United States Environmental Protection Agency
Region V
230 South Dearborn
Chicago, Illinois 60604
July, 1979
Water Division

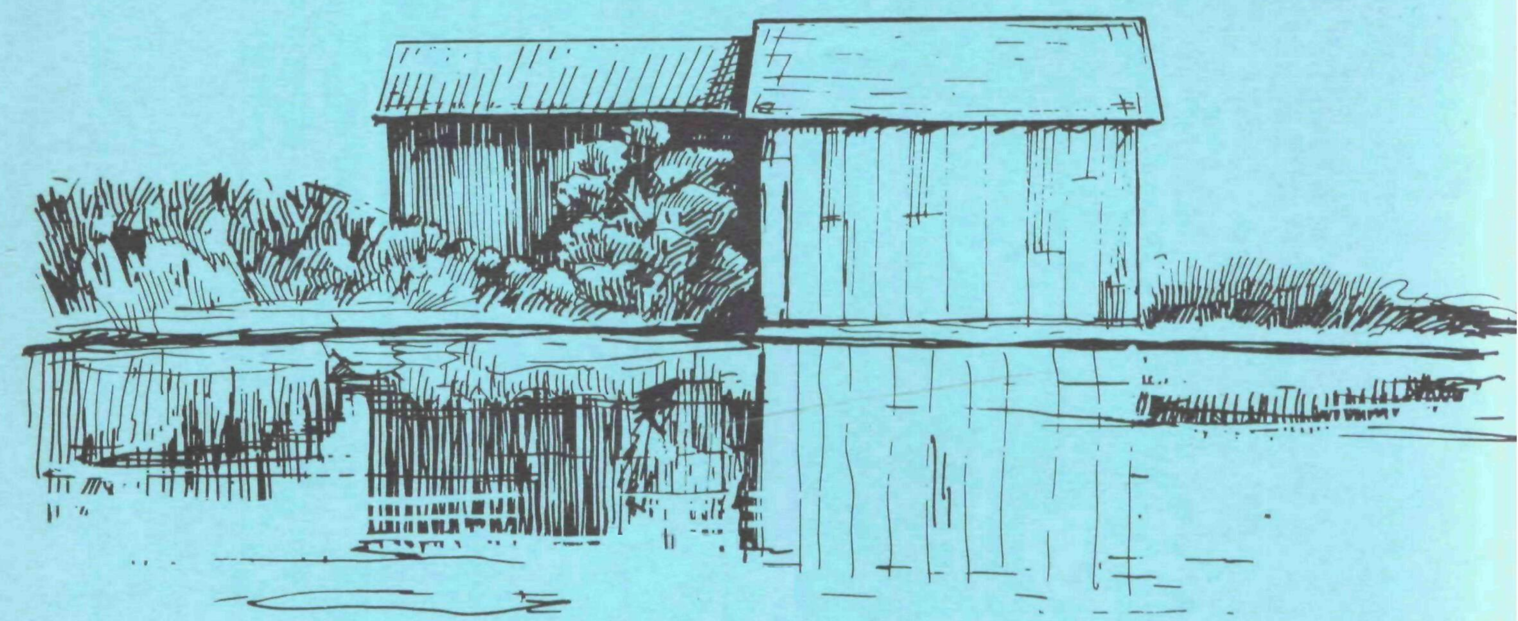
EPA

Environmental Impact Statement

Draft

Alternative Waste Treatment Systems For Rural Lake Projects

Case Study Number 3 Springvale-Bear Creek Sewage Disposal Authority Emmet County, Michigan



VOLUME I

DRAFT ENVIRONMENTAL IMPACT STATEMENT

ALTERNATIVE WASTEWATER TREATMENT SYSTEMS FOR RURAL LAKE PROJECTS

CASE STUDY No. 3: SPRINGVALE-BEAR CREEK SEWAGE DISPOSAL AUTHORITY

EMMET COUNTY, MICHIGAN

Prepared by the

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION V, CHICAGO, ILLINOIS

AND

WAPORA, INCORPORATED

WASHINGTON, D.C.

Approved by:

John McGuire
Regional Administrator
U.S. Environmental Protection Agency

July, 1979

DRAFT ENVIRONMENTAL IMPACT STATEMENT

CROOKED/PICKEREL LAKES FACILITY PLANNING AREA
Emmet County, Michigan

Prepared by

US ENVIRONMENTAL PROTECTION AGENCY, REGION V

Comments concerning this document are invited and should be received by OCT 8 1979.

For further information, contact
Mr. Alfred Krause, Project Monitor
US EPA Region V
230 South Dearborn St.
Chicago, Illinois 60609
312/353-2314

Abstract

A 201 Facility Plan was prepared for the Crooked/Pickerel Lakes Facility Planning Area. The Facility Plan concluded that extensive sewering would be required to correct malfunctioning on-site wastewater disposal systems and to protect water quality.

Concern about the high costs of the Facility Plan Proposed Action prompted re-examination of the Study Area and led to preparation of this EIS. This EIS concludes that complete abandonment of on-site systems in the area is unjustified. An alternative to the Facility Plan Proposed Action has therefore been presented and is recommended by this Agency.

LIST OF PREPARERS

This Environmental Impact Statement was prepared by WAPORA, Inc. under the guidance of Alfred Krause, EPA Region V Project Officer. Key personnel for WAPORA included:

WAPORA, Inc.
6900 Wisconsin Avenue
Chevy Chase, MD 20015

J. Ross Pilling II	- Project Manager
Winston Lund, P.E.	- Water Quality Modeler
Gerald Peters	- Project Advisor
Michael Goldman	- Project Engineer

In addition, several subcontractors and others assisted in preparation of this document. These along with their areas of expertise, are listed below:

Aerial Survey
Environmental Photographic Interpretation Center
Vint Hill Farms Station
Warrenton, VA
Barry Evans

Septic Leachate Analysis
K-V Associates
Falmouth, MA
William Kerfoot

Engineering
Arthur Beard Engineers
6900 Wisconsin Avenue
Chevy Chase, MD 20015
David Wohlscheid, P.E.

Soils Interpretation
University of Michigan Biological Station
Pellstonm MI 49769
Arthur Gold and John E. Gannon

Sanitary Survey
University of Michigan Biological Station
Pellston, MI 49769
Samuel Ehlers

Water Quality Study
University of Michigan Biologic Station
Pellston, MI 49769
John E. Gannon and Daniel J. Mazur

SUMMARY

CONCLUSIONS

A large number of on-site systems around Crooked/Pickerel Lakes are operating satisfactorily. Approximately 51 septic tank effluent plumes are found to be entering the Lakes. Eight septic system surface malfunctions were found in the Proposed Service Area. Backup of sewage into homes is relatively infrequent. On-site systems do not appear to be a significant contributor of nutrients into the Lakes -- of the total input of phosphorus into the lakes only 1.3% is derived from septic tanks in Crooked Lake and 1.6% in Pickerel Lake. Where plumes do emerge, they appear to be supporting localized growth of Cladophora.

In the Facility Plan, septic systems were suspected of contributing to degraded water quality and public health problems although there was little evidence to support this suspicion. Neither the Facility Plan Proposed Action nor the EIS Alternatives are expected to either adversely or beneficially affect the water quality of the open bodies of Crooked/Pickerel Lakes. The lack of measurable improvement in the quality of these open waters is due to the mignitude of non-point source loadings which would not be controlled by any wastewater management alternative. This loading constitutes an estimated 71.9% and 88.1% of the total phosphorus input to Crooked Lake and Pickerel Lake, respectively.

Many of the on-site systems presently in use within the EIS Service Area are poorly maintained and many are inadequately designed. Routine maintenance for all on-site systems and upgrading of inadequately designed systems will substantially reduce the number of problems caused by them. Where problems cannot be solved by routine maintenance or upgrading alone, alternatives to the conventional septic tank subsurface absorption systems are feasible.

Future growth in the Crooked/Pickerel Lakes Study Area depends on the number of new lots that can be developed and the allowable density. Wastewater disposal alternatives relying on continued use of on-site systems around the lakes would restrict both the number of new lots as well as their density. An effect of these limitations would be to preserve the present character of the community.

Total present worth for the more centralized alternatives (Facility Plan Proposed Action, EIS Alternatives 2, 3, and 4) are considerably higher than for the decentralized alternatives (EIS Alternatives 1, 5, and 6). As calculated in this EIS the Facility Plan Proposed Action is 1.5 times more expensive than EIS Alternative 1 and 3.3 times more expensive than EIS Alternative 6. Differences in water quality impacts are not proportionate to these large differences in costs. Because of the high costs and limited benefits to water quality with the more centralized alternatives (Facility Plan Proposed Action and EIS Alternative 2, 3, and 4), they are not cost-effective and are not recommended.

DRAFT EIS RECOMMENDATIONS

This EIS recommends the formulation of a small waste flows district and construction of EIS ALternative 6 at a miminum. This alternative calls for upgrading on-site systems and 2 cluster systems at Ellsworth Point and Botsford Landing. The alternative may vary somewhat from the design presented in Chapter IV. This is becuase detailed site by site design work needed to determine the level of on-site upgrading for each house (see Section II.E.2.b.) may indicate that particular dwellings have problems requiring different technology than those incorporated in EIS Alternative 6. Where upgrading of existing conventional septic tank-soil absorption systems is found to be impractical alternative on-site measures should be evaluated. These include composting or other alternative toilets, flow reduction, as well as holding tanks and separate greywater/blackwater disposal.

Cluster systems in addition to those in EIS Alternative 6 may be eligible for Construction Grants funding where site data, evaluation of conventional and alternative on-site systems and cost-effective analysis demonstrate the practicality of off-site treatment and disposal. It is possible that one or more cluster system could be required by localized site conditions notably in the area of Channel Road or Oden Island.

HISTORY

In October 1976, the Little Traverse Bay Area Facility Plan for the Springvale-Bear Creek Area Segment was submitted to EPA Region V by the Springvale-Bear Creek Sewage Disposal Authority as the applicant for funding under the Construction Grants Program. The Facility Planning Area included the northern portions of Resort and Bear Creek Townships east and west of the city of Petosky, as well as the areas around Crooked/Pickerel Lakes in Springvale and Littlefield Townships. The EIS Study Area is limited to the portion of the Facilities Planning Area around Crooked/Pickerel Lakes in Springvale and Little Field Townships. The Proposed Service Area, to which this EIS is addressed, includes the south shore of Crooked Lake, Oden Island in Crooked Lake, the shore of Pickerel Lake and the corridor between the two lakes.

