and nearly level to undulating loamy soils on till plains. The gently sloping upland soils are well to moderately drained soils. Intervening flats, swales and drainages are occupied by organic, poorly drained soils. These soils have high natural fertility, while permeability is moderately slow.

The growing season is of 130-150 days duration. Average date of last freezing temperatures in the spring is May 10-20 and the average date of the first killing frost is October 1-10. Precipitation averages 26.8 inches per year with 40 percent occurring during the four month period, May through August. Average annual snowfall ranges from 60-80 inches.

Agricultural production practices in the watershed are a combination of row crops, such as corn, beans, and small grains as well as beef and dairy operations. The northern portion of the watershed, drained by Holcomb Creek, has a considerable amount of idle farmland because of the poorly drained soils and lack of adequate tile drainage systems. In the early sixties, 2.8 miles of Holcomb Creek was channelized as part of a Watershed Protection and Flood Prevention Act (PL-566) Project. Three spillways were also installed as part of the project. Approximately two and one half miles upstream from the confluence of Holcomb Creek and the Devils River are three beef producers utilizing the Holcomb Creek corridor for pasturing livestock.

The southern portion of the watershed has more intensive row crop, dairy and beef production. This area is bisected by numerous dendritic like surface drainages. In some instances, producers are plowing, fertilizing, planting, cultivating and spreading manure across these small drainages. There are also several small beef cattle operations pasturing livestock on these surface drainages. Near the confluence of Holcomb Creek and the Devils River is a 75 head dairy operation and two beef producers with approximately 40-50 head each. At this writing, livestock pasturing areas are located on the river with unlimited access to the water.

The headwaters of the south branch of the Devils River drains a beef production area of Alcona County. Haylands, pastureland and row crops are found in the area, although, there are large tracts of idle land, especially along intermittant drainage ways.

Water Quality Survey

Based upon June and July sampling results, the water quality of the south branch of the Devils River is poorer than that of the other two watersheds surveyed. Two sampling sites were utilized on the Devils River. The downstream sampling site A is located on Scott Road. The river at this site can be described as 6-10 feet wide, slow moving over a soft sedimented bottom, with a floodplain of 250-300 feet wide. Efforts to locate an upstream sampling site on the south branch of the Devils River were hampered by the fact that the entire headwaters drain agricultural lands or are intermittant streams. Site B located on Hurbert Road, located approximately two miles upstream from Site A, was selected because of its availability as a year-round sampling site, accessability and upstream location. The river size, flow and bottom is quite similar to Scott Road with the exception of isolated gravel deposits (see Devils River Watershed Map, page 21).

Origins of the river are a combination of surface runoff and numerous small springs. Most of the small finger drainages flow only during spring runoff and periods of intense precipitation.

The June sampling took place immediately after the area received .88 inches of rain over a ten hour period as recorded by the National Weather Service, Phelps Collins Airport. Temperature of 11.0°C (51.8°F) at Hurbert and 13.4°C (56°F) at Scott Road were recorded in June with dissolved oxygen ranging from a high of 74% saturation at Hurbert Road down to 54% at Scott Road. Turbidity increased from 12 FTU at Hurbert Road to 17 FTU at Scott Road. Uniform chlorophyll *a* readings of 1.5 ug/l at Hurbert Road and 1.7 ug/l at Scott Road were also recorded. Rather high available nutrient levels were reported at both Hurbert and Scott Roads sampling sites. Total orthophosphate levels of 104 ug/l at Hurbert Road and 178 ug/l at Scott Road and nitrate levels of 118 ug/l at Hurbert Road and 315 ug/l at Scott Road are significantly higher compared to most streams in the region. Ammonia nitrogen levels increased from 10 ug/l at Hurbert Road to 45 ug/l at Scott Road.

July sampling results show an increase in temperature of 16.5°C (61.7°F) at Hurbert Road and 20.5°C (68.9°F) at Scott Road with a severe depletion in dissolved oxygen evidenced by readings of 42% (4.2 mg/l) at Hurbert Road and 29% (2.5 mg/l) at Scott Road (see Figure 1). It should be noted that June and July dissolved oxygen levels are very near or below the State's water quality standard of 4 mg/l dissolved oxygen for individual samples in waters naturally capable of supporting warm water fish. A dissolved oxygen profile using four sampling stations on the river was conducted 2 July 1980 (see Figure 2). The four stations examined, Devils River at Hurbert, Behning and Scott Roads and Holcomb Creek at Scott Road, had a daily average of 6.03 mg/l of dissolved oxygen. The State's water quality standard minimum daily average for a warm water stream is 5.0 mg/l dissolved oxygen. Noticeable fluctuations of alkalinity and conductivity were observed at Scott Road sampling site from June to July. Alkalinity in June was 252 mg/l and increased to 341.2 umhos/cm in July. Perhaps of more significance is the more than two-fold increase in chlorophyll *a*, 1.5 ug/l and 1.7 ug/l in June opposed to 3.8 ug/l and 4.2 ug/l recorded in July, while orthophosphate and nitrate dramatically decreased to 24 and 29 ug/l orthophosphate and 15 and 27 ug/l nitrate (see Figures 3 & 4). Two probable explanations can be ascertained from the data. First, higher concentrations of nutrients in June were the result of storm event surface runoff and chlorophyll *a* concentrations decreased because of increased flow and the possibility of particulates interfering with analysis technique. The second explanation is that higher aquatic plant populations, reflected by increased chlorophyll *a* concentrations utilized available nutrients lowering concentrations of orthophosphate and nitrate. The best explanation may be a combination of the two.

Fish shocked this summer indicate the species recovered prefer densely vegetated, clear, slow moving streams with sand and gravel substrate. These fish species (i.e. Banded killifish, *Fundulus diaphanus* and Creek Chub *Semotilus atromaculatus*) in general, are quite tolerant of warmer temperatures and low oxygen levels.

In summary, data for the south branch of the Devils River shows definite deterioration of water quality from Hurbert Road downstream to Scott Road. Also, the river is of poorer water quality than similar streams in the region. Since it is an agricultural watershed with very little other types of land use, recommendations to minimize water quality impacts from agricultural activities must be investigated. A list of apparent problem sites and recommendations for pollution abatement are found in Table 1. The problem sites are also found on the Devils River Watershed Map (page 21).

Figure 1

South Branch of Devils River
Dissolved Oxygen Concentrations
% Saturation
6 June and 10 July 1980

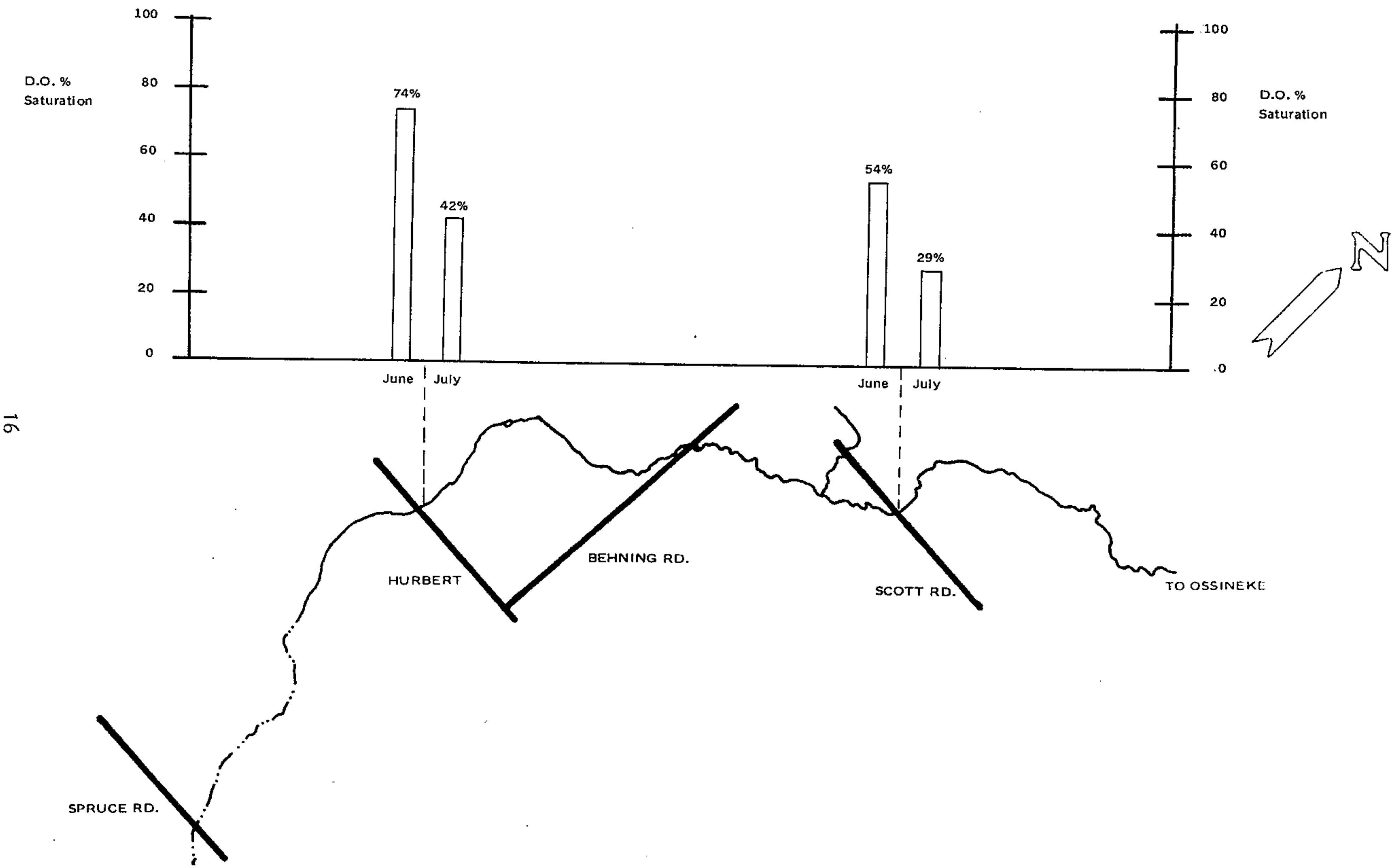


FIGURE 2

South Branch of Devils River
Dissolved Oxygen Profile
2 July 1980

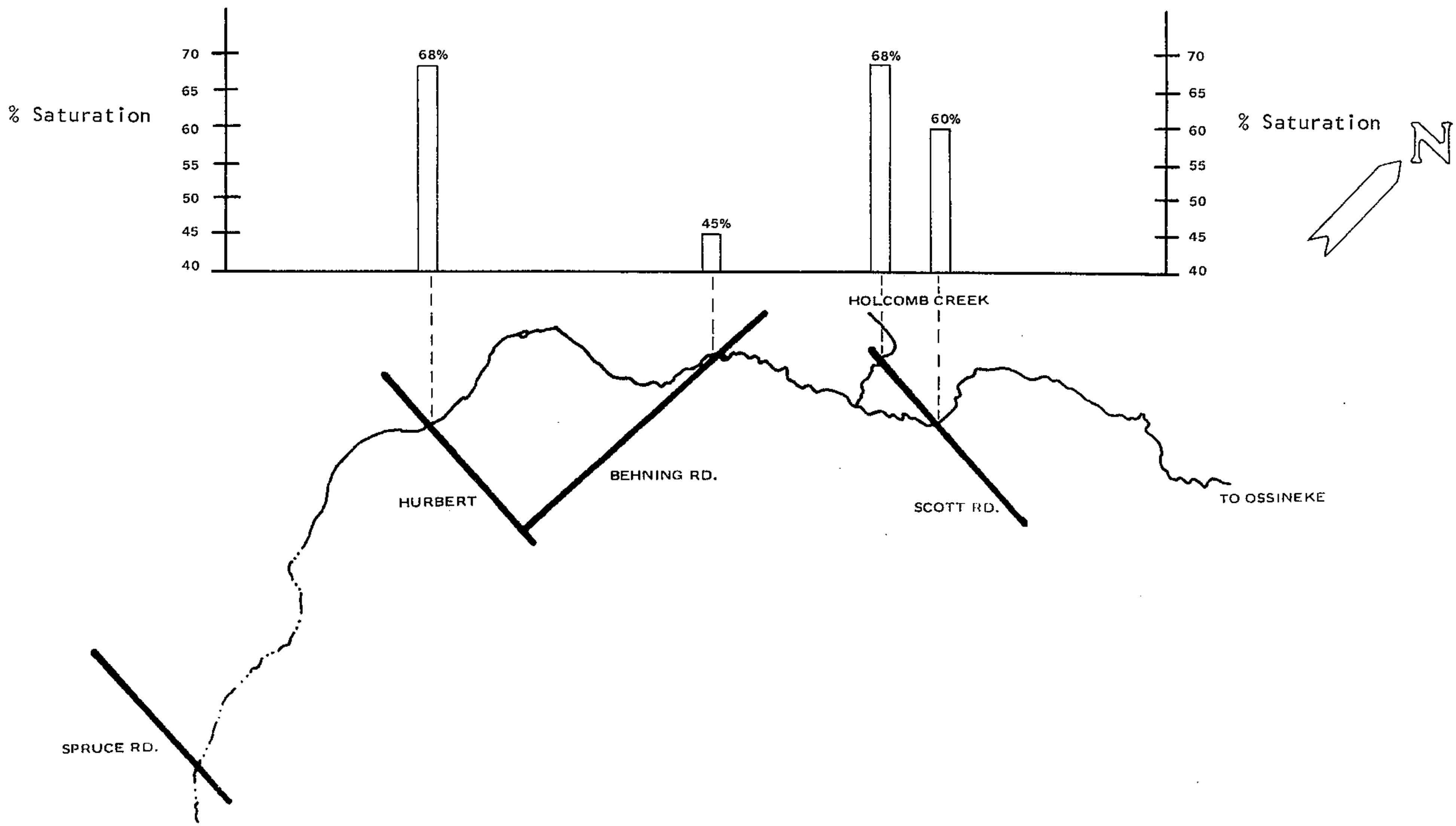


Figure 3

South Branch of Devils River
Chlorophyll *a* Concentrations
6 June and 10 July 1980

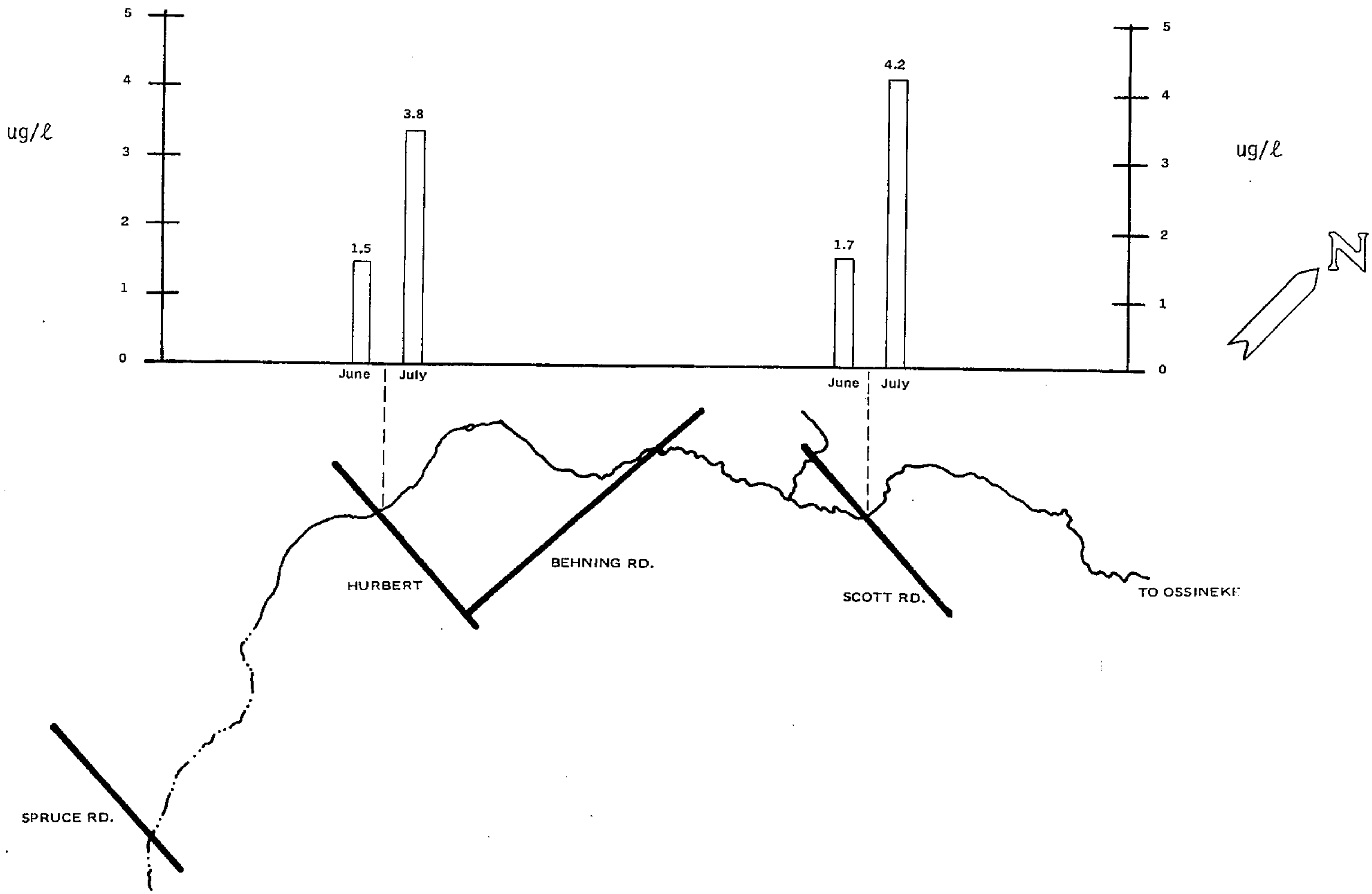


Figure 4

South Branch of Devils River
Orthophosphate and Nitrate Concentrations
6 June and 10 July 1980