The Facility Plan recommended centralized collection of wastewaters in the Proposed Service Area with Treatment at the Petosky Plant (its alternative) as the wastewater management plan in the Springvale-Bear Creek Area Segment. It cites cost-effectiveness and implementability as reasons for the selection of this alternative.

EIS ISSUES

Cost-Effectiveness and Financial Impact. The per capita and per residence cost of the Facility Plan Proposed Action is very high ($3,100 and $9,285 respectively), particularly considering that half of the population is seasonal and that many of the permanent residents in the area are of retirement age. The acceptability and affordability of the local share of this cost burden has not been adequately addressed. The low housing density and distance from the Petoskey Treatment Plant makes the cost-effectiveness of sewering the area questionable. Consequently, lower cost alternatives have been fully examined in this EIS.

Secondary Impacts. The project appears capable of generating a variety of secondary impacts, including development pressure on wetland areas, increased non-point runoff from construction of new housing, and increased demands for roads and other community services.

Interbasin Transfer. There will be a limited amount of interbasin transfer from the Lake Huron watershed to the Lake Michigan watershed, if wastewater collected from around Crooked/Pickerel Lakes is routed to the treatment plant at Petoskey. The impact of diversion of water from one basin to the other has not previously been addressed.

ENVIRONMENT

Soils. Opportunities for suitable treatment of domestic wastewater using soils exist at selected sites in much of the Study Area. Major factors restricting the use of some soils for on-site waste disposal systems are permeability and a seasonal high water table. The variability of these glacial soils is significant as it requires that detailed soils and groundwater investigations be performed prior to construction of soil dependent treatment systems.

Surface Water Resources. Crooked Lake and Pickerel Lake are classified as mesotrophic systems. This means that they are waters with a moderate supply of nutrients and, compared to eutrophic waters, have less production of organic matter. Because they fall in the low range of this classification they are lakes of good water quality.

There is evidence that existing systems are contributing insignificant bacterial loads to the lakes. Bacterial levels along nearshore areas were reported to be lower than State and local standards. Values in excess of the standard were found in one station in Crooked Lake near Conway. Kerfoot (1979) detected very low levels of fecal coliforms (generally less than 10 organisms per 100 ml) in the surface water located at the discharge of septic leachate plumes.

Groundwater Resources. Groundwater serves as the source of drinking water for the entire EIS Service Area. Groundwater quality information for Springvale and Littlefield Townships is limited. Available information indicates that the groundwater is suitable for domestic use although it is too hard for certain industrial purposes.

Additional Studies. During the preparation of this EIS, EPA pursued three additional studies in order to evaluate the need for improved wastewater management facilities in the EIS Service Area. They are briefly described as follows:

1) A study of septic effluent (leachate) movement into Crooked/Pickerel Lakes was conducted in November 1979. Observations

were obtained from shoreline profiles and analysis of groundwater and surface water samples. A total of 51 effluent plumes were found to be entering Crooked/Pickerel Lakes. The highest concentration of effluent plumes was found in the southeast part of Pickerel Lake in the vicinity of Ellsworth Point and Botsford Landing.

2) A sanitary survey was conducted by the University of Michigan during August and September 1978. The results of the survey indicate that 90% of the existing on-site systems have been constructed on sites with severe soils limitations (as defined by SCS). Several systems are also in violation of the Emmet County Sanitary Code with respect to lake setback distances and undersized septic tanks. Only 9% of the existing systems experience recurrent problems with backups or surface ponding of effluent.

3) An aerial survey was performed by EPA's Environmental Photographic Interpretation Center (EPIC) on August 20, 1978. Surface malfunctions were not found to be widespread; 8 failing or marginally failing systems were observed in the Proposed Service Area.

Existing Population and Land Use. Approximately 74% of the EIS Service Area population is seasonal. The permanent resident population is characterized by a moderate income that is above the median for Emmet County but lower than state and national figures. The moderate income level is attributable to the agricultural and tourism orientation of the local economy and the large number of retired persons living on limited or fixed income.

The predominant land uses within the Study Area include agriculture, open space, and State forest land. Low density residential development exists on the shoreline areas serving largely seasonal residents. Development is also scattered along major highways and section line roads.

ALTERNATIVES

Based upon the high cost of conventional wastewater collection and treatment technology, 6 new alternatives were developed in this EIS. These alternatives evaluated alternative collection systems (pressure sewers), treatment techniques (land application), individual and multi-family septic systems (cluster systems), and water conservation.

EIS Alternative 1. This alternative proposes decentralized collection using low pressure and gravity sewers and treatment employing multi-family cluster absorption areas. Ten cluster systems would serve the entire existing and future population with the exception of the south shore of the Crooked/Pickerel channel which would be served by holding tanks.

EIS Alternative 2. This alternative employs central collection and land application for a majority of the area around each lake. The remaining segments would be served by cluster systems and holding tanks. The central collection system would use both pressure and gravity sewers. Treatment systems would include a waste stabilization or facultative lagoon for primary treatment and storage followed by land application of wastewater by spray irrigation.

EIS Alternative 3. This alternative proposes centralized collection for the areas around Crooked Lake and Oden Island with treatment of wastewater at the Petosky plant. Cluster systems and holding tanks would serve the remaining part of the Service Area.

EIS Alternative 4. This alternative proposes centralized collection of the entire Service Area and land application of wastewater at a site north of Pickerel Lake.

EIS Alternative 5. This alternative is similar to EIS Alternative 3 in that it proposes centralized collection of wastewater for the south shore of Crooked Land and land application near Hardwood State Forest. The remainder of the area would be served by cluster systems or holding tanks.

EIS Alternative 6. EIS Alternative 6 constitutes a "limited action" alternative. Most on-site systems would be upgraded by replacing undersized septic tanks, and upgrading existing drainfields or replacing them with elevated sand mounds. Cluster systems would serve limited areas in Ellsworth Point and Botsford Landing. The Crooked/ Pickerel channel area would be served by holding tanks.

IMPLEMENTATION

Local jurisdictions have the legal and financial capability of implementing small waste flows districts. Although the concept of public management of septic systems has not been legally tested in Michigan, present sanitary codes have been interpreted as authorizing such management by local governments. Some local jurisdictions have experience in the organization and operation of small waste flows districts. California and Illionis provide some specific examples. New management concepts for implementing small waste flows districts are discussed.

IMPACTS OF ALTERNATIVES

Five major categories of impacts were relevant in the selection of an alternative. These categories included: surface water, groundwater, environmentally sensitive areas, population and land use, and socio-economics.

Surface Water. No alternative is expected to have a significant impact on the trophic status of Crooked/Pickerel Lakes. Non-point sources will continue to contribute the largest percentage of nutrients to the lakes. EIS Alternative 6 may enable localized growth of *Cladophora* to continue.

Groundwater. No significant primary or secondary impacts on groundwater quality or quantity are anticipated either as a result of short-term construction activities or long-term operation of any of the various alternatives.

Environmentally Sensitive Areas. The high rate of induced growth that would occur with the Facility Plan Proposed Action and EIS Alternatives 2 and 4 would have a significant impact on wetlands, prime agricultural land, and habitat for endangered species. EIS Alternatives 1, 5 and 6 would result in little or no impact.

Population and Land Use Impacts. The Facility Plan Proposed Action and EIS Alternatives 2 and 4 would result in significant induced growth. Population growth would occur up to 100% above the population projected for the year 2000. This would result in an additional 93 to 130 acres of residential development at high densities. The decentralized alternatives, EIS Alternatives 1 and 5, would result in moderate rates of growth; 67 to 77% above existing levels. Residential acreage would increase 77 to 79 acres in medium density residential development. EIS Alternative 6 would hold population 10% below anticipated year 2000 levels resulting in an increase of 38 acres of scattered low density residential development.

Economic Impacts. Annual user charges are higher for the more centralized alternatives than the decentralized alternatives. The high annual user charge of the Facility Plan Proposed Action and EIS Alternatives 2 and 4 would place a significant financial burden on households in the Study Area. This could result in displacement pressure of 20 to 45% of the population. EIS Alternatives 1, 5 and 6 are not identified as high cost projects and would not significantly influence the composition and character of the Crooked/Pickerel Lakes Study Area.

TABLE OF CONTENTS

Page

Page

Page

Page

Page

LIST OF FIGURES

List of Figures (Continued)

LIST OF TABLES

List of Tables (Continued)

SYMBOLS AND ABBREVIATIONS

*	An asterisk following a word indicates that the term is defined in the Glossary at the end of this report. Used at the first appearance of the term in this EIS.
<	less than
>	greater than
ρ	Rho
μ	Mu, micro
ν	Nu
σ	Sigma

TECHNICAL ABBREVIATIONS

AWT	advanced wastewater treatment
BOD	biochemical oxygen demand
DO	dissolved oxygen
ft^2	square foot
fps	feet per second
$g/m^2/yr$	grams per square meter per year
GP	grinder pump
gpcd	gallons per capita per day
gpm	gallons per minute
I/I	infiltration/inflow
kg/yr	kilograms per year
kg/cap/yr	kilograms per capita per year
kg/mile	kilograms per mile
lb/cap/day	pounds per capita per day
mgd	million gallons per day
mg/l	milligrams per litre
ml	millilitre
msl	mean sea level--implies above msl unless otherwise indicated
MPN	most probable number
N	nitrogen
NH_3-N	ammonia nitrogen
NO_3-N	nitrate nitrogen
NPS	non-point source

O&M	operation and maintenance
P	phosphorus, or "as phosphorus"
pH	measure of acidity or basicity; <7 is acidic; >7 is basic
PO_4	phosphate
ppm	parts per million
psi	pounds per square inch
RBC	rotating biological contactor
SS	suspended solids
STEP	septic tank effluent pumping
STP	sewage treatment plant
ST/SAS	septic tank/soil absorption system
TKN	total Kjeldahl nitrogen
TP-P	total phosphorus as phosphorus
µg/l	micrograms per liter
EPAECO	name of a mathematical model

NON-TECHNICAL ABBREVIATIONS

DNR	Michigan Department of Natural Resources
EIS	Environmental Impact Statement
EPA	United States Environmental Protection Agency
EPIC	Environmental Photographic Interpretation Center (of EPA)
FWS	Fish and Wildlife Service, United States Department of the Interior
GT-L-BHD	Grand Traverse-Leelanau-Benzie District Health Department
HUD	United States Department of Housing and Urban Development
NOAA	National Oceanic and Atmospheric Administration, United States Department of Commerce
NES	National Eutrophication Survey
NPDES	National Pollutant Discharge Elimination System
SCS	Soil Conservation Service, United States Department of Agriculture
STORET	STOrage and RETrieval (data base system of EPA)
USDA	United States Department of Agriculture
USGS	United States Geological Survey, Department of the Interior

CHAPTER I
INTRODUCTION, BACKGROUND AND ISSUES

A. PROJECT LOCATION AND HISTORY

1. LOCATION

The subject of this Environmental Impact Statement (EIS) is Federal funding of a proposed wastewater collection facility in the Crooked/Pickerel Lakes portion of the Springvale-Bear Creek Facility Planning Area, Emmet County, Michigan (see Figure I-1). Located just east of Lake Michigan's Little Traverse Bay in the upper northwest corner of the southern peninsula, the Crooked/Pickerel Lakes area comprises approximately 43,000 acres of farmlands, woodlands, and lowland lake areas. The predominant features of the area are Crooked Lake and Pickerel Lake and the residential development along on their shores.

The Facility Planning Area includes the northern portions of Resort Township and Bear Creek Township east and west of the city of Petoskey, as well as the areas around Crooked Lake and Pickerel Lake in Springvale Township and Littlefield Township. The Springvale-Bear Creek portion of the Facility Planning Area is the EIS Study Area (see Figure I-2). The predominately residential areas to be served by the proposed wastewater facilities will be collectively referred to as the Proposed Service Area (see Figure I-3). This area includes the south shore of Crooked Lake, Oden Island in Crooked Lake, the shore of Pickerel Lake, and the corridor between the two lakes.

2. HISTORY OF THE CONSTRUCTION GRANT APPLICATION

The wastewater management needs of the Crooked/Pickerel Lakes Study Area have received substantial consideration prior to the preparation of this Environmental Impact Statement. The following summarizes of these events:

CROOKED/PICKEREL CHRONOLOGY

1971	-	Preliminary feasibility study prepared for sewer service to areas of Littlefield Township.
1971	-	Springvale Township board authorized preliminary feasibility study of system to serve the development on the shorelines of Crooked/Pickerel Lakes.
September 1972	-	Grant application filed by Littlefield Township for Federal and State grant funds.

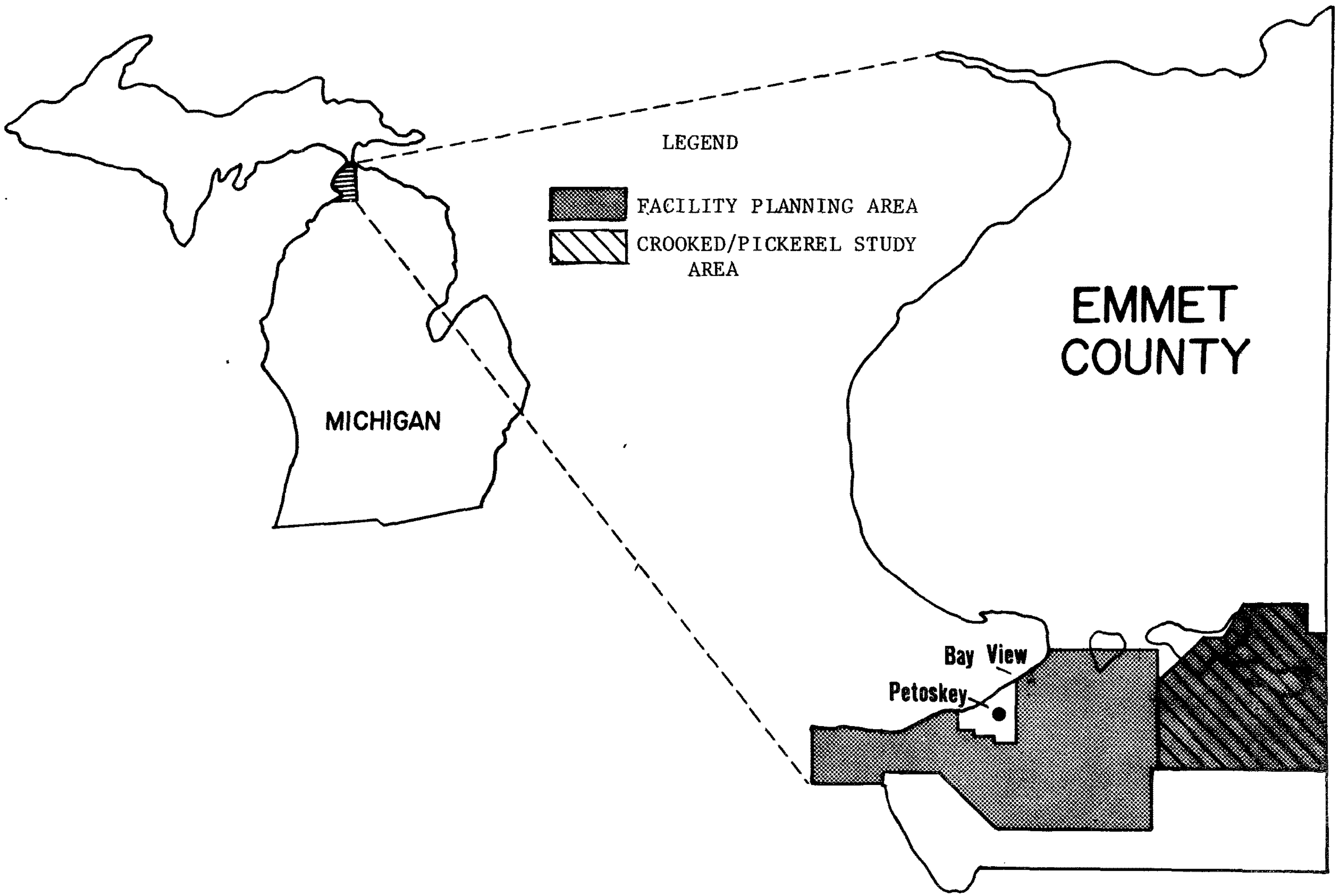


FIGURE I-1 LOCATION OF THE CROOKED/PICKEREL STUDY AREA

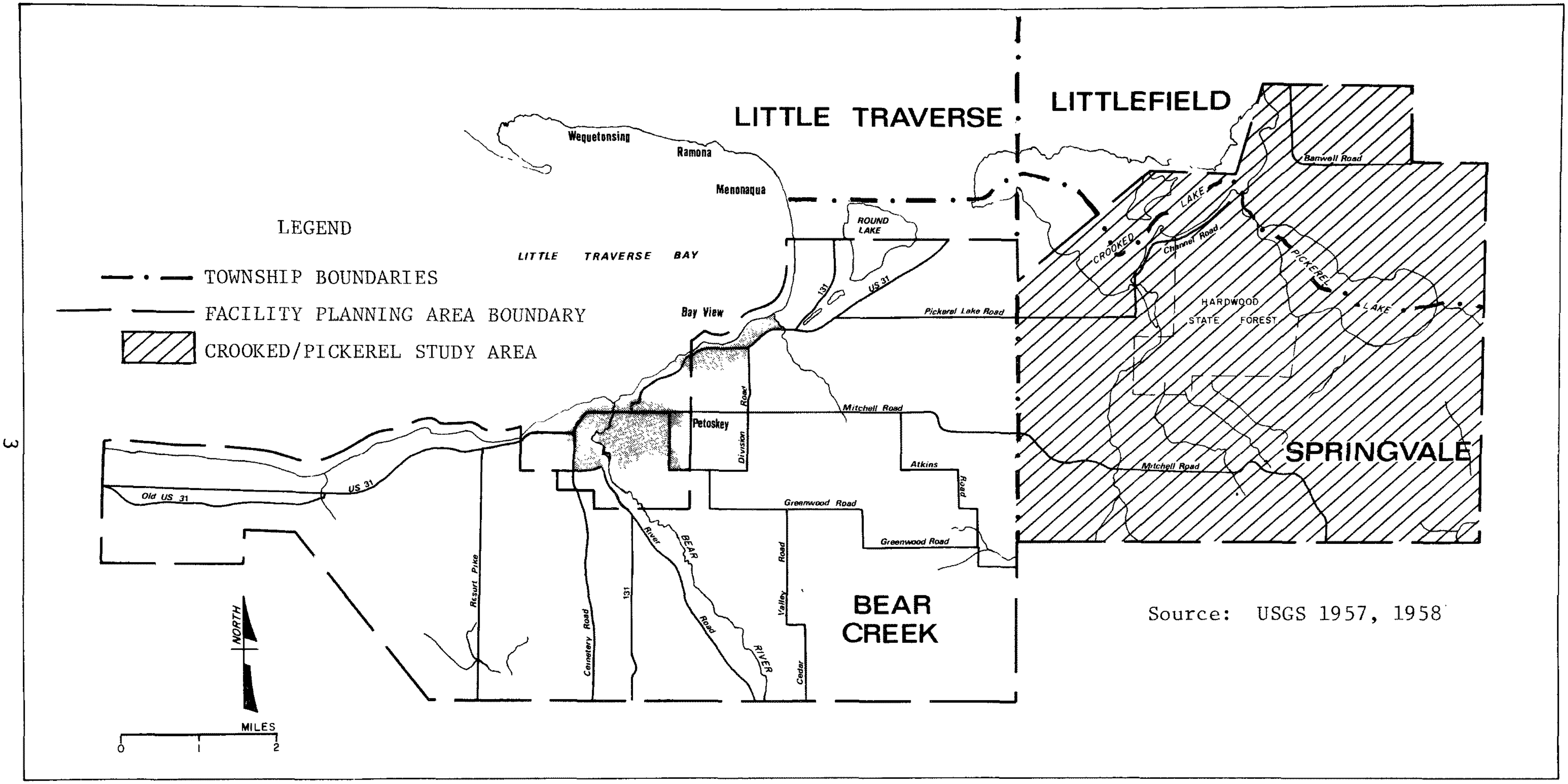


FIGURE I-2 BASE MAP OF THE FACILITY PLANNING AREA AND THE CROOKED/PICKEREL STUDY AREA

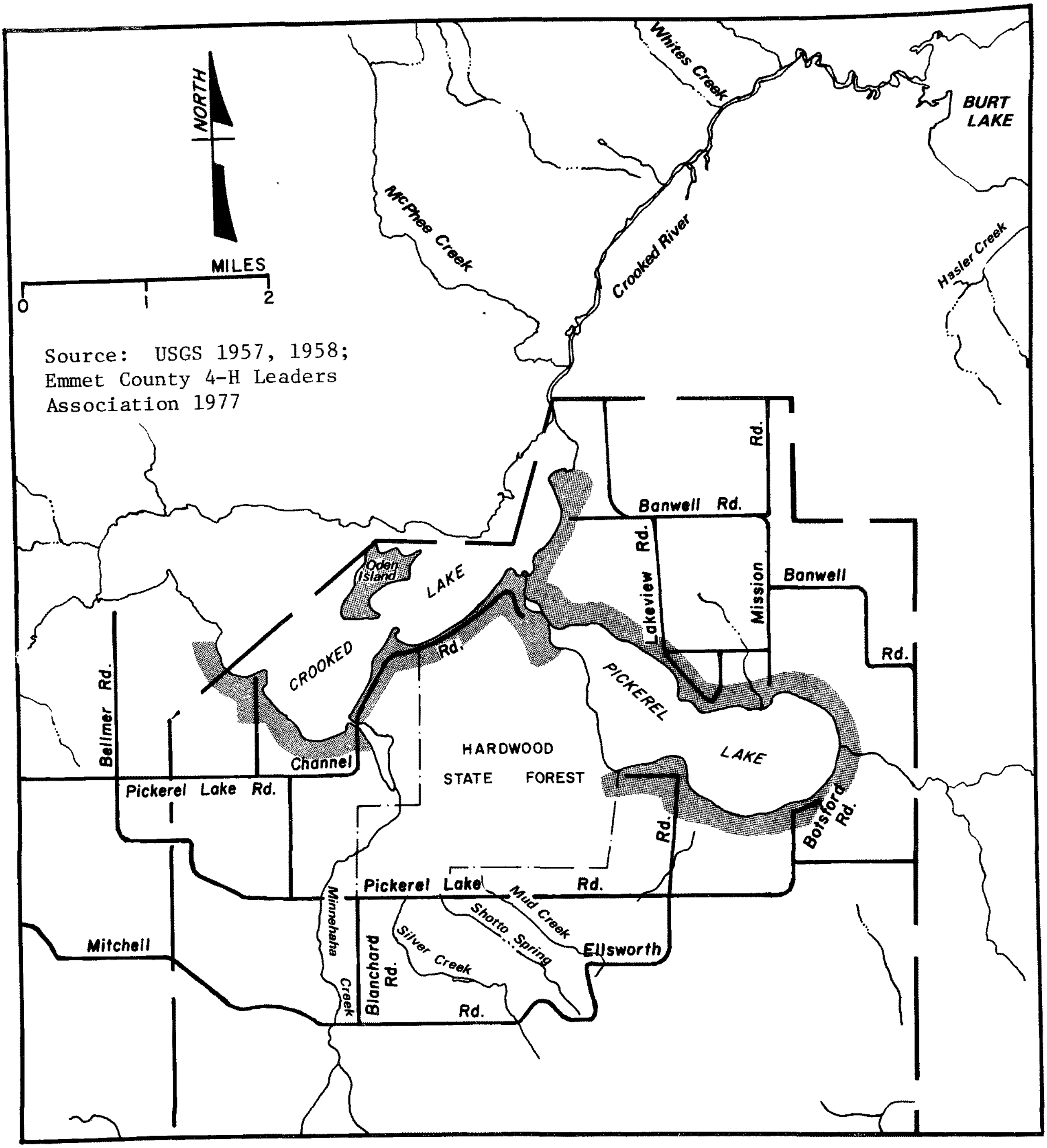


FIGURE I-3 LOCATION OF ROADS AND PROPOSED SEWER SERVICE AREA IN THE CROOKED/PICKEREL STUDY AREA

LEGEND

PROPOSED SEWER SERVICE AREA

EIS STUDY AREA BOUNDARY

September 1972	-	Grant application filed by Springvale Township for grant funds.
September 5, 1975	-	Notice of Intent to apply for Step I Facility Planning grant filed by Springvale-Bear Creek Sewage Disposal Authority.
September 8, 1975	-	Application filed by Springvale-Bear Creek Sewage Disposal Authority to the U.S. Environmental Protection Agency (EPA) for Step I Facility Planning Grant.
February 23, 1976	-	Step I Grant offer made to the Springvale-Bear Creek Sewage Disposal Authority by EPA Region V.
June 16, 1976	-	Public hearing by the Springvale-Bear Creek Sewage Disposal Authority on proposed Facility Plan for the Springvale-Bear Creek Area.
June 1976	-	Review of Step I Facility Plan completed by the Michigan Department of Management and Budget Office of Intergovernmental Affairs.
June 1976	-	Review of the preliminary volume of the Facility Plan for the Springvale-Bear Creek Area Segment, by the Planning and Wastewater Engineering Section of the Water Quality Division of the Michigan Department of Natural Resources.
October 1976	-	Final publication of the Little Traverse Bay Area Facility Plan for the Springvale-Bear Creek Area Segment by Williams and Works.
July 20, 1977	-	Declaration by EPA Region V of Intent to prepare an EIS on the Facility Plan for the Crooked/Pickerel Lakes portion of the Springvale-Bear Creek Area Segment.
October 1977	-	Work begun by WAPORA, Inc. on the EIS for the Crooked/Pickerel Lakes portion of the Springvale-Bear Creek Area Segment.
December 16, 1977	-	Public information meeting on the preparation of an EIS by EPA Region V and WAPORA, Inc.
August 21, 1978	-	Aerial Photographic Survey conducted by EPA EPIC (Environmental Photographic

		Interpretive Center) to locate malfunctioning septic systems.
August 24, 1978	-	Public information meeting to present the wastewater collection and treatment alternatives for the Crooked/ Pickerel Lakes Area.
September 8, 1978	-	Sanitary Survey of Crooked/Pickerel Lakes on-site wastewater disposal systems conducted.
November 18, 1978	-	Septic Snooper Survey of Crooked/ Pickerel Lakes area to detect failing septic systems.
January 22, 1979	-	Septic Snooper Report finished and incorporated in the EIS.

3. SPRINGVALE-BEAR CREEK AREA SEGMENT OF THE FACILITY PLAN