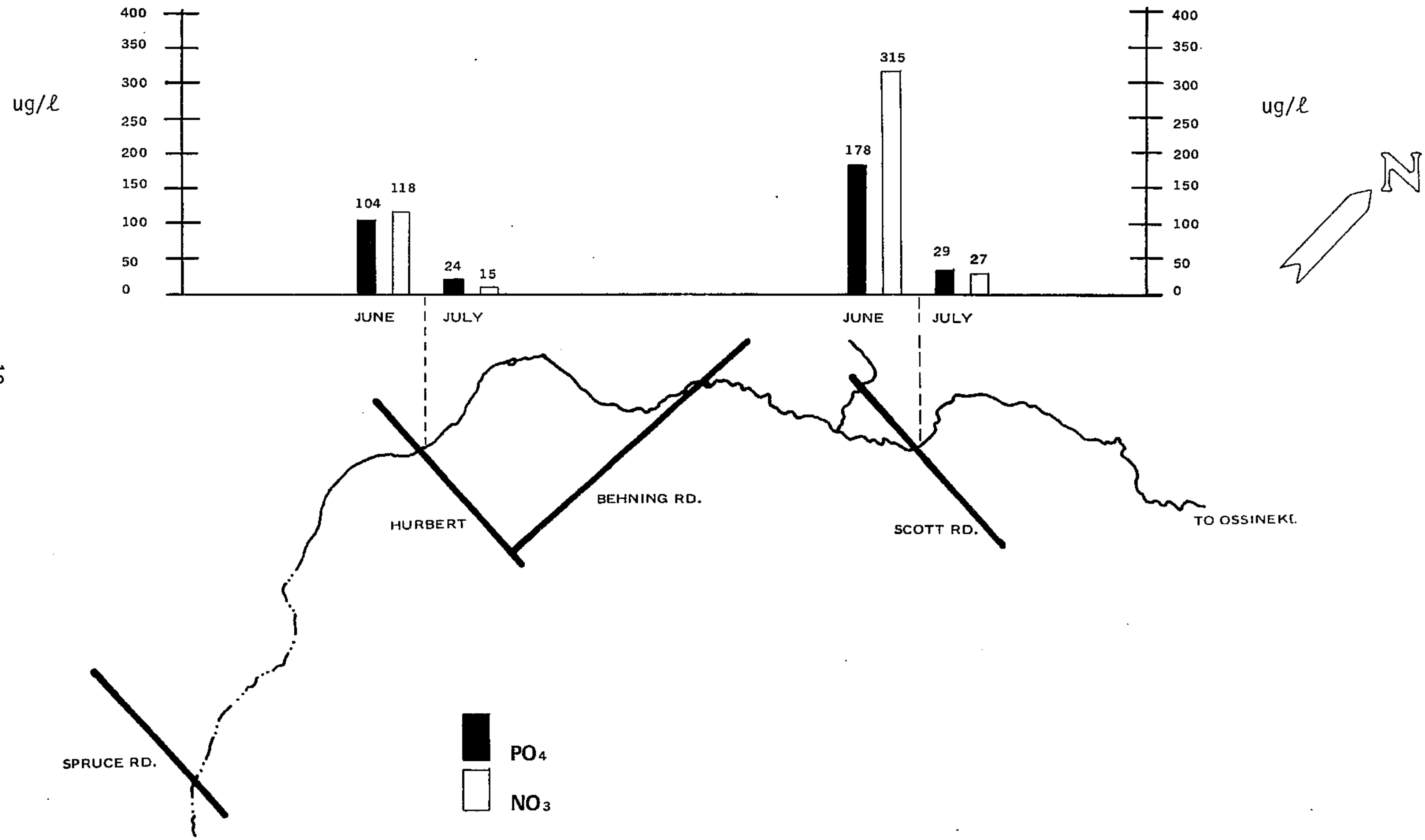
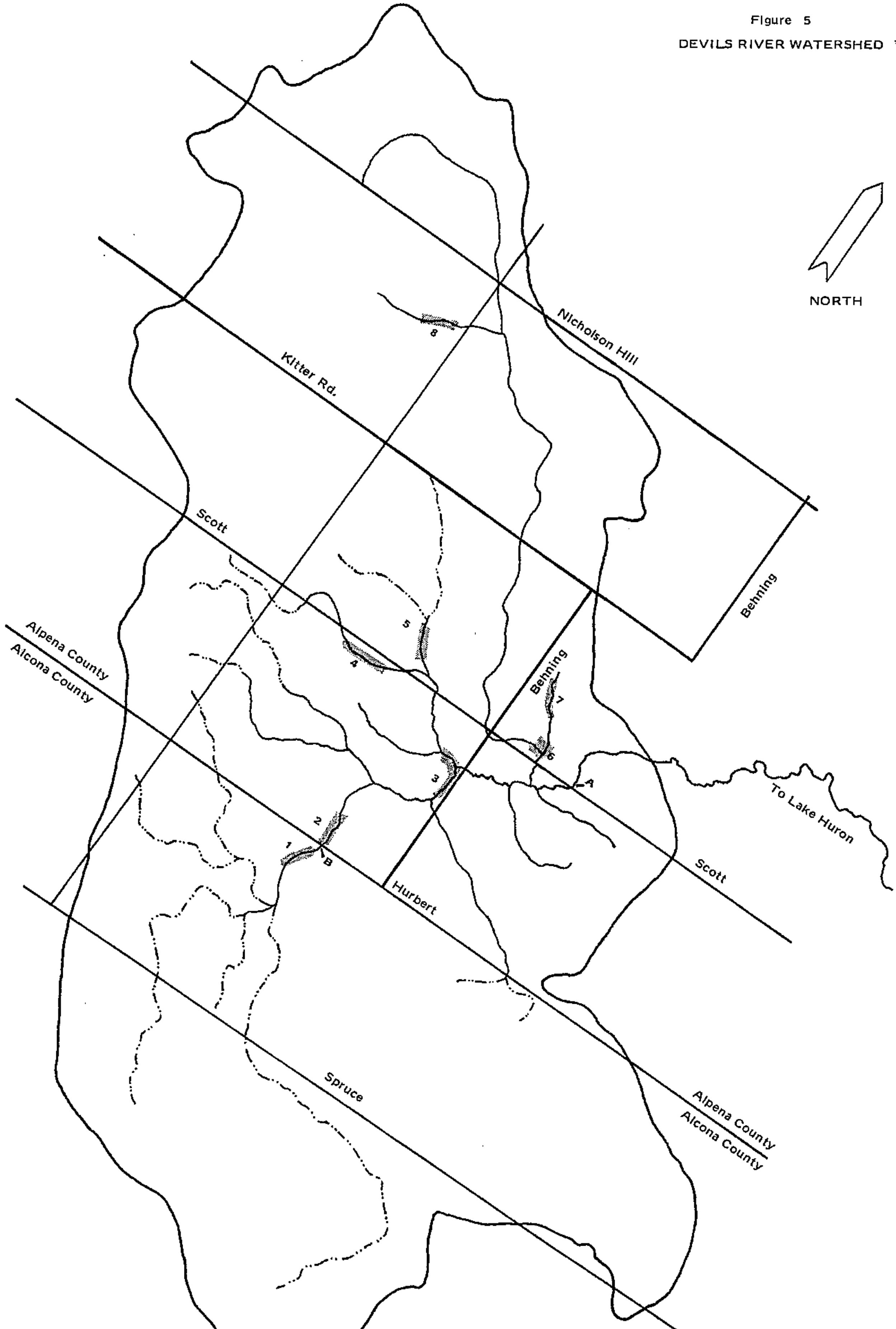


TABLE 1: Devils River Problem Sites

Site #	Problem	Recommendations
1	Livestock access on headwaters beginning to lose natural vegetation, increased sedimentation.	Restrict livestock access, provide watering area.
2	Livestock access to river, loss of streambank vegetation.	Streambank vegetative buffer strip.
3	Livestock access on river, complete loss of stream bank vegetation, significant bank slumping and erosion. Overgrazing apparent.	Restrict livestock access, provide watering area, establish vegetative buffer strip, stabilize banks. Reseed uplands and protect from overgrazing.
4	Livestock access to river, loss of vegetation.	Restrict livestock access to river, establish streambank vegetative buffer strip.
5	Livestock access to river, loss of streambank vegetation	Restrict livestock access to river, establish streambank vegetative buffer strip.
6	Livestock access to river, loss of vegetation.	Restrict livestock access to river, establish streambank vegetative buffer strip.
7	Cultivating of row crops across drainage. Barnyard and feedlot runoff apparent.	Install and maintain grass waterway. Install animal waste system
8	Livestock access to river, loss of natural vegetation	Maintain natural vegetation

Figure 5

DEVILS RIVER WATERSHED *



* Principal Agricultural Watershed Illustrated

OCQUEOC RIVER WATERSHED

Background

The Ocqueoc River Watershed is approximately 25 miles long, 4-8 miles wide, encompassing about 85,000 acres. The watershed can be divided into three distinct sub basins based on land use and soil types. The area south of County Road 638 is noted for its numerous lakes, streams, marshes, and large tracts of forest land. Slopes range from moderate to steep with well drained sandy soils. Small amounts of loamy material and gravel are found in the deep sands. The soils have rapid permeability with moderately low to low fertility and poor water holding capacity. Organic soils composed of plant remains from trees, grasses, sedges and other wetland vegetation occupy drainages, marshes and swamps.

The area around Millersburg to Ocqueoc Falls can be described as undulating to hilly with steep slopes and escarpment bedrock features bordering the river. Sandy loam and loam soils with limestone bedrock within two to three feet of the surface characterize this area. These soils are well to moderately well drained.

The northern portion of the watershed from Ocqueoc Falls to Ocqueoc Lake consists of nearly level to undulating soils of sand, sandy loams and sands over silt and clay loams. These soils are well to poorly drained with medium to moderately low natural fertility. Steep slopes border the river and tributaries in this area, where a floodplain of organic mucks varies from 50 to 300 feet in width.

Mean annual precipitation ranges from 28-30 inches while 43°F degrees is the mean annual temperature. The area averages 120-140 days growing season with first frost occurring between September 17 and October 7 and the last frost occurring between May 24 and June 7. However, the southern half of the watershed does have a shorter growing season being farther from Lake Huron.

Within the watershed are two agricultural production areas. The agricultural practices occurring in the central portion of the watershed, around the Village of Millersburg, include production of row crops such as potatoes, kidney beans, corn in rotation with small grain and hay. Because the area receives generally less precipitation and has a shorter growing season, farming is less intense than in the northern portion of the watershed. Idle land and large chunks of forest lands are evidence of this. While fall plowing is a common practice in this area and may constitute a soil erosion problem, there is no evidence that it is causing water quality problems on the Ocqueoc.

From Ocqueoc Falls to Ocqueoc Lake agricultural practices are quite similar to the area around Millersburg, but of somewhat higher intensity. It should be noted that this area north of Ocqueoc Falls supports the watershed's 600-700 head of beef and dairy cattle. Row crop production activities occur on the broad plateau regions off the steep slopes associated with the river. A few farms utilize the Ocqueoc River for irrigating corn and potatoes. Approximately 90% of the grazing land in this region is bisected by the Ocqueoc or its tributaries. As stated previously, the slopes along the river in this region are quite steep. Steep slopes, the majority of the watershed's livestock intensively utilizing the river corridor, and the unlimited access afforded the animals creates the potential for water quality problems.

Water Quality Survey

The Ocqueoc River is a warm water river. In June, the temperature at Domke Road (Site A) was 14.1°C (57.4°F) and 19°C (66°F) recorded at Ocqueoc Falls Campground (Site C). Likewise, temperatures in July ranged from 20.0°C (68°F) at Site A and 25.0°C (77°F) at Site C. Warmer temperatures were recorded as one moved upstream towards the Village of Millersburg. It is expected that the Little Ocqueoc River, Silver Creek and other spring fed small tributaries are responsible for cooling the Ocqueoc as it makes its way to Lake Huron (see Figure 6).

Lowland cedar swamp terrain borders the river at downstream sampling Site A on Domke Rd. Signs of cattle grazing in the cedar-spruce forest are evident.

The river is 35-40 feet wide with a primarily sand substrate with some gravel riffles of pebble to golf ball size material. Sampling Site B is located ½ mile downstream of Pomaranke Road. The east river bank is primarily lowland cedar, spruce and adler forest while the west bank is a cleared pasture with very little vegetation other than grass remaining. A sandy substrate covered with logs, stumps and branches with some algae present dominate the river bottom. The river is 25-30 feet wide at this point.

Sampling Site C, the upstream site, is located west of Ocqueoc Falls State Forest Campground, upstream of Ocqueoc Falls. The site has a combination of cedar, spruce, birch and alder forest. The river bank is well vegetated. The river is approximately 20-25 feet wide with a gravel and limestone bedrock substrate.

June sampling results indicated increases in the concentrations of alkalinity, conductivity, total phosphorus and nitrate at Domke Road. Alkalinity increased from 136 mg/l at Ocqueoc Falls SFCG and 142 mg/l at Pomaranke Road to 155 mg/l at Domke Road. Conductivity rose from 277.4 umhos/cm at Site C and 286.2 umhos/cm at Site B to 307.1 umhos/cm at Site A. Slight increases in turbidity from 3 FTU and 6 FTU at Ocqueoc Falls SFCG and Pomaranke Road respectively, to 10 FTU at Domke Road were also recorded. Significant increases of total phosphorus and nitrate were noted. Total phosphorus levels increased from 22 ug/l and 17 ug/l at Ocqueoc Falls SFCG and Pomaranke Road to 105 ug/l at Domke Road, while nitrate levels were 41 and 36 ug/l at Ocqueoc SFCG and Pomaranke Road and rose to 105 ug/l at Domke Road (see Figure 7).

July sampling results did not indicate the decline in downstream water quality as did the June sampling. All parameters were relatively constant for each sampling site, except for nitrate which was higher (155 ug/l) at Domke Road. Dissolved oxygen averaged 100% saturation at all sites during both June and July. High pH levels of 8.4 and 8.6 were recorded. State Water Quality Standards state that pH shall not fall below 6.5 or exceed 8.8.

While June sampling shows signs of somewhat poorer quality water downstream of agricultural activities, the July results indicate the river is uniformly of good water quality. A possible explanation is surface runoff from agricultural lands did not transport sediment and organic materials to the river because of the extremely dry weather. Table 2 describes apparent problem sites and recommendations to correct problems on the Ocqueoc River. The problem sites are also illustrated on the Ocqueoc River Watershed Map (Page 29).