In October of 1976, Williams and Works completed the Facility Plan for the Springvale-Bear Creek Area. It evaluated alternative wastewater collection and treatment technologies for the Crooked/ Pickerel Lakes Study Area. It developed a plan for construction of a new wastewater collection facility which was subsequently submitted to EPA Region V by the Springvale-Bear Creek Sewage Disposal Authority, the grant applicant, for funding under the EPA Construction Grants Program. As noted previously, only the collection system proposed for that portion of the Facility Planning Area around Crooked/Pickerel Lakes in Springvale Township and Littlefield Township is the subject of this EIS. Wastewater collection and treatment facilities proposed for the remaining portions of the Facility Planning Area have been approved by the Environmental Protection Agency.

The Springvale-Bear Creek Area Segment of the Facility Plan used information then available on existing wastewater treatment facilities in the Crooked/Pickerel Lakes Study Area to determine the water quality problems, the need for the project, alternative solutions, and recommend a course of action. This information is summarized here to inform the reader of the key issues addressed in the Facility Plan. Conclusions reached in the Facility Plan are not necessarily those reached in this EIS.

a. Existing Wastewater Treatment Facilities

Individual septic tank systems are the main treatment for wastewaters along the south shore of Crooked Lake and along the shore of Pickerel Lake. The Facility Plan did not specifically address the design and condition of these systems. It did, however, state that existing septic tank systems in the entire Proposed Service Area cannot provide adequate wastewater treatment. Reasons cited for this include site limitations including small lot sizes and a high groundwater table.

A wastewater collection system presently serves the city of Petoskey. The City has adopted a Master Sewer Plan for future additions and improvements to the system. Wastewaters are treated at a complete-mix activated sludge plant in Petoskey. Details of the plant design are described in Chapter 4 of the Facility Plan. Operating data indicate that National Pollution Discharge Elimination Standards (NPDES) limitations are being met for BOD_5 and suspended solids but not for phosphorus removal.

b. Existing Problems with Water Quality and Wastewater Treatment Facilities

The Facility Plan has identified the following problems associated with the existing on-site systems in the Springvale-Bear Creek Area Segment:

- Many of the existing septic tanks are not capable of providing adequate treatment. In many areas, according to the Plan the lots are so small that there is not enough room to construct an adequate drainfield. On other lots, the water table is too close to the surface for the drainfield to operate properly. The Plan considers many of the septic tanks in the area to be a source of pollution and a potential health hazard.

- Many of the cottages around Crooked Lake were built prior to the time when septic tanks were required for sewage disposal, and many existing systems were installed before the local sanitary code went into effect in 1970.

- According to information sent by the District Health Department No. 3 and cited in the Facility Plan, the land around Crooked/Pickerel Lakes consists mostly of muck, clay, and calcareous soils. These conditions have caused numerous sewage disposal problems often resulting in sewage flowing into the lake directly, or through a minimal amount of soil.

In addition, the following conditions associated with the water quality of Crooked Lake were identified by the University of Michigan Biological Research Station and were cited in the Facility Plan:

- According to the Plan, water quality in Crooked Lake has noticeably declined due to human impact on its shores. Swimming beaches have been intermittently closed during the past few years due to high coliform bacteria counts. The Lake has also been subject to noticeable phytoplankton blooms.

c. Proposed Solutions: Alternatives Addressed in the Facility Plan

The Facility Plan divided the Springvale-Bear Creek Segment into three subareas: the Township areas directly tributary to Petoskey; the Bear Creek Township area east of Petoskey; and the areas around Crooked/ Pickerel Lakes in Springvale and Littlefield Townships (the EIS Study Area). It concluded that it would not be practical to serve the subarea directly adjacent to Petoskey other than to provide sewer service by short extensions of the existing Petoskey sewers.

Three alternatives were evaluated for serving the remaining two portions of the Springvale-Bear Creek Area. All three provided for centralized collection of wastewaters in the Facility Plan's entire Proposed Service Area. The three treatment alternatives evaluated by the Facility Plan were the following:

- Treatment at the Petoskey plant,
- Treatment at a separate plant south of the Petoskey State Park in Bear Creek Township, discharging to Tannery Creek, and
- Treatment by land application in Sections 8 and 17 of Springvale Township, south of Crooked and Pickerel Lakes.

A detailed description of these alternatives can be found in Chapter 6 of the Facility Plan.

The Facility Plan's estimated present worth of capital costs, present worth of operation and maintenance costs, and total net present worth are listed in Table I-1. An interest rate of 6 5/8% and a 20-year planning period were used in developing the costs presented in the table. It should be noted that the costs presented are for the collection and treatment of wastewaters from all three subareas of the Springvale-Bear Creek Area Segment. Costs for wastewater facilities serving the EIS Study Area were not presented in the Facility Plan.

Table I-2 presents 1998 population design flow used to size the collection and treatment systems for the three alternatives developed in the Facility Plan. Assumed loadings were 100 gallons per capita per day (gpcd) for year-round residents, 60 gpcd for seasonal residents and tourists, and 100 gpcd for commercial users. Figures for Springvale Township and Littlefield Township represent the contribution from the EIS Study Area.

d. Facility Plan Proposed Action

The Facility Plan recommended centralized collection of wastewaters in the Proposed Service Area with Treatment at the Petosky Plant (its alternative) as the wastewater management plan in the Springvale-Bear Creek Area Segment. It cited cost-effectiveness and implementability as reasons for the selection of this alternative. Chapter 8 of the Facility Plan presents further design and cost information.

B. <u>ISSUES OF THIS EIS</u>

The Environmental Protection Agency, reviewing the proposed wastewater facilities for the Springvale-Bear Creek Area Segment determined

Table I-1

PRESENT WORTH OF ALTERNATIVES ADDRESSED
IN THE FACILITY PLAN FOR THE SPRINGVALE-BEAR CREEK AREA SEGMENT

	Treatment at Petoskey Plant	Treatment at RBS Plant	Treatment at Land Disposal System
Sanitary Sewer			
Total Construction Cost	7,019,700	6,795,300	8,248,800
Misc. Exp. (Incl. land & easements)	1,346,700	1,279,100	1,504,500
Estimated Project Cost	8,366,400	8,074,400	9,753,300
Operation & Maintenance (20 yrs)	377,400	377,400	377,400
Salvage Value	1,095,600	1,069,700	1,232,700
Total Net Present Worth	7,648,200	7,382,100	8,898,000
Wastewater Treatment			
Total Construction Cost		1,853,500	1,949,200
Misc. Exp. (Incl. land & easements)		392,900	620,900
Estimated Project Cost		2,246,400	2,570,100
Operation & Maintenance (20 yrs)		946,800	399,000
Salvage Value		153,200	197,600
Project Present Worth		3,040,000	2,771,500
Treatment at Petoskey	1,577,400	361,000	361,000
Total Net Present Worth	1,577,400	3,401,000	3,132,500
Sewers and Treatment			
Total Construction Cost	7,019,700	8,648,800	10,198,000
Misc. Exp. (Incl. land & easements)	1,346,700	1,672,000	2,125,400
Estimated Project Cost	8,366,400	10,320,800	12,323,400
Operation & Maintenance (20 yrs)	377,400	1,324,200	776,400
Salvage Value	1,095,600	1,222,900	1,430,300
Project Present Worth	7,648,200	10,422,100	11,669,500
Treatment at Petosky	1,577,400	361,000	361,000
Total Net Present Worth	9,225,600	10,783,100	12,030,500

Source: Williams and Works, 1976.

Table I-2

PROJECTED WASTEWATER FLOWS, 1998
SPRINGVALE-BEAR CREEK AREA SEGMENT

	Total Population Equivalent P.E.	Peak Day Flow MGD*	Summer Months Flow MGD	Winter Months Flow MGD	Yearly Average Flow MGD
Springvale-Bear Creek Area Segment					
1. Townships Directly Tributary to Petoskey					
Bear Creek	1,270	.12	.11	.10	.11
Resort	600	.05	.05	.04	.04
Total	1,870	.17	.16	.14	.15
2. Bear Creek Township East of Petoskey	4,715	.44	.43	.41	.42
3. Springvale Township	1,150	.10	.09	.08	.08
4. Littlefield Township	850	.07	.07	.05	.06
5. Total for Segment	8,585	.78	.75	.68	.71

Source: Williams and Works, 1976

*Million gallons per day.

that issues related to the eastern portion of the proposed project warranted an Environmental Impact Statement. To the Agency, the proposed collection system around Crooked/Pickerel Lakes could have significant environmental and socioeconomic effects including the following:

1. COST-EFFECTIVENESS AND FINANCIAL IMPACT

The per capita and per residence cost of the proposed project is very high ($3,100 and $9,285 respectively), particularly considering that half of the population is seasonal and that many of the permanent residents in the area are of retirement age. The acceptability and affordability of the local share of this cost burden has not been adequately addressed. The low housing density and distance from the Petoskey Treatment Plant makes the cost-effectiveness of sewering the area questionable. Consequently, lower cost alternatives must be fully examined.

2. SECONDARY IMPACTS

The project appears capable of generating a variety of secondary impacts, including development pressure on wetland areas, increased non-point runoff from construction of new housing, and increased demands for roads and other community services.

3. INTERBASIN TRANSFER

There will be a limited amount of interbasin transfer from the Lake Huron watershed to the Lake Michigan watershed, if wastewater collected from around Crooked/Pickerel Lakes is routed to the treatment plant at Petoskey. The impact of diversion of water from one basin to the other is not addressed.

C. NATIONAL PERSPECTIVE ON THE RURAL SEWERING PROBLEM

Some EIS issues listed above are not unique to the proposed plan for wastewater management in the Crooked/Pickerel Lakes Study Area. They are typical of concerns raised by a large number of wastewater projects for rural and developing communities that have been submitted to EPA for funding. The scope of the problem has grown in the last few years as controversy has mounted over the high costs and possible impacts of providing conventional sewerage facilities to small communities across the country.

1. SOCIOECONOMICS

To assess the magnitude of the cost burden that many proposed wastewater collection projects would impose on small communities and the reasons for the high costs, EPA studied over 250 facilities plans from 49 states for pending projects for communities under 50,000 population (Dearth 1977). EPA found that, even with substantial State and Federal construction grants, the costs of conventional sewering are sometimes beyond the means of families in rural and semi-rural areas. This was particularly true for those communities where the completely new facilities proposed would result in annual user charges of more than $200 per household.

The Federal government has developed criteria to identify high-cost wastewater facilities projects (The White House Rural Development Initiatives 1978). Projects are considered to place a financial burden on rural community users when annual user charges (debt service plus operation and maintenance) would exceed:

- 1.5% of median household incomes less than $6,000;
- 2.0% of median household incomes between $6,000 and $10,000; or
- 2.5% of median household incomes over $10,000.

Annual user charges exceeding these criteria would materially affect the households' standard of living. Federal agencies involved in funding wastewater facilities will work with the community to achieve lower project costs through a change in the project's scope or design. If the project's scope or design is not changed, the agencies will work with the community until they are assured that the community is aware of the financial impacts of undertaking the high-cost project.

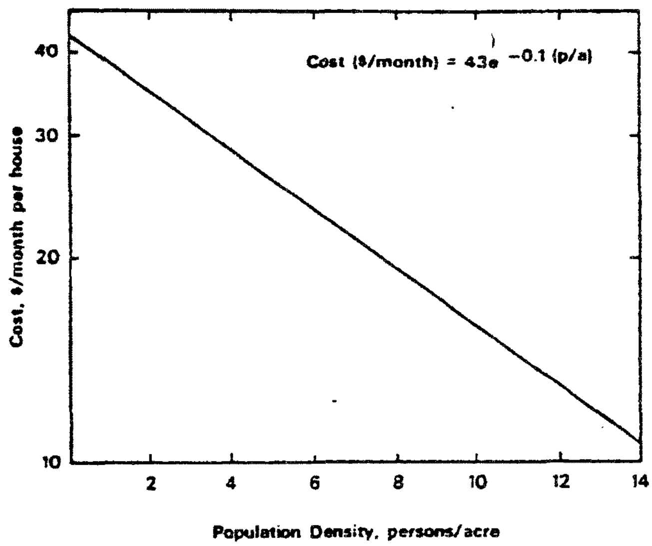
It is the collection system that is chiefly responsible for the high costs of conventional sewerage facilities for small communities. Typically, 80% or more of the total capital cost for newly serviced rural areas is spent for collection system. Figure I-4 indicates that the costs per residence for gravity sewers increases exponentially as population density decreases. Primary factors contributing to this cost/density relationship were found to be:

- greater length of sewer pipe per dwelling in lower-density areas;
- more problems with grade, resulting in more lift stations or excessively deep sewers;
- regulations or criteria which set eight inches as the smallest allowable sewer pipe diameter; and
- inability of small communities to spread capital costs among larger populations sewered previously.

In addition to the comparatively high costs of sewers, facilities were sometimes found to be more expensive than necessary due to:

- oversophistication in design, with accompanying high chemical usage, large energy requirements, and costly maintenance and operator expense, when simpler methods would do.
- use of expensive construction materials such as non-locally produced brick and block and terrazzo when a prefab steel and concrete building would perform satisfactorily.

Figure I- 4



Monthly Cost Of Gravity Sewers

Dearth, K.H. 1977. In proceedings of EPA national conference on less costly wastewater treatment systems for small communities, April 12-14, 1977, Reston, VA.

- abandonment of existing treatment works without economic justification.

2. SECONDARY IMPACTS

Installation of centralized collection and treatment systems in previously unsewered areas can have dramatic effects on development and, hence, on the economy, demography and environment of rural communities. These effects can be desirable, or they may substantially offset community objectives for water resource improvement, land use planning and environmental protection.