Figure 6

Ocqueoc River Watershed
Temperature Profile
1 July 1980

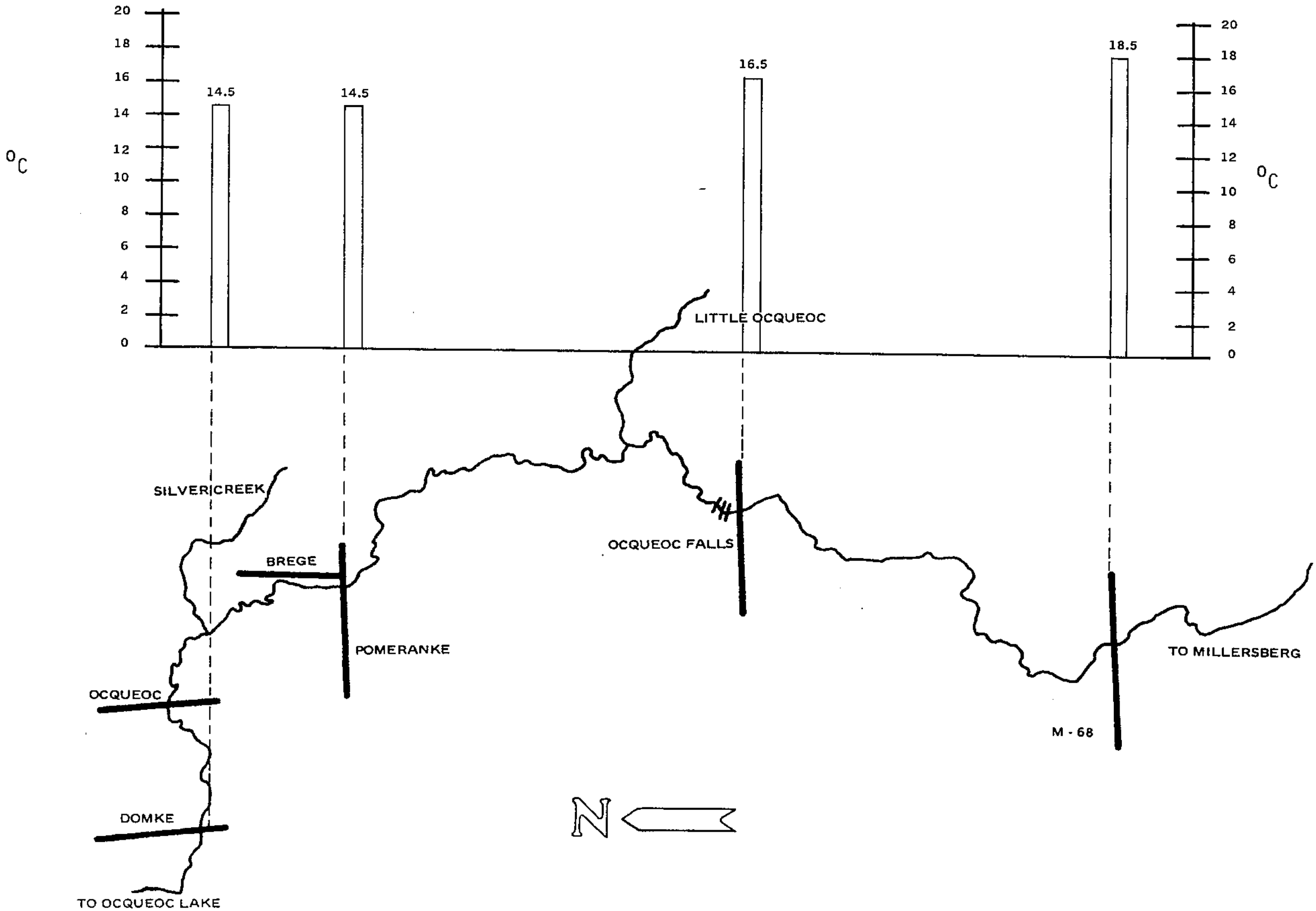


Figure 7

Ocqueoc River Watershed
Total Phosphorus and Nitrate Concentrations
5 June 1980

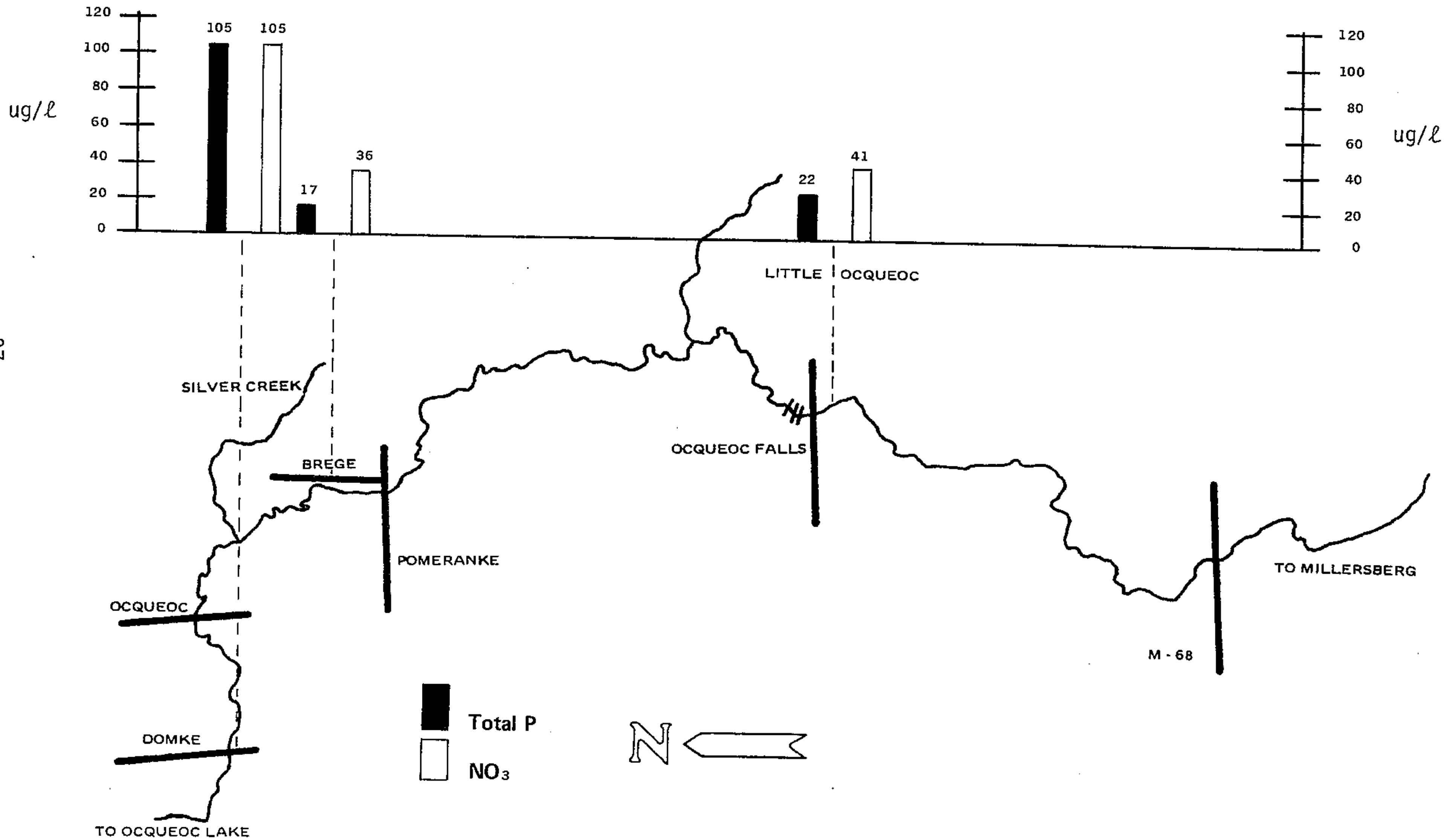


TABLE 2: Ocqueoc River Problem Sites

Site #	Problem	Recommendations
1	Livestock access along feeder drainages and in conifer lowlands along river; irrigation practices may be a problem.	Restrict livestock access, provide water facilities; institute practices to prevent backflow of irrigation water when fertilizers, herbicides and pesticides are introduced.
2	Livestock access to river, loss of native vegetation, slumping of banks and sedimentation.	Restrict livestock access, establish vegetative buffer strip, stabilize steep banks and provide livestock watering areas.
3	Livestock access to river, loss of native vegetation, slumping of banks and sedimentation.	Restrict livestock access, establish vegetative buffer strip, stabilize steep banks and provide livestock watering areas.
4	Livestock pasturing area on drainage way, loss of some native vegetation.	Establish vegetative buffer strip.
5	Livestock pasturing area on drainage way, loss of some native vegetation.	Establish vegetative buffer strip.
6	Hog barn yard draining into creek	Install a diversion
7	Livestock pasturing area	Maintain vegetative buffer strip
8	Livestock access to creek, loss of native vegetation, slumping and erosion of banks.	Restrict livestock access, provide livestock watering areas, establish vegetative buffer strip, stabilize banks.
9	Livestock access to creek, loss of native vegetation, slumping and erosion of banks	Restrict livestock access, provide livestock watering areas, establish vegetative buffer strip, stabilize banks.
10	Livestock access to river, loss of native vegetation, slumping and erosion of banks	Mainstream vegetative buffer strip, stablize banks.

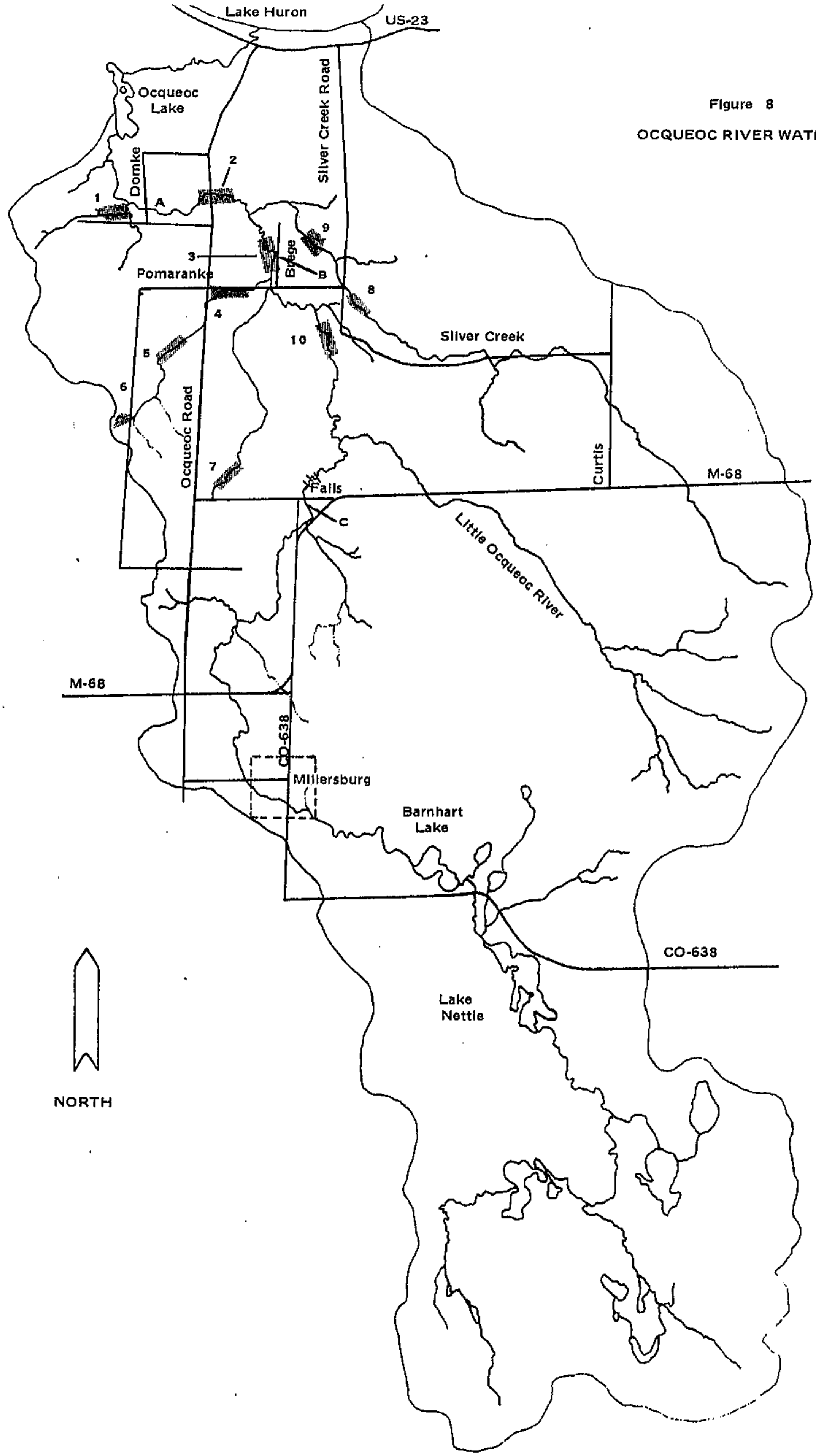


Figure 8

OCQUEOC RIVER WATERSHED

VAN ETTEN CREEK WATERSHED

Background

The Van Etten Creek Watershed in southeast Alcona County, is the County's primary agricultural production area. The watershed is located in Harrisville Township, about 2½ miles west of Harrisville. The Van Etten is part of the Pine River Watershed which in turn is a sub basin of the famous Au Sable River.

Mean annual precipitation is 28-30 inches with a mean annual temperature of 43°F. Average annual snowfall ranges from 50-70 inches. Length of the growing season ranges between 120-140 days with the first frost occurring sometime between September 17 and October 7 and the last frost between May 10 and May 24.

Nearly level to undulating loamy and clayey soils characterize a major portion of the watershed. Sandy soils are found in uplands and are well or moderately well drained. The loamy soils have high natural fertility and water holding capacity. Permeability is moderately slow. The upland sandy soils have low natural fertility with little water holding capacity and rapid permeability. Organic soils of low fertility and poor permeability are associated with drainage ways and swales.

Van Etten Creek Watershed comprises an area of approximately 9000 acres. Of this, 1400 acres are cropland, 6300 acres of hay and pastureland and 1300 acres of woodland. As common with most agricultural areas in Alcona and Alpena Counties, the area produces corn, beans and other small grains in combination with beef and dairy cattle enterprises. There is also a sheep producer and a small hobby farm raising ducks and geese in the northern portion of the watershed. Three dairy farms, including the county's largest, and four or five beef cattle operations account for about 700 head of cattle on the watershed. Two of the dairy producers have installed animal waste systems, although an increased herd size at one of the farms now warrants additional storage capacity. Primary beef pasturelands are bisected by the Van Etten Creek and cattle have unlimited access to the creek for several miles south of M-72 highway to King Rd.

Origins of Van Etten Creek are two fold. Its original headwaters drainage system is a combination of two springs, one in Section 7 of Harrisville Township and the other now emerging beneath M-72 Highway just east of Coville Road. A couple a decades ago, a private individual discovered, while drilling a well for his residence, that he had an artesian flow. This artesian well now provides his residence and duck pond with a constant flow of water as well as establishing a new drainage to the Van Etten Creek. This additional source of water increased the creek's discharge and usefulness as a year-round water source for livestock.

Water Quality Survey

Water quality sampling Site A is located downstream at the Mikado Road Bridge ½ mile east of Mikado. The creek at this site has a very slow flow and is 25-30 feet wide over a soft mucky bottom. Site B is located upstream north of Highway M-72 and 3/4 miles west of McGregor Road. The creek here is faster flowing and 3-5 feet wide over sand, rock and gravel bottom.

June sampling took place 2-3 hours after a rainfall of .88 inches as recorded by the National Weather Service Office at Phelps Collins Airport in Alpena. July sampling took place after unusually dry weather. The creek at M-72 can be classified as a cold water stream. Temperatures at M-72 were 9.1°C (48.4°F) in June and 12.0°C (53.6°F) in July. However, downstream sampling at Site B showed substantial increases of 16.5°C (61.7°F) in June and 22.0°C (71.6°F) in July for temperature. Dissolved oxygen ranged from 78% to 87% saturation at both sites in June and July. A dissolved oxygen and temperature profile of the creek taken 2 July 1980 is illustrated in Figure 9. Alkalinity and conductivity measurements remained constant in June and July. Alkalinity ranged from 262 mg/l to 277 mg/l at M-72 and from 203 mg/l to 223 mg/l at Mikado. Conductivity ranged from 380.9 umhos/cm to 396.3 umhos/cm at M-72 and from 323 umhos/cm to 330.2 umhos/cm at Mikado. Turbidity increased in both June and July from 7 and 5 FTU's at M-72 to 10 and 18 FTU's at Mikado Road. Chlorophyll *a* at M-72 decreased from 1.1 ug/l to 0.4 ug/l while at Mikado chlorophyll *a* increased from 1.5 ug/l to 3.3 ug/l (see Figure 10). Total orthophosphate levels in June were 78 ug/l at M-72 and 160 ug/l at Mikado.

These levels decreased in July to 14 ug/l at M-72 to 34 ug/l at Mikado (see Figure 11). Nitrate concentrations ranged from 30 ug/l to 43 ug/l except during June at M-72 where a level of 266 ug/l was recorded. This is probably due to increased runoff from the large wooded swamp upstream. Ammonia concentrations ranged from 10 ug/l to 19 ug/l with an exception of the July reading of 85 ug/l at Mikado. The pH levels for Van Etten Creek averaged 7.9.