In broad terms, a community's potential for recreational, residential, industrial, commercial or institutional development is determined by economic factors such as the availability of land, capital, skilled manpower and natural resources. However, fulfillment of the potential can be limited by the unavailability of facilities or services called infrastructure elements, such as water supply, sewerage, electric power distribution and transportation. If a missing infrastructure element is supplied, development of one type or another may take place, depending upon prevailing local economic factors. Such development is considered to be "induced growth" and is a secondary impact of the provision of the essential infrastructure element.

Conflicts between induced growth and other types of existing or potential development are also termed secondary impacts as are induced growth's effects on existing water resources, land use, air quality, cultural resources, aesthetic features and environmentally sensitive areas.

Secondary impacts of new wastewater facilities may be highly desirable. For example, diversification of the local employment base may be possible only when sufficient wastewater collection and treatment capacity is provided for commercial or industrial development. On the other hand, new commercial or industrial development may not be compatible with existing recreational or agricultural interests. Residential development accompanying expansion of the employment base may take place on prime agricultural land, steep slopes or wetlands, or may otherwise infringe on valued natural features.

3. THE NEED FOR MANAGEMENT OF DECENTRALIZED ALTERNATIVE SYSTEMS

A promising alternative to expensive centralized sewer systems in rural areas is a decentralized wastewater management system. Both engineering and management are integral parts of such a system, and "decentralized alternatives," as used in this EIS, incorporate both engineering and management elements.

Briefly, the engineering element consists of the use of existing and new on-site systems, rehabilitation or replacement of those systems where necessary, and construction of small-scale off-site systems where existing on-site systems are not acceptable.

The management element consists of continuing supervision of the systems' installation, maintenance, rehabilitation and appropriate monitoring of the systems' environmental impacts.

While other factors such as soil characteristics, groundwater hydrology and lot configurations are highly important, adequate management may be critical to the success of decentralized alternatives in many communities. Similarly, lack of adequate management undoubtedly contributed to past failures of many on-site wastewater facilities and, therefore, the lack of trust in which they are held by local public health officials and consulting engineers.

Historically, state and local health officials were not empowered even to regulate installation of on-site systems until after World War II. They usually acted in only an advisory capacity. As the consequences of unregulated use of the septic tank-soil adsorption systems became apparent in the 1950s and 1960s, health officials were granted new authority. Presently most health officials have authority to inspect and permit or deny new installations, and can require renovation and replacement of on-site systems. However, their role in the operation and maintenance of on-site systems remains largely advisory. There is seldom either a budget or the authority to inspect or monitor a system.

In the 1970's, the Congress recognized the need for continuing supervision and monitoring of on-site systems in the 1977 Clean Water Act. EPA regulations implementing that Act require that, before a construction grant for on-site systems may be made, the applicant must meet a number of requirements and must:

- Certify that it will be responsible for properly installing, operating and maintaining the funded systems;

- Establish a comprehensive program for regulation and inspection of on-site systems that will include periodic testing of existing potable water wells and, where a substantial number of on-site systems exists, more extensive monitoring of aquifers; and

- Obtain assurance of unlimited access to each individual system at all reasonable times for inspection, monitoring, construction, maintenance, operation, rehabilitation and replacement.

In some cases, implementation of these requirements by municipalities may be hindered by lack of state enabling legislation for small waste flow management districts and by lack of adequately trained manpower. The municipality may have no control over the former and be at a disadvantage because of the latter. Other implementation factors, over which municipalities should have control, are discussed in Section III.E of this EIS.

D. PURPOSE AND APPROACH OF THE EIS AND CRITERIA FOR EVALUATION OF ALTERNATIVES

1. PURPOSE

This EIS documents EPA's review and analysis of the application for EPA Step II funding of the Facility Plan Proposed Action. Based upon this review, the Agency will take one of several actions:

- Approve the grant application, possibly with recommendations for design changes and/or measures to mitigate impacts of the Facility Plan Proposed Action;
- With the applicant's and State's concurrence, approve Step II funding for an alternative to the Facility Plan Proposed Action;
- Return the application with recommendations for additional Step I analysis; or
- Reject the grant application.

The review and analysis focused on the issues identified in Section I.B and was conducted with an awareness of the more general considerations of rural sewering problems discussed in Section I.C. Major emphasis has been placed on developing and evaluating alternative wastewater management approaches to be compared with the Facility Plan Proposed Action.

2. APPROACH

The review and analysis reported in this EIS included a series of tasks, which were undertaken in approximately the following sequence:

a. Review of Available Data

Data presented in the Facility Plan and other sources were reviewed for applicability in development and/or evaluation of the Plan Proposed Action and of the new alternatives developed for the EIS (EIS Alternatives). Sources of data are listed in this Bibliography.

b. Segment Analysis

As a basis for revised population projections and for development of alternatives, the Proposed Service Area was partitioned into a number of segments. The number of dwellings in each segment was counted from black and white aerial photographs. Available information on soils, depth to groundwater, water quality problems, environmentally sensitive areas and land use capabilities was tabulated for each segment and the tabulations used to make preliminary estimates of the need for off-site wastewater disposal.

c. Review of Wastewater Design Flows

Available population projections were revised on the basis of the segment house counts. New EPA guidelines for estimating design wastewater flows were then used to revise the year 2000 wastewater flow projections.

d. Development of Alternatives

First, technologies that might potentially reduce project costs or minimize adverse impacts while still solving existing problems were examined. Four categories of alternative technologies -- flow reduction, low-cost sewers, decentralization, and land application -- were considered according to their functions in a wastewater management system. Next, several specific areawide alternatives were developed, combining the alternative technologies into complete wastewater management systems that would serve the Proposed Service Area. The technologies and the alternatives are described in Chapter III and IV.

e. Estimation of Costs for Alternatives

To assure comparability of costs between the Facility Plan Proposed Action and EIS alternatives, all alternatives were designed to serve a fixed design year population. Total present worth and local user charge estimates were based upon unit costs listed in a separate engineering report (Arthur Beard Engineers, Inc. 1978)

f. Evaluation of the Alternatives

The new alternatives were developed with a knowledge of the local environmental setting and with the understanding that they will be evaluated under criteria from several disciplines. The general criteria for evaluating both the Facility Plan Proposed Action and the EIS alternatives are listed in Section I.D.3 below.

g. Needs Documentation

The need for improved wastewater management on Crooked/Pickerel Lakes is clear and is not at issue in this EIS. However, the effects of lakeshore on-site systems on Crooked/ Pickerel Lakes, groundwaters and public health had not been clearly documented in the Facility Plan. Because determination of eligibility for Federal funding of a substantial portion of the Facility Plan Proposed Action will be based on the documentation of these effects, several supplemental studies were conducted:

- an aerial survey of visible septic tank system malfunctions using low-altitude color and infrared photography by EPA's Environmental Photographic Interpretation Center (EPIC);
- estimation of the existing Crooked/Pickerel Lakes nutrient budget and empirical modeling of the lakes' eutrophic status;

- a sanitary survey of lakeside residences conducted by the University of Michigan Biological Station to evaluate usage, design and condition of on-site systems;
- a "Septic Snooper" survey to locate and sample septic tank leachate plumes entering the Lakes from nearby on-site systems; and
- evaluation by the Soil Conservation Service of soil suitability for on-site systems.

The results of these needs documentation studies were not available when the alternatives were initially developed. The results of each study have required continuing modification of the alternatives as initially designed and have been the basis for necessary refinements in the determination of the eligibility of any new sewers around Crooked/ Pickerel Lakes for Federal funding.

3. MAJOR CRITERIA FOR EVALUATION OF ALTERNATIVES

While the high cost of sewering rural communities is a primary reason for examining alternative approaches to wastewater management, cost is not the only criterion. Trade-offs between cost and other major impacts will have to be made. The various criteria are defined below.

a. Cost

With some exceptions for innovative technologies, EPA construction grant regulations allow funding of only the most cost-effective alternatives. Cost effectiveness has been measured here as the total present worth of an alternative, including capital costs for facilities needed now, capital costs for facilities required later in the 20-year planning period, and operation and maintenance costs for all wastewater facilities. Salvage value for facilities expected to be in service after 20 years has been deducted. Analyses of cost effectiveness do not recognize differences between public and private expenditures.

The responsible municipality or sanitary district will recover operation, maintenance and local debt retirement costs through periodic sewage bills. The local economic impact of new wastewater facilities will be felt largely through associated residential user charges. Only publicly financed costs were included in residential user charges. Salvage value was not factored into residential user charges.

No assumptions were made here about frontage fees or hook-up charges that might be levied by the municipalities. Therefore, the user charges reported here for the alternatives are not directly comparable to those reported in the Facility Plan, where each newly sewered residence would pay $1,300 in connection and stub fees.

Some homeowners may incur costs that they would have to pay directly to contractors. Installation of gravity house sewers on private land and renovation or replacement of privately owned on-lot systems for seasonally occupied dwellings are not eligible for Federal funding and are seldom financed by municipalities. These private costs are identified for each alternative.

b. Significant Environmental and Socioeconomic Impacts

The system selected for the Proposed Service Area will impact on environmental and socioeconomic resources within the Study Area. Following a comprehensive review of possible impacts of the Facility Plan Proposed Action and the EIS alternatives, several types of impacts were determined to warrant in-depth evaluation and discussion in this EIS. These impacts are classified as follows:

- Surface Water Quality Impacts,
- Groundwater Impacts,
- Population and Land Use Impacts including Infringement on Environmentally Sensitive Areas, and
- Economic Impacts.

c. Reliability

Reliability criteria for the alternatives include both ability to remedy existing water quality problems and prospects of protecting water quality in the future. This first criterion was applied in the analysis of surface and groundwater impacts of the alternatives presented in Chapter V. That analysis assumed that the collection, treatment and disposal units of each alternative would operate effectively as designed. The second criterion recognizes that all structural, mechanical and electrical facilities are subject to failure. Types of possible failures and appropriate remedies and preventive measures were reviewed for selected components of the alternatives.

d. Flexibility

The capability of an alternative to accommodate increasing wastewater flows from future development in the Proposed Service Area is referred to as its flexibility. In order to demonstrate the relative levels of investment for different alternatives, all were designed and costed to provide service for the same population -- the design year population projected in Chapter II. However, factors such as the amount of land that could be developed using on-lot systems or the ability to increase the capacity of a treatment plant might have a significant effect on future development in the Study Area. The capability of the alternatives to accomodate increased wastewater flows is reviewed in Chapter IV. The effects of the alternatives' flexibility on population growth are predicted in Chapter V.

CHAPTER II
ENVIRONMENTAL SETTING

A. PHYSICAL ENVIRONMENT

1. PHYSIOGRAPHY

Moranic ridges and lowland lakes, formed during glacial advance and retreat, dominate the Crooked/Pickerel Lakes Study Area topography. Elevation ranges from 600 feet (183 meters) above mean sea level (MSL) on the lake plain south of Crooked/Pickerel Lakes to 1100 feet (335 meters) in the southeast part of the Study Area. Steep slopes, often greater than 30% are found in the southeast and southwest corners of the Study Area. In contrast, the Study Area north of Pickerel Lake is generally level. Figure II-1 shows major topographic features.

Crooked/Pickerel Lakes are the beginning of the Inland Water Route, a series of interconnecting lakes and rivers eventually emptying into Lake Huron through the Cheboygan River. The immediate Crooked/Pickerel Lakes drainage area includes 29,631 acres (11,996 hectares) and 34,013 acres (13,770 hectares), respectively (Gannon and Mazur 1979).

Approximately 60% of the total watershed acreage lies in the Study Area. The Crooked Lake watershed includes the drainage basin of Pickerel Lake as well as Round Lake and Mud Lake west of the Study Area.

2. GEOLOGY

a. Bedrock Geology

The underlying bedrock is composed primarily of Traverse limestone and Antrim shale. Figure II-2 delineates the extent of these deposits. The bedrock is covered with glacial deposits to a depth of 100-250 feet (30-76m) over most of the Study Area. However, in the area southeast of Crooked Lake, near the border of the Springvale-Bear Creek Township, limestone deposits are found at shallow depths of 18-30 feet (5.5 - 9.1m) below the surface. In Littlefield Township, north of Pickerel Lake, the shallowest depth of bedrock is about 60 feet (18.2m) (MDNR, Department of Public Health 1977).

b. Surficial Geology

The land surface features of the Study Area are the result of depositional processes of continental glaciation. These surfaces have been modified slightly by erosion. The layer of glacial drift laid down by great ice sheets which transported rock debris, gravel, sand and clay covers the bedrock (see Figure II-3).