Fish shocking revealed changes in the Van Etten Creek aquatic ecosystem from Site A to Site B. Brook Trout (*Salvelinus fontinalis*) and slimy sculpin (*Cottus cognatus*) were common in the creek at M-72. Moving downstream to Mikado, slimy sculpin and creek chub (*Semotilus atromaculatus*) were retrieved. Brook trout prefer clear, cool, well oxygenated streams and tend to seek temperatures below 20°C (68°F). The creek chub occupies warmer, less oxygenated waters replacing the brook trout as a sight feeder. Temperature and dissolved oxygen levels most likely account for the change in fish species, with temperature the limiting factor in the creek.

In summary, the Van Etten Creek which is classified as a designated trout stream by the State of Michigan suffers from warm temperatures and intermittantly depressed dissolved oxygen levels. There are also signs of high phosphorus concentrations increasing aquatic plant growth in the creek. Table 3 describes apparent problem sites and recommendations to correct problems on Van Etten Creek. The problem sites are also illustrated on the Van Etten Creek Watershed Map (page 38).

Figure 9: Van Etten Creek
Dissolved Oxygen and Temperature Profile
2 July 1980

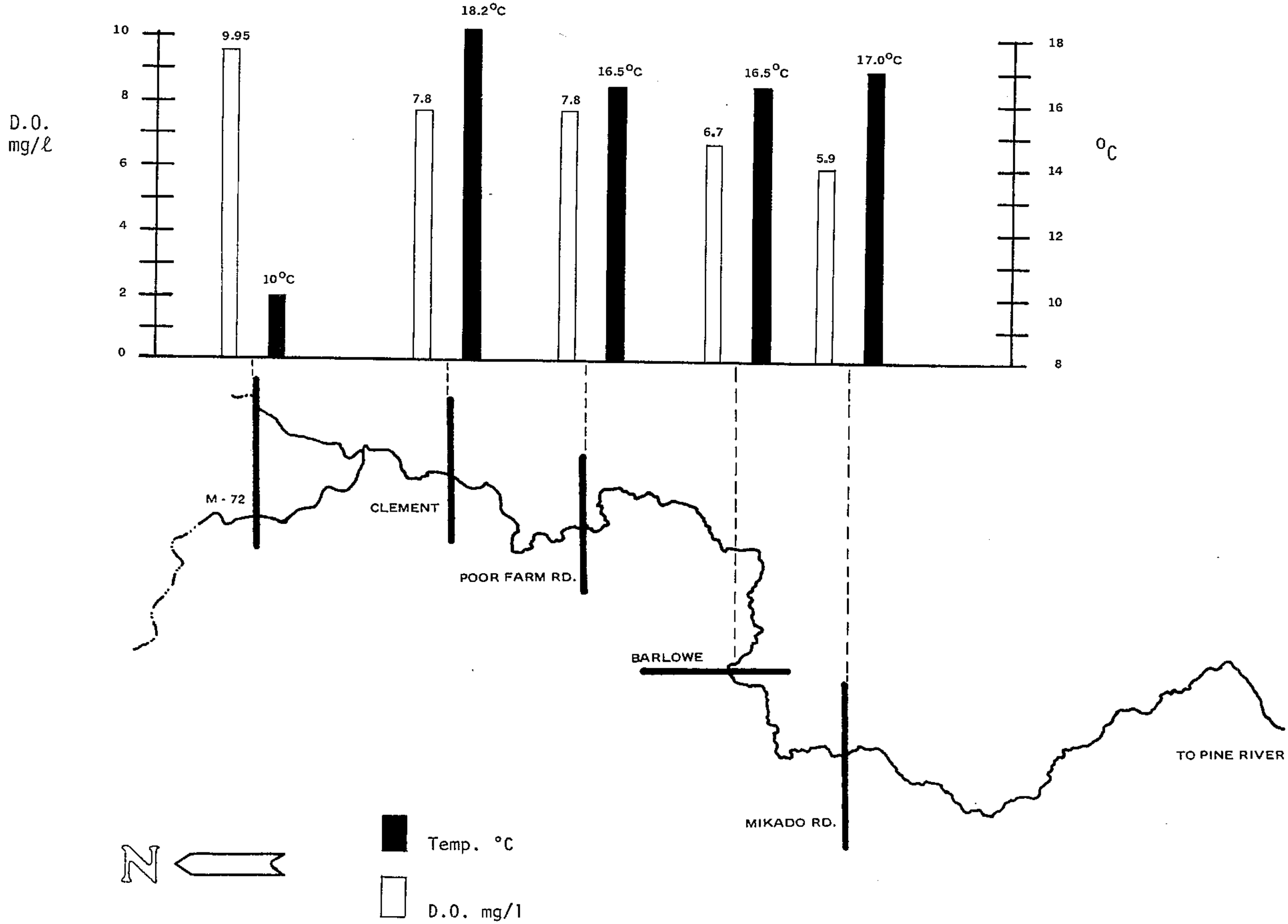


Figure 10

Van Etten Creek
Chlorophyll *a* Concentrations
6 June & 10 July 1980

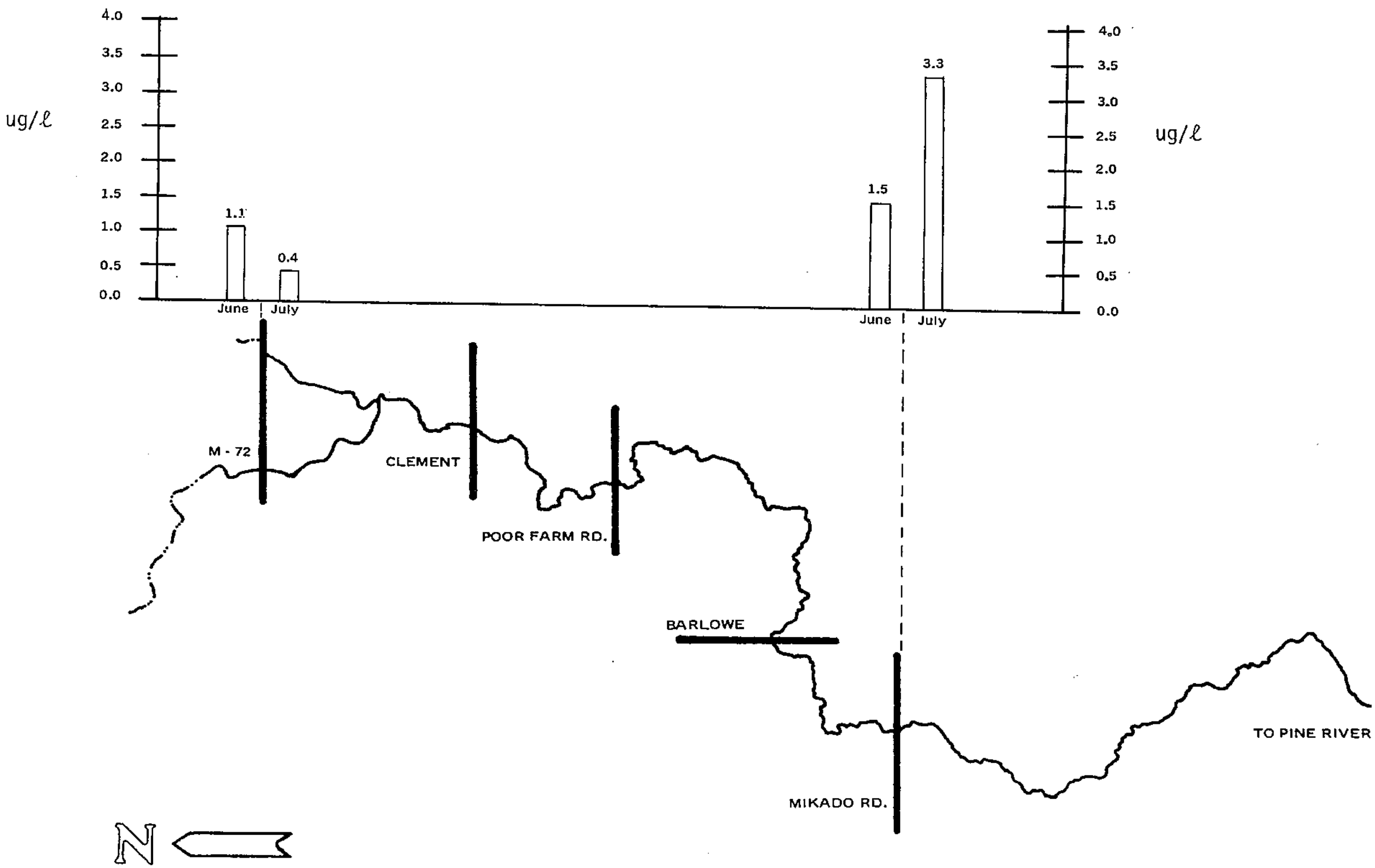


Figure 11

Van Etten Creek
Total Orthophosphate Concentrations
6 June & 10 July 1980

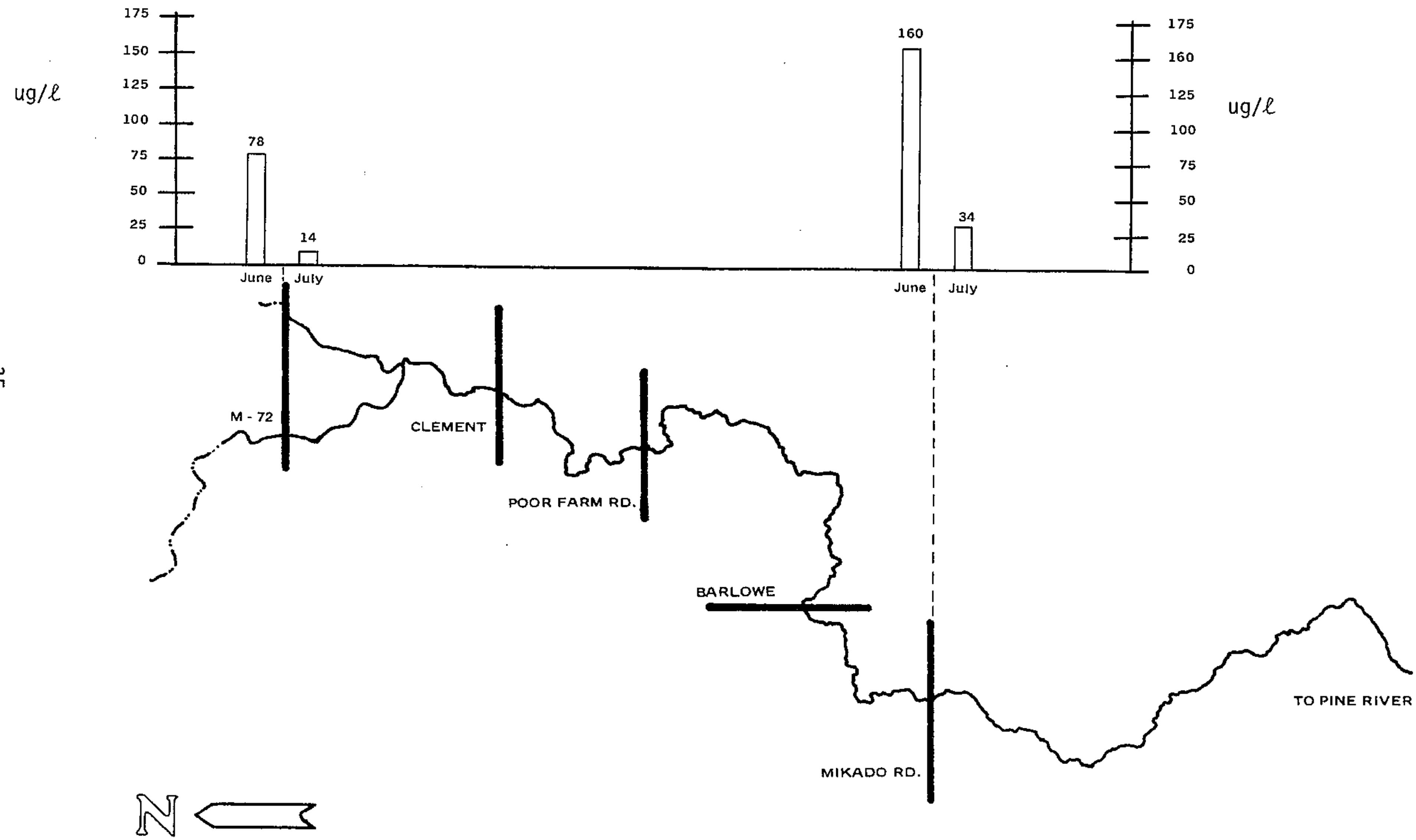


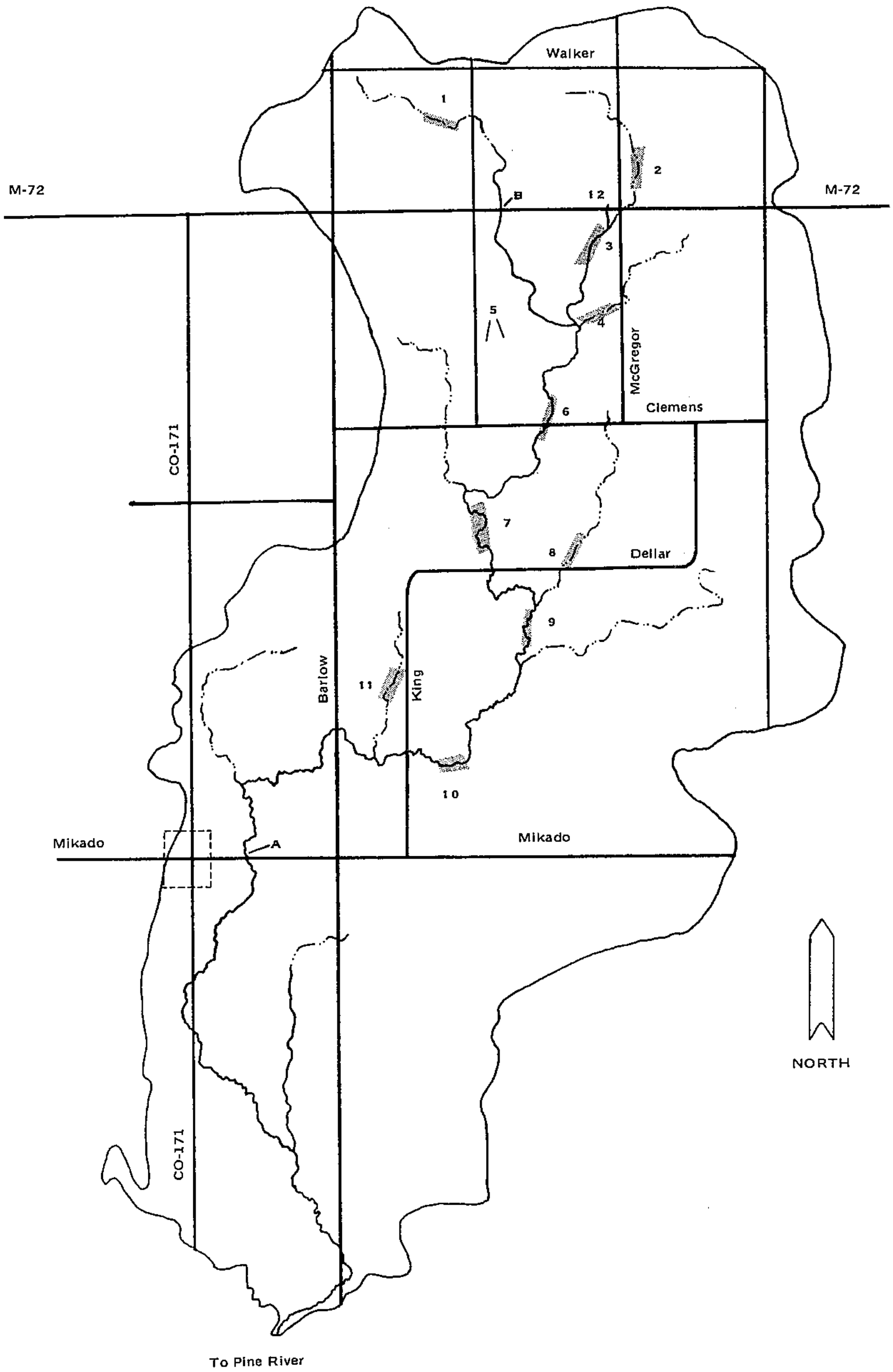
TABLE 3: Van Etten Creek Problem Sites

Site #	Problem	Recommendations
1	Livestock access beginning to remove natural vegetation, cultivation of row crops across drainage.	Maintain natural vegetation, consider utilizing grass water way.
2	Livestock pasturing on surface drainages	Protect from over grazing, maintain natural vegetation along drainage ways.
3	Livestock access to creek, severe loss of natural vegetation, slumping and erosion of banks, numerous cattle crossing and wallowing areas.	Restrict livestock access, establish vegetative buffer strip, stabilize banks, provide livestock watering areas.
4	Livestock pasturing on surface drainage.	Protect from over grazing, maintain natural vegetation along drainage way.
5	Application of manure and commercial fertilizer may be exceeding soil and crop requirements.	Annual soil test to determine nutrient deficiencies apply fertilizer and manure accordingly
6	Livestock access to creek severe loss of natural vegetation, slumping and erosion of banks, numerous cattle crossing and wallowing areas.	Restrict livestock access, establish vegetative buffer strip, stabilize banks, provide livestock watering areas.
7	Livestock access to creek, severe loss of natural vegetation, slumping and erosion of banks, numerous cattle crossing and wallowing areas.	Restrict livestock access, establish vegetative buffer strip, stabilize banks, provide livestock watering areas.
8	Drainage way through livestock yard.	Install diversion
9	Livestock access to creek, loss of natural vegetation, some bank slumping and erosion.	Restrict livestock access, provide watering area, maintain vegetative buffer strip, stabilize stream banks.
10	Livestock access to creek, loss of natural vegetation, some bank slumping and erosion	Restrict livestock access, provide watering area, maintain vegetative buffer strip, stabilize streambanks.

TABLE 3 : Van Etten Creek Problem Site (continued)

Site #	Problem	Recommendation
11	Livestock access to creek loss of natural vegetation, some bank slumping and erosion	Restrict livestock access, provide watering area, maintain vegetative buffer strip, stabilize streambanks.
12	Location of residence, artesian well and duck pond	Only unused groundwater to be discharged to stream, relocate duck pond off of discharge.

Figure 12
VAN ETTEN CREEK WATERSHED



ADDITIONAL
AREAS OF WATER QUALITY CONCERN

IDENTIFICATION AND PRIORITIZATION PROCESS

The process used for identifying and prioritizing agricultural areas of water quality concern involved many key organizations and agencies within the agricultural community. Initial meetings with the District and County Directors of the Agricultural Stabilization and Conservation Service (ASCS) and the area conservationists from the Soil Conservation Services (SCS) provided a regional perspective of water quality problems arising from agriculture. Staff then attended every Soil Conservation District (SCD) meeting in the region and met with each district conservationist of SCS to discuss the project and receive input from each respective county as to the location and nature of water quality problems arising from agriculture. Five of the eight SCD's submitted a total of twelve problem areas. Each district supplied background information while staff acquired additional information from the SCS.

A draft document reviewing the twelve Agricultural Areas of Water Quality Concern (AWQC) was prepared, discussing each problem area and recommending a regional priority for each area. This document was then submitted for review and comment to NEMCOG's Natural Resources Advisory Committee (NATRAC). After receiving several comments, the draft was revised and the six highest priority areas were established. The Ocqueoc River, Devils River, and Van Etten Creek were selected first, second and third, respectively. Because of time and manpower only the three highest priority areas were eligible to be part of the water quality survey discussed in the previous section. This section reviews the nine remaining Agricultural AWQC.*

NATRAC and NEMCOG staff will continue to investigate other problem areas as well as reevaluate and reassign existing or new priorities based on additional information and local interest. Table 4 presents twelve Agricultural Areas of Water Quality Concern and their assigned regional priority.

* Note: Originally 13 areas were submitted, however, two areas were dropped after field investigations determined lack of water quality problems. One area was added, based on new information. (See Figure 13)

FIGURE 13

AGRICULTURAL AREAS OF WATER QUALITY CONCERN
IN NORTHEAST MICHIGAN

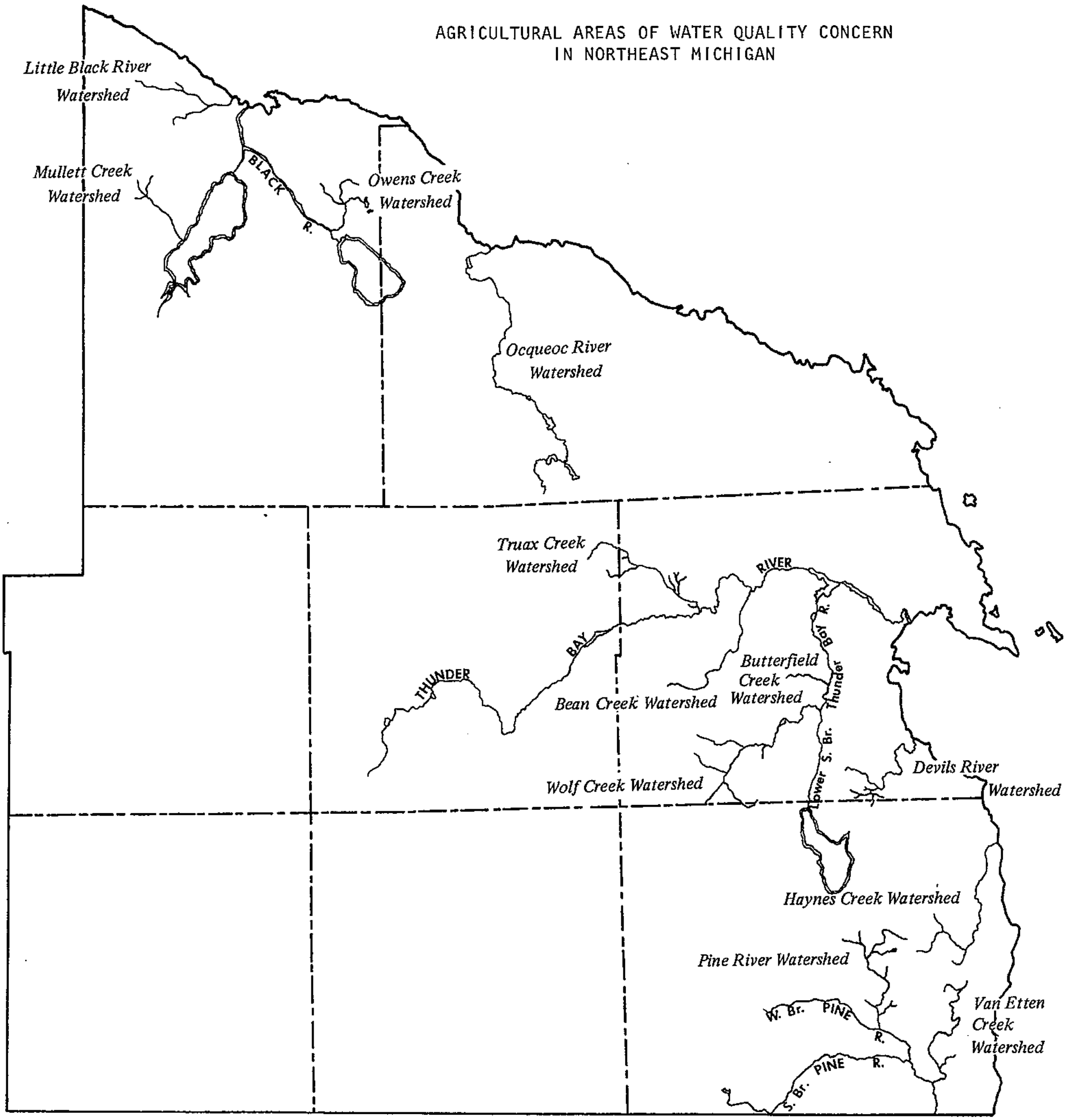


TABLE 4: AGRICULTURAL AWQC REGIONAL PRIORITIES

Agricultural AWQC	County	Regional Priority
Devils River	Alpena	1
Ocqueoc River	Presque Isle	2
Van Etten Creek	Alcona	3
Little Black River	Cheboygan	4
Bean Creek*	Alpena	5
Pine River-East Branch	Alcona	6
Truax Creek	Montmorency	7
Wolf Creek	Alpena	8
Owens Creek	Cheboygan	9
Haynes Creek	Alcona	10
Mullett Creek	Cheboygan	11
Butterfield Creek	Alpena	12

* Added based on water quality data from the NEMCOG report entitled "Water Quality of the Thunder Bay Watershed: An Assessment and Management Strategy", 1980.

ALCONA COUNTY

Haynes Creek - Priority #10

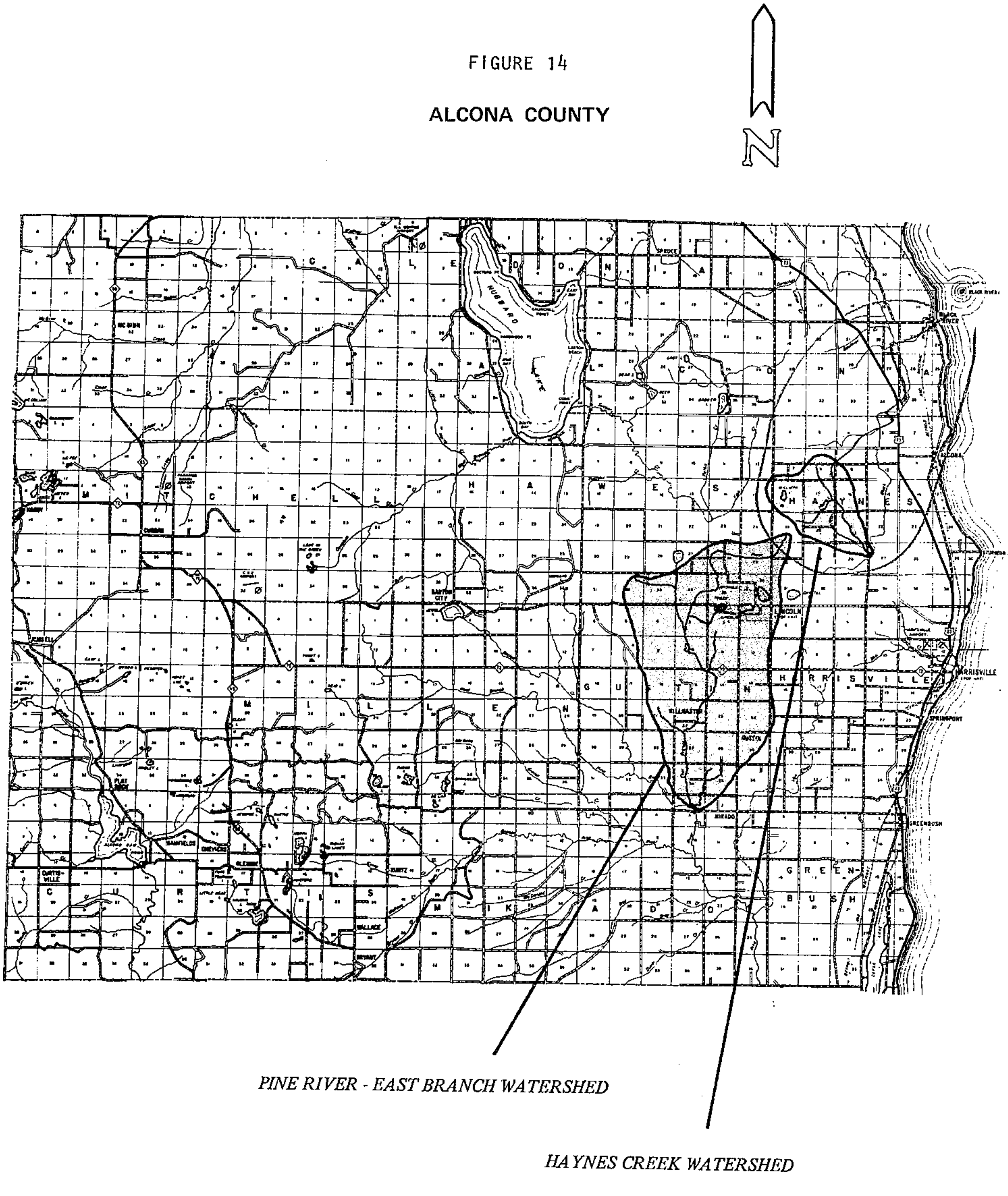
Haynes Creek is part of the Black River coastal watershed located in northeast Alcona County. The area is characterized by well to moderately drained sandy and loamy soils. Organic, poorly drained soils are found along surface drainages and depressions. There are three dairy farms approximately $\frac{1}{4}$ to $\frac{1}{2}$ mile from the creek and one beef operation adjacent to Haynes Creek allowing livestock access. Row crop production practices along and across feeder streams of Haynes Creek may be causing excessive soil erosion and sedimentation problems impairing the water quality of Haynes Creek.

Pine River, East Branch - Priority #6

Encompassing approximately 19,000 acres, the east branch of the Pine River is comprised of 60% hay and pastureland, 10% cropland and 20% woodland. There are 20 active dairy and beef producers in the watershed handling 600-700 head of cattle. Livestock access to the river is the major problem. There is evidence of loss of vegetation, slumping of banks and increased sedimentation at several spots along the river. Just south of Killmaster, steep pastured slopes border the river. Several small feeder streams are also intensively used by livestock. Soils in the area range from well to moderately drained sandy loam and loamy soils on uplands to poorly drained organic and clayey soils associated with drainage ways and swales.

FIGURE 14

ALCONA COUNTY



PINE RIVER - EAST BRANCH WATERSHED

HAYNES CREEK WATERSHED

ALPENA COUNTY

Bean Creek - Priority #5

Bean Creek drains the heart of Alpena's berry producing land. Extensive fields of strawberries and raspberries occupy the headwaters while downstream and adjacent to the creek are large wooded swamps. As part of a comprehensive study of the Thunder Bay Watershed conducted the summer of 1980, Bean Creek showed elevated levels of total phosphorus and turbidity with declining dissolved oxygen levels when compared to other Thunder Bay tributaries.

Butterfield Creek - Priority #12

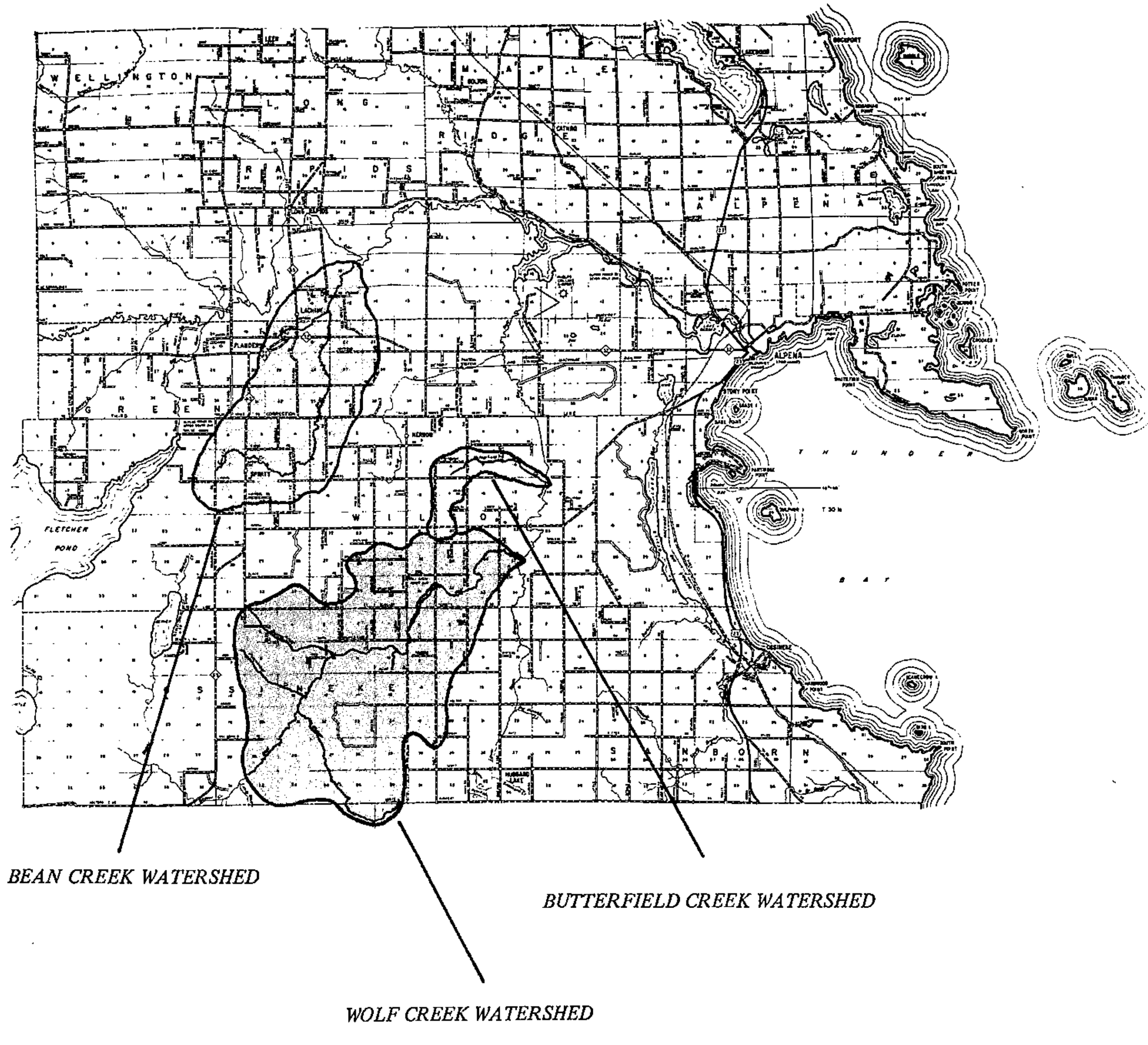
Butterfield Creek is a small tributary feeding the south branch of the Thunder Bay River. Soils in the 5760 acre watershed range from sandy loams to clay loams. Organic and muck soils are associated with drainages. All three dairy herds, comprising approximately 200 animals collectively, are ¼ mile or more from surface waters. The dairy operation nearest the creek has installed an animal waste system. Erosion of cropland is a concern since over 90% of the watershed is in row crop production.

Wolf Creek - Priority #8

Wolf Creek comprises an area of 50,560 acres of which 12,940 or 25% of the watershed is cropland. Approximately 250 head of cattle associated with five dairy farms operate in the area near the old Wolf Creek Power Dam. Three of the livestock operations are located on the Creek. Lack of animal waste systems, runoff from feedlots and livestock access to surface waters suggest the possibility of a water quality problem. Additionally, the number one site specific erosion problem in Alpena County is located on Wolf Creek.

FIGURE 15

ALPENA COUNTY



CHEBOYGAN COUNTY

Little Black River - Priority #4

The Little Black River Watershed containing 17,130 acres has approximately 2198 acres of cropland, 3712 acres of hay and pastureland, 8542 acres of woodland and 2678 acres of miscellaneous land use. The dominent soils in the area are nearly level to undulating, moderately to very poorly drained loams and clays. Only 10% of the soils are well-drained, 50% are inperfectly drained and 40% are poorly drained. There are 181 farms in the watershed consisting of beef and dairy production and cash cropping. Five dairy farms and a commercial dairy facility (615 head of cattle) are in operation close to the mainstream. The commercial dairy facility has a lagoon wastewater treatment system under a Michigan Department of Natural Resources Groundwater Discharge Permit. Only one of the other dairy operations has an animal waste system. Three of the farms allow access to the river. Barnyard feedlots are generally bisected by the river, or its tributaries; or have ponded water in them because of high groundwater and poor drainage. The poor drainage is responsible for heavy runoff during spring thaw. In 1958, a Watershed Protection and Flood Prevention Project (PL-566) was completed. This project included the construction of four water retention structures to hold back water and release it slowly. Poor maintenance of these structures may now be contributing some sediment to the river, but the structures' are effective in mitigating flood damage to the City of Cheboygan.

Mullett Creek - Priority #11

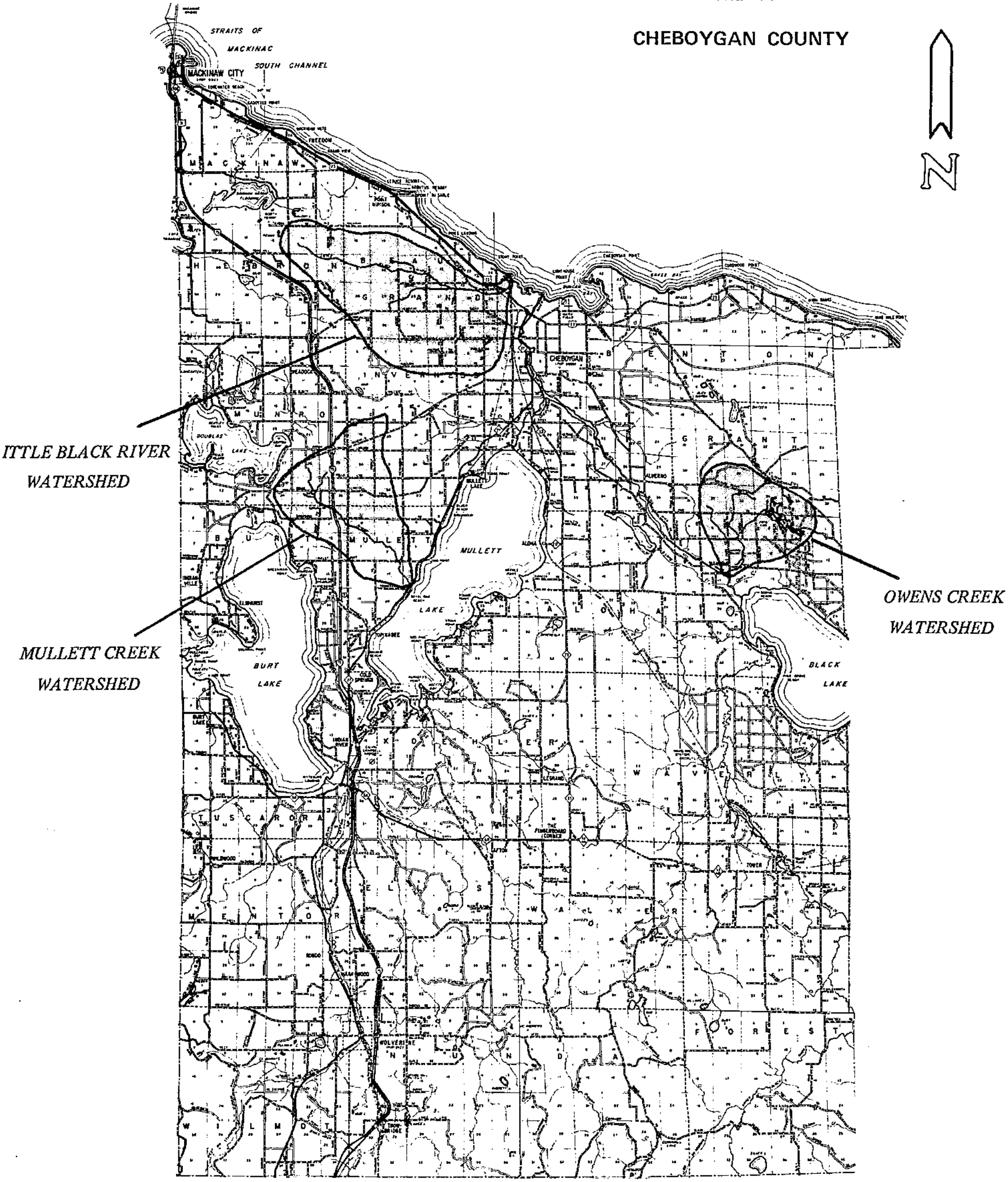
Forty farms operate in this 7000 acre watershed northeast of Burt Lake and just west of Interstate 75 in Cheboygan County. A breakdown of land use in the area is as follows: hay and pastureland, 3625 acres; cropland, 900 acres; woodland, 2128 acres; and miscellaneous, 300 acres. About 300 cattle are associated with two dairy farms, one of which has an animal waste system. The area is dominated by undulating to steep, sandy and loamy soils. Concern for this creek which feeds Mullett Lake are cropping and tillage practices occurring on the steep slopes.

Owens Creek - Priority #9

Owens Creek Watershed comprises an area of 4000 acres with twenty active agricultural operations. This low lying area contains two dairy farms, with row crop production making up the watershed's remaining agricultural activities. Cropland amounts to about 1000 acres while there is about 1500 acres of hay and pastureland. One of the dairy operations has an animal waste system that is undersized and requires expansion to facilitate the handling of incoming waste from 250 cows. The other dairy farm does not have an animal waste system for its 150 dairy cows. Ninety percent of the area is nearly level to undulating, moderate to very poorly drained loamy and clayey soils. Close proximity of livestock operations to ground and surface waters are the primary water quality concern.

FIGURE 16

CHEBOYGAN COUNTY

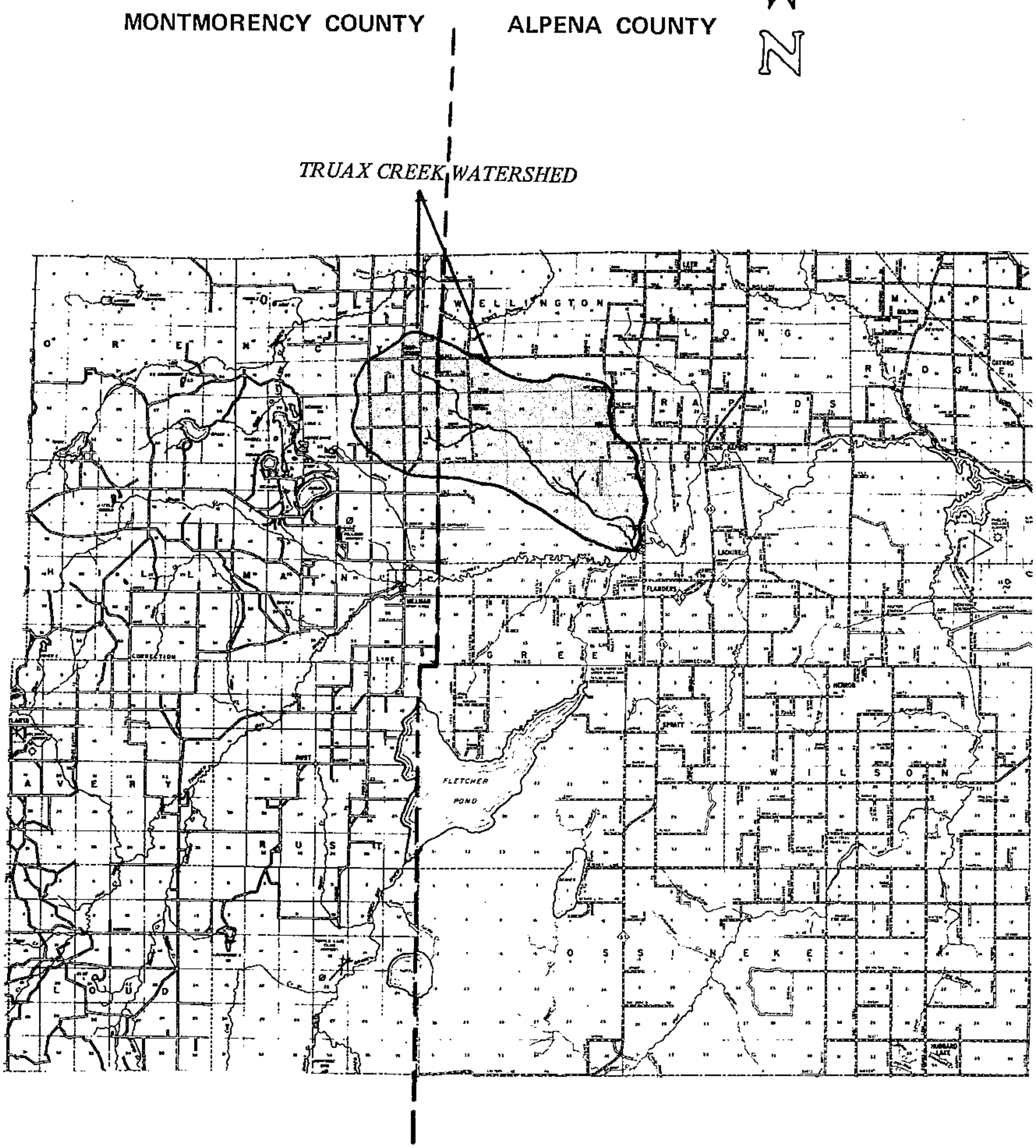


MONTMORENCY COUNTY

Truax Creek - Priority #7

Truax Creek Watershed is rectangular in shape, about 5½ miles by 3½ miles, and contains approximately 10,240 acres. Of this, 3560 acres is in cropland, 1450 acres of pasture, 4710 acres of forestland and 520 acres miscellaneous land use. Major soils in the watershed are fine sandy loam, silt loam and clay loam which range from somewhat poorly drained to very poorly drained. Principal crops are corn, hay and small grains. Six dairy farms and two beef producers are active in the area, supporting approximately 600 head of cattle. Presently, only one animal waste system has been installed in the area.

FIGURE 17


MONTMORENCY COUNTY
ALPENA COUNTY
N
TRUAX CREEK WATERSHED
WELLINGTON
LONG
RAPIDS
MAPLE RIDGE
GREEN
WILSON
OSSINEKE
FLETCHER POND
HILLMAN
AVERY
RUST
LOUD
LACHINE
FLANDERS
SPRATT
HUBBARD LAKE

RECOMMENDED BEST MANAGEMENT PRACTICES

RECOMMENDED AGRICULTURAL CONSERVATION BEST MANAGEMENT PRACTICES

Management of agricultural activities to minimize water quality impacts will require the application of Best Management Practices (BMP's). The term Best Management Practices means a practice or combination of practices that is determined by the State or designated regional planning agency as a means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water quality goals. Establishment of BMP's should take into account assessment of problems; review of alternative practices; public participation and comments; and institutional and economic considerations. Best Management Practices to reduce water pollution from agricultural operations can include structures to trap sediment and other pollutants before they run into surface waters and non-structural measures to prevent erosion and minimize the use of pesticides and fertilizers. Table 5 describes examples of structural and non-structural BMP's.

TABLE 5

Structural BMP	Non-structural BMP
Barriers/catchment systems	Permanent plant cover
Diversions	Windbreaks
Storage basins	Buffer or filter strips
Animal waste systems	Conservation tillage
Drainage systems	Preserving wetlands
Fencing	Cooperating with local SCD

The recommended BMP's presented in Table 6 were developed by the Michigan Department of Agriculture and revised by NEMCOG's Natural Resources Advisory Committee. The recommended BMP's should be selected by the producer and his technical advisors on the basis of the physical nature of the individual site, the land uses and cropping systems proposed for it, the degree of water quality protection desired, and the costs of the BMP's. Naturally, the appropriateness of BMP's will vary from site to site.

TABLE 6 : Recommended Best Management Practices

DIVERSION: A channel with a supporting ridge on the lower side constructed across the slope.

Purpose: To divert water from areas where it is in excess to sites where it can be used or safely transported from the site; to maintain or improve water quality.

DIVERSION cont.

Where Practice Applies: On sites where: runoff from higher lying areas is damaging cropland, pastureland, farmsteads, developing areas and construction sites, or conservation practices; surface and shallow subsurface flow is damaging sloping upland; required as part of a pollution abatement system.

Diversions shall not be substituted for terraces on land requiring terracing for erosion control. Diversions are not usually applicable below high sediment producing areas unless land treatment practices or structural measures, designed to prevent damaging accumulations of sediment in the channels, are installed with or before the diversions.

AGRICULTURAL WASTE MANAGEMENT SYSTEM: A planned agricultural waste management system to contain and manage liquid and solid wastes including runoff from concentrated waste areas with ultimate disposal in a manner which does not degrade air, soil or water resources; includes systems for safe disposal of livestock wastes, municipal waste treatment plant effluents and sludges and agricultural processing wastes through use of soil and plants.

Systems include those components required for complete management of wastes under given site conditions. Such components may include existing practices included in the National Handbook of Conservation Practices, adaptations thereof, and other measures necessary for collection, storage, treatment, utilization or safe disposal of wastes including treatment and management of disposal areas.

Purpose: To manage wastes in a manner which prevents or minimizes degradation of air, soil and water resources and protects public health and safety. Such systems are planned to preclude discharge of pollutants to surface or groundwater and to the fullest practicable extent, recycle wastes through soil and plants.

Where Practice Applies: Where a complete system is needed to manage agricultural or other wastes disposed and utilized through soil and plants.

Conditions to Consider: Location (proximity to a stream or lake), temperature (frozen or snow covered or open land), surface condition (vegetation and/or tillage) soil (texture, permeability, slope), wind, rainfall, snowfall.

Specification Guide: Methods of application, time of year, type, chemical content and consistency of wastes, type of cropping system, utilization ability of crops, rates/acre, runoff control practices which minimize soil losses.

TABLE 6 : Recommended Best Management Practices cont.

LIVESTOCK EXCLUSION: Excluding livestock from an area where grazing is likely to increase erosion hazards.

Purpose: To protect, maintain or improve water quality; to maintain cover to protect the soil; and to maintain moisture resources.

Where Practice Applies: Where desired forest reproduction, soil hydrologic values, ditch or streambank conditions, existing vegetation (including trees) are prevented or damaged by livestock.

SOIL TESTING AND FERTILITY MANAGEMENT: Chemical soil analysis to determine soil nutrient needs for growing a particular crop.

Purpose: To utilize fertilizers both economically and ecologically so as to minimize degradation of surface water quality caused by nutrients entering receiving waters and protect groundwaters from excess nitrates leaching through the soil.

Where Practices Applies: All agriculture/silviculture land where fertilizers are used.

PESTICIDE APPLICATION: The proper application of pesticides used to control pests (insects, weeds, diseases) in agricultural and silvicultural operations.

Purpose: To use pesticides according to manufacturers' recommended methods and procedures provided by law in the control of agricultural and silvicultural pests so as to minimize degradation of water quality and risks to human and animal health.

Where Practice Applies: All situations associated with the application of pesticides to crops, soils (fumigation and incorporation) fruits, forests, Christmas trees and ponds (aquatic weed and mosquito larvae control.

Specificiation Guide: Soil conditions (slope, permeability, texture, tillage method) rainfall, temperature, wind, application method, timing, rates of application, adaptability of compound, soil and water conservation practices which minimize runoff and soil loss.

COVER AND GREEN MANURE CROP: A crop of close-growing grasses, legumes or small grain used primarily for seasonal protection and soil improvement. It usually is grown for one year or less.

Purpose: To control erosion during periods when the major crops do not furnish adequate cover; add organic material to the soil; and improve infiltration, aeration and tilth; improve or maintain water quality.

Where Practice Applies: On cropland; certain wildlife land; orchard, vineyard and small fruit areas.

CROP RESIDUE USE: Utilizing available plant residues to protect cultivated fields during critical erosion periods.

Purpose: To reduce soil loss; increase infiltration; improve soil tilth; and conserve moisture; improve or maintain water quality.

Where Practice Applies: On land where crop residues are produced.

TABLE 6: Recommended Best Management Practices cont.

CRITICAL AREA PLANTING: Planting vegetation such as trees, shrubs, vines, grasses or legumes on highly erodible areas.

Purpose: To stabilize the soil; reduce damage from sediment and runoff to downstream areas.

Where Practice Applies: On sediment-producing, highly erodible or severely eroded areas, such as dams, dikes, levees, cuts, fills, surface-mined areas, and denuded or gullied areas where vegetation is difficult to establish with usual seeding or planting methods.

MINIMUM TILLAGE: Limiting the number of cultural operations to those that are properly timed and essential to produce a crop and prevent soil damage and loss.

Purpose: To control erosion; retard deterioration of soil structure; reduce soil compaction and formation of tillage pans; and to improve soil aeration, permeability and tilth; improve or maintain water quality.

Where Practice Applies: On all land where cultural and tillage practices are used on a regular or intermittent basis.

FIELD WINDBREAK: A belt of trees or shrubs established within or adjacent to a field.

Purpose: To reduce soil blowing; control snow deposition; conserve moisture; and to prevent wind blown soil from being deposited in drains or water courses.

Where Practice Applies: In or around open land which need protection against wind damage to soils which may result in water quality degradation.

MULCHING: Applying plant residues or other suitable materials not produced on the site to the soil surface.

Purpose: Reduce runoff and erosion; help establish plant cover; prevent surface compaction or crusting; conserve moisture and maintain or improve water quality.

Where Practice Applies: On soils subject to erosion on which low residue producing crops, such as grapes and small fruit are grown; on highly erodible areas; and on soils that have a low infiltration rate.

PERMANENT VEGETATIVE COVER: Establishing and re-establishing long-term stands of adapted species of perennial or biennial forage plants.

Purpose: To reduce wind and water erosion and maintain or improve water quality.

Where Practice applies: On existing pasture and hayland or other land where soil capability and limitations determine that permanent cover is most practical erosion control measure.

TREE PLANTING: Planting tree seedlings or cuttings

Purpose: To establish or reinforce a stand of trees to conserve soil and moisture; maintain or improve water quality.

Where Practice Applies: Where erosion control or watershed protection is needed; in open fields, in understocked woodland; or where a combination of these is desired.

TABLE 6 : Recommended Best Management Practices cont.

CONTOUR STRIPCROPPING: Growing crops in a systematic arrangement of strips or bands on the contour to reduce water erosion. The crops are arranged so that a strip of grass or close-growing crop is alternated with a strip of clean-tilled crop or fallow or a strip of grass is alternated with a close-growing crop.

Purpose: To reduce erosion and control water runoff; maintain or improve water quality.

Where Practice Applies: On sloping cropland and other land where the topography is uniform enough that tilling and harvesting can be done practically; and where it is an essential part of a cropping system to effectively reduce soil and water losses.

FIELD STRIPCROPPING: Growing crops in a systematic arrangement of strips or bands across the general slope (not on the contour) to reduce water erosion. The crops are arranged so that a strip of grass or close-growing crop is alternated with a clean-tilled crop or fallow.

Purpose: To help control erosion and runoff on sloping lands where contour stripcropping is not practical; maintain or improve water quality.

Where Practice Applies: On sloping cropland and other lands.

STRIPCROPPING, WIND: Growing wind-resistent crops in strips alternating with row crops or fallow and arrange at angles to offset adverse wind effects. (Includes any herbaceous vegetative wind barrier that reduces wind velocities of both the leeward and windward, but predominantly the leeward, flow of air across the land surface).

Purpose: To control wind erosion, trap snow and increase stored soil moisture; prevent introduction of windborne soil to waters.

NO-TILL: The planting by a single operation using chemical weed control and no conventional tillage methods.

Purpose: Reduce erosion; retard deterioration of soil structure; reduce soil compaction and formation of tillage pans; and to improve soil aeration, permeability and tilth; maintain or improve water quality.

Where Practice Applies: On cropland, hayland, pastureland and on certain recreation and wildlife land.

CONTOUR FARMING: Cultivating land in such a way that tillage and harvesting operations are done on the land contour.

Purpose: To reduce erosion and control water runoff, maintain or improve water quality.

Where Practice Applies: On sloping cropland where other cultural and management practices in a cropping system do not control soil and water loss.

CONSERVATION CROPPING SYSTEM: Growing crops in combination with needed cultural and management measures. Cropping systems include rotations that contain grasses and legumes as well as rotations in which the desired benefits are achieved without the use of such crops.

TABLE 6 : Recommended Best Management Practices cont.

Purpose: Protect the soil during periods when erosion usually occurs; to improve or maintain good physical condition of the soil; improve or maintain water quality.

Where Practice Applies: On all cropland.

CONTOURING ORCHARD AND OTHER FRUIT AREAS: Planting orchards, vineyards, or small fruits so that all cultural operations can be conducted on the land contour

Purpose: To reduce soil and water loss; to improve water control and use.

Where Practice Applies: On sloping land where soil and water loss require controls, especially where permanent cover is not established.

DEBRIS BASIN: A barrier or dam constructed across a waterway or at other suitable locations to form a debris or sediment basin

Purpose: To preserve the capacity of reservoirs, ditches, canals, diversions, waterways, and streams; to prevent undesirable deposition on bottomlands and developed areas; to trap sediment originating from construction sites; and to reduce or abate pollution by providing basins for deposition and storage of silt, sand, gravel, stone, agricultural wastes and other undesirable waterborne materials.

Where Practice Applies: This practice applies where physical conditions of land ownership preclude the treatment of the sediment source by the installation of erosion control measures to keep soil and other material in place, or a debris basin offers the most practical solution to the problem.

GRASSED WATERWAY OR OUTLET: A natural or constructed water course shaped or graded and established in vegetation suitable to safely dispose runoff from a field, diversion, terrace or other structure.

Purpose: To prevent excessive soil loss and gully formation; reduce sedimentation of water.

Where Practice Applies: Where concentrated runoff must be disposed of at safe velocities.

STREAMBANK PROTECTION: Stabilizing and protecting banks of streams, lakes or excavated channels against scour and erosion by vegetative or structural means.

Purpose: To prevent erosion; reduce sediment loads causing damages and pollution.

Where Practice Applies: This practice applies to streams, lakes, or excavated channels, where the banks are subject to erosion from the action of water, ice or debris or to damage from livestock or vehicular traffic.

TABLE 6 : Recommended Best Management Practices cont.

PARALLEL TERRACE: A system of parallel ridges and channels constructed across the slope at a suitable spacing and with an acceptable grade.

Purpose: Parallel gradient terraces normally are limited to cropland having a water erosion problem. Gradient terraces may be used only where suitable outlets are or will be made available.

Where Practice Applies: Level terraces are limited to deep soils that are capable of absorbing and storing extra water without appreciable crop damage and in areas where the rainfall pattern is such that storage of rainfall in the soil rather than removal is practical and desirable.

FILTER STRIPS: An area or strip of dense vegetation consisting of grasses and/or legumes that acts as a filter trap to collect sediment.

Purpose: To reduce erosion and trap sediment before entry into a water course, body of water or other area.

Where Practice Applies: Adjacent to drainage ditches, streams, lakes or other unprotected areas.

GRADE STABILIZATION STRUCTURE: A structure to stabilize the grade or cutting of natural or artificial channels and control gully erosion.

Purpose: Grade stabilization structures are installed to stabilize the grade and control erosion in natural or artificial channels, prevent the formation or advance of gullies and reduce environmental and pollution hazards.

Where Practice Applies: Where the concentration and flow velocity of water are such that structures are required to stabilize the grade in channels or to control gully erosion.

ASSISTANCE PROGRAMS

This section reviews the assistance programs currently available to producers, from various federal, state and local governments or agencies, for the purpose of conserving soil and water resources.

Cost-Share Programs

The Agriculture Conservation Program (ACP) administered by ASCS was established in 1936. The program objectives include the control of erosion and sedimentation, voluntary compliance with Federal and State requirements to solve point and nonpoint source pollution. The program will be directed towards the solution of critical soil, water, woodland and pollution abatement problems. Cost share is available to producers with a limit of $3,500 per year per producer. The program is administered in each county of Michigan by the ASCS County Director and County Committeemen.

The ACP Special Projects can be an important program to solve specific problems in a specific area. This program is administered and funded by the ASCS State office and Committee. A wide variety of critical problems and demonstration projects have been funded in Michigan. Federal allocations for Fiscal Year 1980 for Special Projects in the State of Michigan was $237,000.

A new program also administered by ASCS is geared specifically towards solving water quality problems caused by agriculture. The Rural Clean Water Program (RCWP) was authorized by Congress in 1980 and is very closely tied to the water quality planning program of the Clean Water Act. The RCWP provides financial and technical assistance to private landowners in approved project areas. The assistance is provided through long term contracts of 3-10 years to install best management practices to solve critical water quality problems resulting from agricultural activities. The project area must reflect the water quality priorities developed through the regional water quality planning program. Cost-share payments range from 30-75 percent with a ceiling of $50,000 per individual for the life of the contract.

The Resource Conservation and Development Program administered by the Soil Conservation Service provides technical and financial assistance for the planning and installation of approved measures specified in the RC&D Area Plan serving purposes such as flood prevention, sedimentation and erosion control, public waterbased recreation, fish and wildlife developments, agricultural water management practices, water quality management, control and abatement of agricultural related pollution. Eligible applicants include State and local governments and non-profit organizations with authority to plan or carry out activities relating to resource use and development in multi-jurisdictional areas. Local or State agencies generally provide 50 percent of the construction costs of applying agricultural water management practices.

Loan Programs

Soil and Water Loans Program administered by Farmers Home Administration (FmHA), facilitates improvement, protection, and proper use of farmland by providing adequate financing and supervisory assistance for soil conservation; water development, conservation and use; forestation; drainage of farmland; the establishment and improvement of permanent pasture; the development of pollution abatement and control facilities; and related measures. Loans may be made to eligible farming partnerships-cooperatives, or domestic corporations as well as individual producers. Approved loans range from $3,300 to $100,000 with the average loan being $17,000.

The Watershed Protection and Flood Prevention Loan Program also administered by FmHA provides loan assistance to sponsoring local organizations in authorized watersheds. Loan funds may be used to help local sponsors provide the local share of the cost of watershed works for flood prevention, irrigation, drainage, water quality management, sedimentation control, fish and wildlife development, public water based recreation, and water storage facilities. To be eligible for a watershed loan, an applicant must be a sponsoring local organization such as municipal corporations, soil and water conservation district or other organization not operated for profit in the approved watershed project and have authority under State law to obtain, give security for and raise revenues to repay the loan and to operate and maintain facilities financed by the loan. Loans range from $4,000 to $5,400,000.

Technical Assistance

The Cooperative Extension Service is a joint informational and educational organization funded by county, state, and federal government. The extension service provides information and assistance on a variety of subjects including agriculture, land management, natural resource conservation, community development, community planning, and home economics. Cooperative extension offices are located in most counties with an extension agent serving as a liaison between the local community and the information and research resources of Michigan State University and the Agricultural Research Service of the U.S. Department of Agriculture. About 45% of the funding for the program is provided by the State of Michigan through appropriations to the University. The balance comes from county and federal sources.

The Department of Natural Resources has limited technical assistance available through its various field, district and regional offices.

The Soil Conservation Service provides technical assistance to individuals and groups in planning and applying soil and water conservation practices and in furnishing technical soil and water conservation information to local units of government. SCS technicians and district conservationists could be found in most counties until recently. Most of northern Michigan SCS positions are no longer being maintained because of increased costs. Availability of technical assistance is becoming very limited.

Other Programs

The Soil Conservation Districts can play a valuable role in providing incentives to implement best management practices. One example is the organization of a SCD work crew. The Crawford-Roscommon SCD has had a district work crew for the past three years. The SCD has discovered that quite often landowners do not have the time to install certain conservation practices such as tree planting, stream bank stabilization and protection practices. The crew can serve as extra incentive to complete a practice with minimal cost. Last year the crew completed several stream bank stabilization and protection practices on the south branch of the Au Sable River.

The Otsego Soil Conservation District purchased a no-till corn planter to assist producers in establishing no-till corn in the county. As a result, several producers have utilized the no-till planter and have thus become eligible for ACP cost-sharing and minimized soil erosion and sedimentation.

The same strategy has worked for several districts who own tree planters and sell trees.

Although the two Federal cost-share programs reviewed provide the needed incentives towards implementing agricultural conservation practices, each program has shortcomings. For instance, the Agriculture Conservation Program funding levels for counties is often below the actual need of a county. This restricts the ability of the county to carry out its objectives. The competition for ACP Special Projects and the RCWP is quite stiff and because of inadequate funding levels, chances for funding are limited.

In light of this, several State and local Soil and Water Conservation Districts have established State and locally administered cost-share programs. These cost-share programs can supplement or augment federal programs to further the soil and water conservation effort. A brief summary of several state and local cost-share programs is found in Appendix B.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

* While overall the water quality of lakes and streams in the region is good, there are isolated water bodies where agricultural practices are degrading water quality. The three watersheds surveyed show definite signs of poorer water quality than other streams in the region.
* Implementation of recommended Best Management Practices will help to maintain and improve water quality in agricultural areas.
* In some instances, additional funding for technical assistance and incentive programs is necessary for the installation of Best Management Practices to improve water quality.

RECOMMENDATIONS

* ASCS County Committees and the Soil Conservation Districts should identify priority areas in their county to improve soil and water resources.
* ASCS County Committees and the Soil Conservation Districts should work together in securing additional funding for technical assistance and cost-share programs for priority areas in the county.
* A more intensive education program must be implemented to inform producers in priority areas of Best Management Practices and encourage their use.

REFERENCES CITED

Atlas of Michigan. 1977. Michigan State University

American Public Health Association and others. 1975. Standard methods for the examination of water and wastewaters, 14th ed., New York.

Crossman, E.J. and Scott, W.B., 1973. Freshwater fishes of Canada. (Bulletin 184), Ottawa.

Shouder, M.F. 1975. Ocqueoc River Structure Plans. Michigan Department of Natural Resources

Work Plan for Little Black River Watershed. 1957. City of Cheboygan and Cheboygan Soil Conservation District.

Work Plan for Sanborn Township. 1959. Alpena Soil Conservation District and Sanborn Township.

Work Plan for Truax Creek Watershed. 1970. Alpena and Montmorency Soil Conservation Districts.

State and local cost-sharing. 1980. National Association of Conservation Districts.

APPENDIX A

PHYSICAL, CHEMICAL AND BIOLOGICAL DATA

AGRICULTURAL AREAS OF WATER QUALITY CONCERN

PHYSICAL — CHEMICAL DATA 1980

Location	Date	Field Temp. °C	D.O. mg/l	Lab Temp. °C	BOD	Alka. mg/l	Cond. umho/cm	Turb. FTU	pH	Chlor. a ug/l	Total P mg/l	Total Ortho PO_4—P mg/l	NO_3—N + NO_2—N mg/l	NH_3—N mg/l
Devils A	6/6/80	13.4	5.7	15.0	—	252	452.4	17	7.8	1.7	—	.178	.315	.045
Devils B	6/6/80	11.0	8.3	11.9	—	260	421.6	12	7.7	1.5	—	.104	.118	.010
Devils A	7/10/80	20.5	2.5	10.0	—	348	341.2	15	7.6	4.2	.071	.029	.027	.079
Devils B	7/10/80	16.5	4.2	11.0	—	250	423.8	25	7.8	3.8	.066	.024	.015	.023
Van Etten A	6/6/80	16.5	8.6	11.2	—	262	380.9	10	7.9	1.5	—	.160	.043	.010
Van Etten B	6/6/80	9.1	10.1	12.1	—	203	323	7	7.9	1.1	—	.078	.266	.019
Van Etten A	7/10/80	22.0	7.7	10.0	—	277	396.3	18	7.8	3.3	.079	.034	.030	.085
Van Etten B	7/10/80	12.0	8.5	10.0	—	223	330.2	5	8.0	0.4	.040	.014	.37	.012
Ocqueoc A	6/5/80	14.1	9.85	20.5	—	155	307.1	10	8.1	0.2	.105	—	.105	.010
Ocqueoc B	6/5/80	15.3	10.2	19.8	—	142	286.2	6	8.2	0.1	.017	—	.036	.010
Ocqueoc C	6/5/80	19.0	9.8	20.3	—	136	277.4	3	8.3	0.1	.022	—	.041	.010
Ocqueoc A	7/15/80	20.0	9.2	19.5	—	156	320.3	12	7.7	.52	.027	.001	.155	.010
Ocqueoc B	7/15/80	21.0	9.1	19.5	—	147	295.0	20	8.4	.45	.034	.001	.043	.005
Ocqueoc C	7/15/80	25.0	9.2	20.0	—	147	279.6	18	8.6	.96	.018	.001	.043	.027

* BOD data lost

FISH SPECIES RECOVERED FROM THE DEVILS RIVER, OCQUEOC RIVER AND VAN ETTEN CREEK*

South Branch Devils River (Scott Rd.)

Common Name	Scientific Name
Ninespine Stickleback	*Pungitius pungitius*
Golden shiner	*Notemigonus crysoleucas*
Common shiner	*Notropis cornutus*
Hornyhead chub	*Nocomis biguttatus*
Creek chub	*Semotilus atromaculatus*
Banded Killifish	*Fundulus diaphanus*
Redside Dace	*Clinostomus elongatus*

South Branch Devils River (Hurbert Rd.)

Common Name	Scientific Name
Brook Stickleback	*Culaea inconstans*
Redside Dace	*Clinostomus elongatus*

Ocqueoc River (Ocqueoc Rd.)

Common Name	Scientific Name
Slimy Sculpin	*Cottus cognatus*
Creek chub	*Semotilus atromaculatus*

Ocqueoc River (off Brege Rd.)

Common Name	Scientific Name
Slimy Sculpin	*Cottus cognatus*
Common shiner	*Notropis cornutus*
Long nose sucker	*Catostomus catostomus*
Creek chub	*Semotilus atromaculatus*

Van Etten Creek (M-72)

Common Name	Scientific Name
Slimy Sculpin	*Cottus cognatus*
Brook Trout	*Salvelinus fontinalis*

Van Etten Creek (Mikado Rd.)

Common Name	Scientific Name
Slimy Sculpin	*Cottus cognatus*
Creek chub	*Semotilus atromaculatus*

* This list is not all inclusive, since additional fish species have been observed in each watershed, especially those species that are transient or seasonal in nature.

HABITAT REQUIREMENTS FOR FISH SPECIES
RECOVERED FROM DEVILS RIVER, OCQUEOC RIVER, AND VAN ETTEN CREEK

Common Name	Scientific Name	General Habitat Requirements
Longnose Sucker	*Catostomus catostomus*	The longnose sucker is the most successful and widespread cypriniform in the north occurring almost everywhere in clear, cold water in moderately large numbers.
White Sucker	*Catostomus commersoni*	White suckers are usually fish of warmer lakes or warm, shallow bays, and tributary rivers of larger lakes.
Banded Killifish	*Fundulus diaphanus*	The banded killifish prefers the quiet waters of lakes and ponds. Small schools are usually found over sand, gravel, or detritus-covered bottom where there are patches of submerged aquatic plants.
Brook Stickleback	*Culaea inconstans*	This stickleback inhabits the clear, cold, densely vegetated waters of small streams and spring-fed ponds, and is found along the swampy margins of beach ponds of larger lakes. It is found occasionally in well-protected coves and bays of large lakes, and in sluggish, stagnant water. The apparent preference of the brook stickleback for cool water limits distribution southward, and it is usually found only in cooler waters at the southern limits of the range.
Ninespine Stickleback	*Pungitius pungitius*	The ninespine stickleback is generally distributed in fresh and salt waters throughout the northern hemisphere. It is often very abundant in salt water or brackish pools. When in abundance, the ninespine stickleback is of considerable importance, forming a large part of the diet of other fish.
Slimy Sculpin	*Cottus cognatus*	Varies greatly depending upon available substrate and temperature. In general, it occupies deeper waters of lakes and cooler streams. It frequents rocky or gravelly streams and lake bottoms.

Common Name	Scientific Name	General Habitat Requirements
Redside Dace	*Clinostomus elongatus*	Redside dace prefer clear, cool, flowing water with gravel or stoney bottom. They are apparently quite sensitive to turbidity.
Brook Trout	*Salvelinus fontinalis*	Brook Trout occur in clear, cool, well-oxygenated streams and lakes. They tend to seek temperatures below 68°F (20°C) when surface waters warm up.
Hornyhead Chub	*Nocomis biguttatus*	The hornyhead chub seems to prefer clear, slow-moving, gravelly streams, more often in the tributaries of large rivers, and the young seek out areas having aquatic vegetation.
Golden Shiner	*Notemigonus crysoleucas*	The golden shiner prefers clear, weedy, quiet waters with extensive shallow areas. It is a lake species rather than a river form, an actively swimming fish that moves in schools, off bottom, over wide areas.
Common Shiner	*Notropis cornutus*	Although principally a stream fish through most of its range, the common shiner frequently occurs in the shore waters of clear-water lakes. Because of its need of gravelly riffles for spawning, it is not usually regarded as well suited to pond culture.
Creek Chub	*Semotilus atromaculatus*	The Creek Chub has been classified as a sight feeder which is in keeping with the clear-water habitat preferred. They probably do not compete seriously with brook trout because they occupy the warmer sections of streams.

APPENDIX B

STATE AND LOCAL COST-SHARE PROGRAMS

MINNESOTA

State Cost-Share Program

LEGISLATIVE AUTHORITY:	Minnesota's Soil and Water Conservation law was amended in 1977 to include the State Cost Share Program.
SOURCE OF FUNDS:	State General Fund
AMOUNT OF FUNDS:	$3 million for the first two years, July 1, 1977 to June 30, 1979. $3.3 million for July 1, 1979 to June 30, 1980. 10% of this total is allocated to districts for their additional technical assistance needs. Also 5% is allocated to districts for their administrative needs.
ADMINISTRATION OF FUNDS:	Program administered by the state Soil and Water Conservation Board through the local conservation districts. The state board allocates funds to districts based upon approval of each district's comprehensive plan and the priorities and needs established in it as well as the state board's priority areas for controlling soil erosion, sedimentation, and related water quality problems. Technical and administrative funds are granted to districts on a base plus approach - that is a base amount plus additional funds determined by the amount of the cost-share practice(s) grant. (1)
PRACTICES COST-SHARED:	The state board, in consultation with the districts, maintains a list of eligible practices. Practices costs shared by districts must be on the approved list which presently includes: erosion control structures; strip cropping; terraces; diversions; stormwater control systems; critical area stabilization.
PERCENT COST-SHARED:	Maximum cost-share levels are set by the state board. Cost-share levels on individual practices are set by the districts as long as they don't exceed the maximum set by the state board. Present maximum is 75%. (2)
DETAILS:	(1) The districts receive the money from the state board in the form of a grant and are responsible for all administrative duties including the distribution of cost-share payments to the participating landowners. (2) Where federal and state cost-share monies are combined the maximum level is still 75% of the total cost.

OHIO

State Cost-Share Programs

LEGISLATIVE AUTHORITY:	State legislation enacted in 1978
SOURCE OF FUNDS:	State General Fund
AMOUNT OF FUNDS:	$225,000 per year
ADMINISTRATION OF FUNDS:	Division of Soil and Water, Ohio Department of Natural Resources and local Soil and Water Conservation Districts.
PRACTICES COST-SHARED:	Animal waste facilities; terraces; contour strip cropping; grassed waterways and outlets; field windbreaks; critical erosion area stabilization; diversions; grade stabilization structures; and buffer strips (1)
PERCENT COST-SHARED:	75%, not to exceed 5,000 per person, unless by special permission of the Ohio Soil and Water Conservation Commission (2)
DETAILS:	(1) Division enforcement of the animal waste program requires 75% cost sharing be available for an administrative order of the chief to be enforceable. There is no enforcement associated with the agricultural sediment practices and all such practices are eligible for cost-share. Practices eligible for cost-share are limited to those requiring a capital investment which provides primarily public benefits and little, if any, benefits to the landowner. (2) Amount of state cost-share is limited to 75% or an amount equaling 75% of all public funds committed to the practice, i.e. ACP pays $1,000, State $500 on a $2,000 eligible practice cost. The level of state cost-sharing are determined by rule adopted by the Chief of the Division. They are currently established at 75%.

WISCONSIN

COST-SHARE PROGRAMS

State Programs

WISCONSIN FUND NONPOINT SOURCE
WATER POLLUTION ABATEMENT PROGRAM

LEGISLATIVE AUTHORITY:	State law S.S. 144.25 passed by the General Assembly in 1978
SOURCE OF FUNDS:	State General Fund
AMOUNT OF FUNDS:	$1,250,000 for cost-share and $50,000 for technical and administrative support in 1978-79 (1)
ADMINISTRATION OF FUNDS:	Cost-share funds are administered by the Department of Natural Resources. The soil and water conservation districts and other designated management agencies implement the program at the local level (2)
PRACTICES COST-SHARED:	Best Management Practices identified in the 208 water quality management plan for both agricultural and urban nonpoint source problems.
PERCENT COST-SHARED:	Average 50-75% of total cost
DETAILS:	(1) At least 70% of the total funds allocated for this program must be spent in priority watershed established in the 208 planning effort. (2) See attached "Guidelines for Nonpoint Source Water Pollution Abatement Program: A Part of the Wisconsin Fund"

AGRICULTURE NONPOINT SOURCE
WATER POLLUTION ABATEMENT PROGRAM

LEGISLATIVE AUTHORITY:	State Law S.S. 92.21 passed by General Assembly in 1978
SOURCES OF FUNDS:	State General Fund
AMOUNT OF FUNDS:	$265,000 in 1978, may not be funded in 1979-80
ADMINISTRATION OF FUNDS:	Administered by the Wisconsin Board of Soil and Water Conservation Districts through the local soil and water conservation districts.
PRACTICES COST-SHARED:	Agricultural Best Management Practices as determined by the districts as part of the 208 planning process (1)

PERCENT COST-SHARED:	Maximum 50% of total cost of practices
DETAILS:	(1) The State Board allocates the funds based on the needs established by the district. Cost share payments are issued by the State Board of Soil and Water Conservation Districts upon certification by the local districts.

District Programs

LEGISLATIVE AUTHORITY:	The district enabling legislation authorizes conservation districts to provide financial as well as technical assistance to landowners.
SOURCE OF FUNDS:	County appropriations and Federal revenue sharing monies allocated to the districts.
AMOUNT OF FUNDS:	$205,000 in 1979 for programs in 12 districts.
ADMINISTRATION OF FUNDS:	Administered totally by the respective local soil and water conservation districts.
PRACTICES COST-SHARED:	Practices are determined by each district to treat problems unique to that district. Most common practices are animal waste facilities; terraces; waterways; and structures.
PERCENT COST-SHARED:	Up to 75% of total cost (1)
DETAILS:	(1) Some districts may choose to put a limit on the amount received per practice. One example - $3,500 maximum on animal waste facilities.

APPENDIX C

GLOSSARY AND LIST OF ABBREVIATIONS

GLOSSARY

Agricultural runoff: Water containing the liquid and solid wastes from all types of farming; pollutants it may carry include pesticides, fertilizers, wastes from feed lots, and sediment from soil erosion.

Algae: Photosynthetic aquatic plants containing chlorophyll that occur as microscopic forms suspended in water (phytoplankton), and as unicellular and filamentous forms attached to rocks and other substrates (periphyton or Aufwuchs). About 15,000 species of fresh water algae are known. Algae form the base of the food chain in aquatic environments. Some species may create a nuisance when conditions are suitable for prolific growth.

Benthic region: The bottom of a body of water. This region supports the benthos, a type of life that not only lives upon, but contributes to the character of the bottom.

Benthos: Plant and animals that live on or in the bottom materials of a lake or stream.

Biochemical oxygen demand (BOD): A measure of the amount of oxygen consumed in the biological processes that break down organic matter in water; large amounts of organic waste use up large amounts of dissolved oxygen, thus the greater the degree of pollution from organic matter, the greater the BOD.

Biological community: All of the living things in a given area or environment.

Chlorophyll *a*: A type of plant pigment common to all species of algae. Chlorophyll *a* is measured as an indicator of the plant related productivity within a body of water.

Dissolved oxygen (DO): The oxygen dissolved in water. Adequate amounts of dissolved oxygen are necessary for thelife of fish and other aquatic organisms and for the prevention of offensive odors. Low dissolved oxygen concentrations generally are due to discharge of excessive organic solids having high BOD.

Ecological impact: The total effect of an environmental change, either natural or man-made, on the ecology of the area.

Ecology: The interrelationships of living things to one another and to their environment.

Ecosystem: A community, including all the component organisms, together with the environment, forming an interacting system. A combination of living and non-living components.

Erosion: The wearing away of the land surface by wind or water.

Limiting factor: Any influence or material which tends to limit growth and productivity in an ecosystem; either too much or too little of these critical factors may limit production.

Nonpoint source pollution: Pollutants which are discharged into a body of water from a non-confined area are known as nonpoint sources of pollutions. Unlike point source pollution, where the location pollutants enter the water is well defined (usually a pipe) and the source of the pollution is pinned down to a discrete area, nonpoint pollution enters the surface and groundwaters of the region almost everywhere and is the result of activities that cover large parcels of land. Major nonpoint sources of pollution in Northeast Michigan include stormwater runoff, bank erosion, septic systems, landfill seepage, and erosion and sedimentation resulting from agricultural, logging, mining, and construction related activities. Although this pollution is often more difficult to identify and control than point source pollution, it must be controlled in order to preserve and enhance Northeast Michigan's water quality and environment.

Nutrients: Elements or compounds essential to life; they are essential as raw materials for organism growth and development and include carbon, oxygen, nitrogen, phosphorus and many others.

Organic: Referring to or derived from living organisms. In chemistry, any compound containing carbon.

pH: Acid or Alkaline measure of a material, liquid or solid. pH is represented on a scale of 0 (most acid) to 14 (most alkaline).

Pollution: Any alteration in the character or quality of the environment which renders it unfit or less suited for certain uses.

Sediment: Solid material both mineral and organic, suspended or moved from its site of origin by water and deposited elsewhere.

Storm water: Rainwater runoff containing pollution such as animal feces, chemicals, and refuse from streets and agricultural fertilizers and pesticides.

Turbidity: The relative clarity of water due to fine suspended particles or organisms in the liquid.

Watershed: A drainage area or basin. All land and water areas which drain or flow toward a central collector such as a stream, river or lake at a lower elevation.

LIST OF ABBREVIATIONS

ACP - agricultural conservation program

ASCS - Agriculture Stabilization and Conservation Service

Agricultural AWQC - Agricultural Area of Water Quality Concern

BMP - Best Management Practice

°C - temperature in degrees centigrade

CES - Cooperative Extension Service

DNR - Department of Natural Resources

EPA - Environmental Protection Agency

FmHA - Farmers Home Administration

ha - hectare, equal to 2.471 acres

l - liter, equal to 1.057 quarts

kg - kilogram, equal to 2.205 pounds

m - meter, equal to 39.37 inches

mg/l - milligrams per liter, same as parts per million

ml - milliliter, 1/1000 of a liter

NATRAC - Natural Resources Advisory Committee

NEMCOG - Northeast Michigan Council of Governments

RCWP - Rural Clean Water Program

SCD - Soil Conservation District

SCS - Soil Conservation Service

RC&D - Huron Pines Resource Conservation and Development Area

ug/l - micrograms per liter, same as parts per billion

umhos - micromhos, unit of electrical conductance

USDA - United States Department of Agriculture