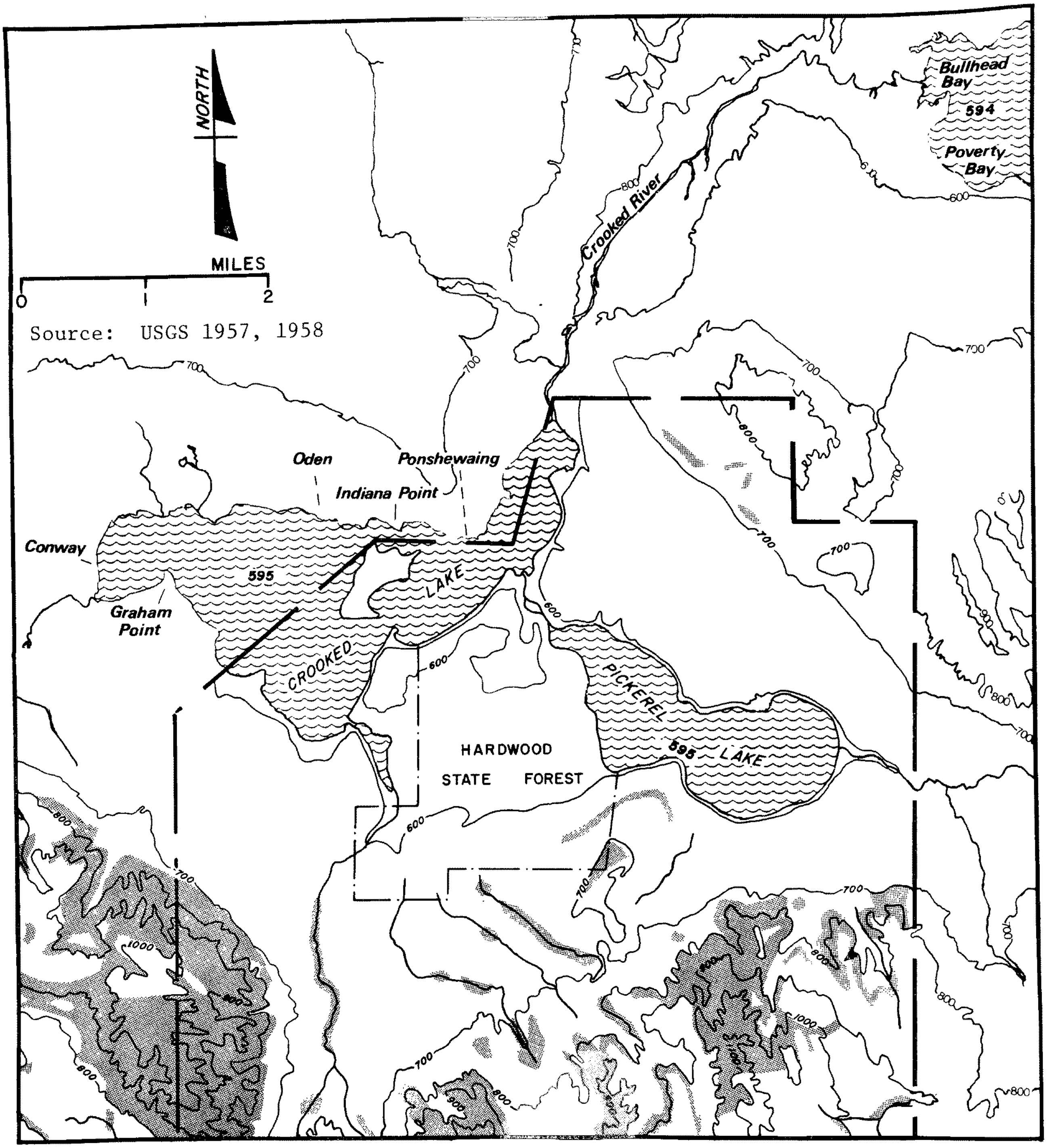


FIGURE II-1 TOPOGRAPHY OF THE CROOKED/PICKEREL STUDY AREA

LEGEND

SLOPES GREATER THAN 15%

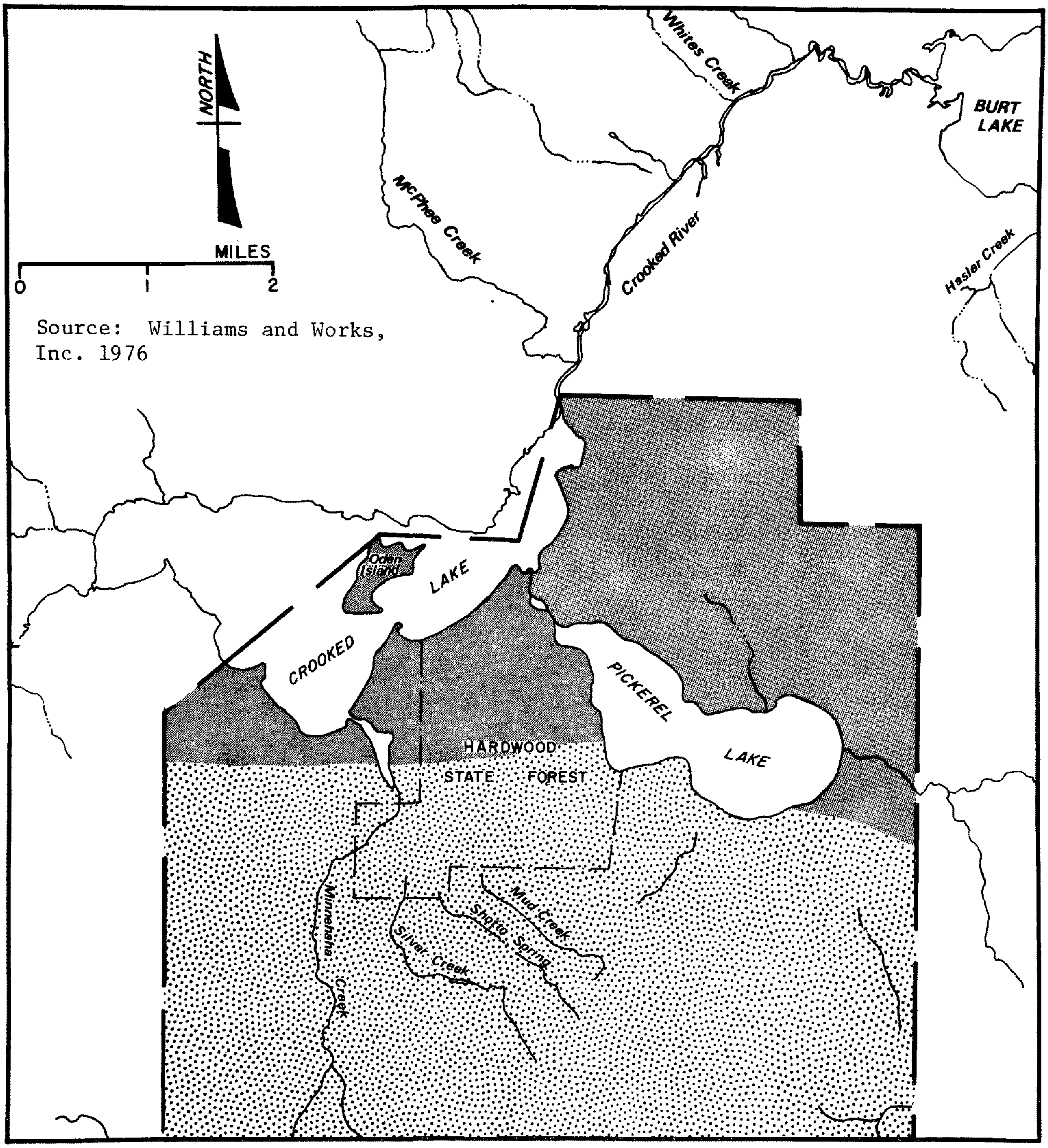


FIGURE II-2 BEDROCK GEOLOGY OF THE CROOKED/PICKEREL STUDY AREA

LEGEND

TRAVERSE LIMESTONE

ANTRIM SHALE

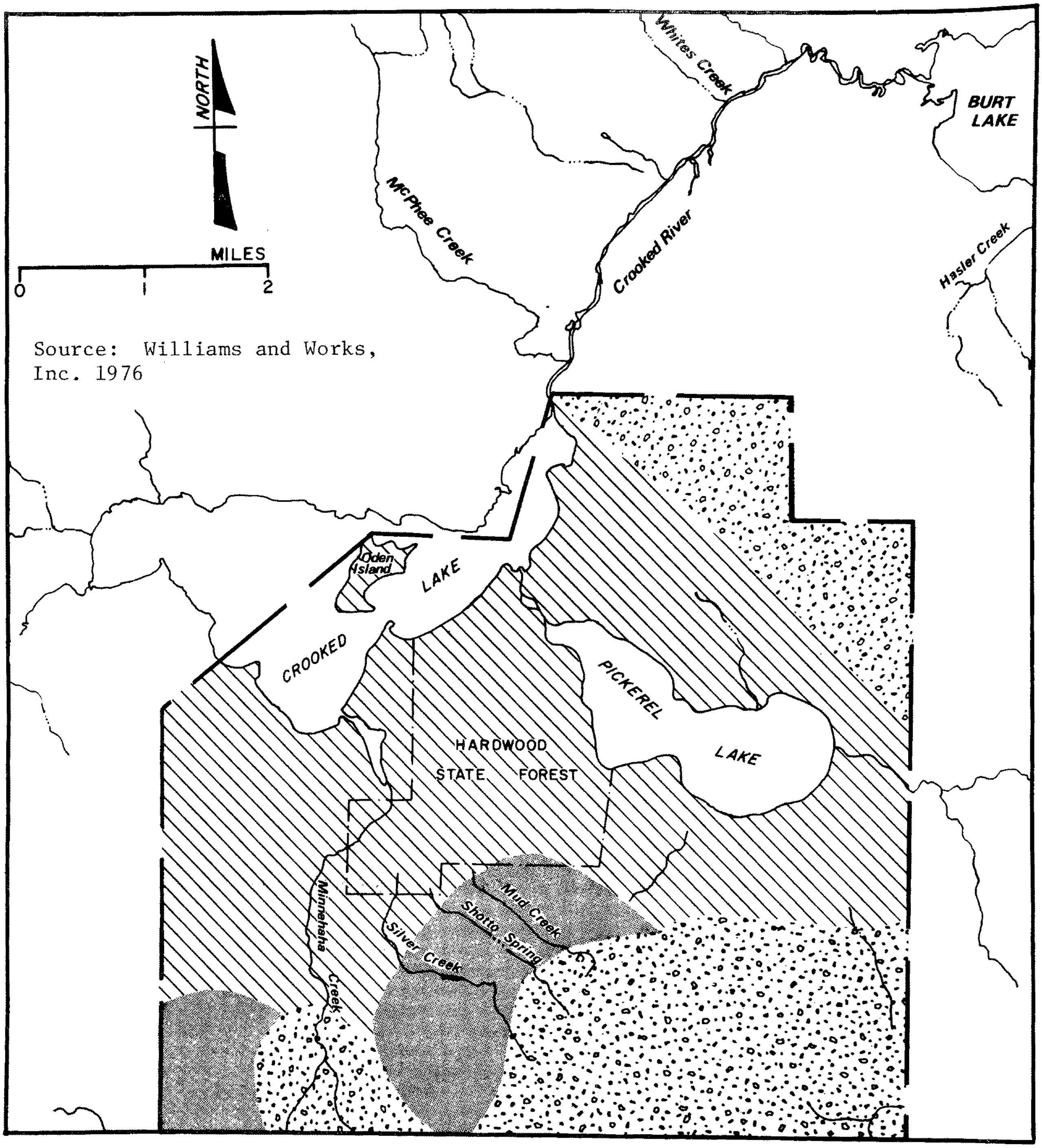


FIGURE II-3 SURFICIAL GEOLOGY OF THE CROOKED/PICKEREL STUDY AREA

LEGEND

OUTWASH
LAKE PLAIN
MORAINE

- The lake plain deposits cover about 65% of the Study Area, including the entire Proposed Service Area. They are composed of reworked, washed and sorted sands and gravel with occasional clay lenses.

- The hilly moraine deposits make up about 25% of the land surface area mostly in the southern Study Area. These deposits are made up of sandy and gravelly clay tills.

- Outwash deposits cover 10% of the land surface. These areas include typically level sands and gravel with occasional clay lenses.

3. SOILS

Soils of the glacial moraines, lake plains and outwash plains exhibit a variable permeability and slope. Table II-1 summarizes the SCS data for the major soil series within the Study Area.

This study used soils characteristics for an initial evaluation of soils suitability for on-site septic disposal, spray irrigation, agriculture and residential development. The Emmet County Soils Survey (USDA 1973), the basis of these evaluations, is not the final word on soils suitability for the Study Area; on-site investigations most verify these data.

Proposed Service Area soils generally exhibit high groundwater levels and low rates of permeability. Outside of Ellsworth Point and Botsford Landing the seasonal high water table is found within 4 feet of the surface. About half the Service Area residences have been constructed on low permeability soils (<2.0 in/hr).

a. Soils Suitability for Septic Tank/Soil Absorption Systems (ST/SAS)

Suitability for ST/SAS is based upon SCS criteria for soils permability, slope, depth to seasonal high water table, phosphorus absorption capacity and other soils characteristics, when available. Appendix A-1 discusses the importance of these characteristics. Table II-2 shows range for these factors categorizing soils as having slight, moderate or severe limitations for ST/SAS. Figure II-4 shows the soil suitability for on-site and cluster systems; Crooked and Pickerel Lakes shoreline soils are generally unsuitable for ST/SAS.

Seasonal high water table and to a lesser extent low permeability and poor phosphorus adsorption capacity are limiting factors (Gold and Gannon 1979). The seasonal high water table lies within 2 feet (0.6m) of the surface in most of the shoreline soils. Kerfoot (1978) further identified the general unsuitability of shoreline lots for septic tanks. Poorly drained, nearly level organic and sandy soils seemingly dominated the shoreline areas. With the low lakeshore relief, it was not unusual to encounter depths of groundwater within 3.3 feet (1m) at distances over 165 feet (50m) from the shore.

Table II-1

MAJOR SOIL SERIES IN THE CROOKED/PICKEREL LAKES STUDY AREA (Concluded)

	DESCRIPTION	APPROXIMATE % STUDY AREA	DEPTH TO SEASONAL HIGH WATER TABLE	DEPTH	PERMEABILITY	SOILS LIMITATIONS FOR ON-SITE SYSTEMS
			(ft.)	(inches)		
Emmet	Gently sloping to very steep, well drained soils formed in loam till	10	>3	0 - 22 22 - 32 32 - 60	2.0 - 6.3 0.63 - 2.00 2.00 - 6.30	Slight where slope is less than 12%
Blue Lake	Nearly level to very steep, well drained soils	<5	>4	0 - 24 24 - 58	6.3 - 20.0 2.0 - 6.3	Slight where slope is less than 12%
Au Gres	Nearly level to gently sloping somewhat poorly drained soils	<5	1 - 2	Variable	6.30 - 20.0 Variable	Severe; high water table
Mancelona	Nearly level to gently sloping, well-drained soils	5	>4	0 - 28 28 - 37 37 - 60	2.0 - 6.3 2.0 - 6.3 6.3 - 20.0	Slight; possible contamination of shallow groundwater supplies
Brimley	Nearly level to gently sloping somewhat poorly drained soils	<5	1 - 2	0 - 20 20 - 28 28 - 50	0.63 - 2.0 0.63 - 2.0 0.63 - 2.0	Severe; seasonal high water table;
Other Minor Associations	-----	10	-----	-----	-----	-----

Table II-1

MAJOR SOIL SERIES IN THE CROOKED/PICKEREL LAKES STUDY AREA

	DESCRIPTION	APPROXIMATE % STUDY AREA	DEPTH TO SEASONAL HIGH WATER TABLE	DEPTH	PERMEABILITY	SOILS LIMITATIONS FOR ON-SITE SYSTEMS
			(ft.)	(inches)		
Carbondale	Deep nearly level very poorly drained organic soils	20	0	0 - 26 20 - 60	2.0 - 6.3 2.0 - 6.3	Severe; high groundwater table
Kalkaska	Nearly level to very steep well drained soils	15	>4	0 - 20 20 - 60	6.3 - 20.0 6.3 - 20.0	Slight where slope is less than 12%; possible contamination of shallow groundwater supplies
Rubicon	Nearly level to very steep, well drained soils formed in sand	5	>4	0 - 16 16 - 65	6.3 - 20.0 6.3 - 20.0	Slight where slope is less than 12%; possible contamination of shallow groundwater supplies
Thomas	Nearly level, poorly drained soils formed in silty clay loam	5	1 - 2	0 - 10 10 - 16 16 - 50	0.63 - 2.0 0.2 - 0.63 0.2 - 0.63	Severe; poorly drained high water table
Leelanau	Gently sloping to very steep, well drained soils formed in loamy sand	15	>4	0 - 30 30 - 48	2.0 - 6.3 2.0 - 6.3	Slight where slope is less than 12%

Table II-2

SOIL LIMITATION RATINGS FOR SEPTIC TANK ABSORPTION FIELDS

Item Affecting Use	Degree of Soil Limitation		
	Slight	Moderate	Severe
Permeability class[1]	Rapid[2], moderately rapid, and upper end of moderate	Lower end of moderate	Moderately slow[3] and slow
Hydraulic conductivity rate (Uhland core method)	More than 1 in./hr[2]	1-0.6 in./hr.	Less than 0.6 in./hr.
Percolation rate (Auger hole method)	Faster than 45 min./in.[2]	46-60 min./in.	Slower than 60 min./in.
Depth to water table	More than 72 in.	48-72 in.	Less than 48 in.
Flooding	None	Rare	Occasional or frequent
Slope	0-8 pct	8-15 pct	More than 15 pct
Depth to hard rock,[4] bedrock, or other impervious materials	More than 72 in.	48-72 in.	Less than 48 in.
Stoniness class[5]	0 and 1	2	3, 4, and 5
Rockiness class[5]	0	1	2, 3, 4, and 5

[1] Class limits are the same as those suggested by the Work-Planning Conference of the National Cooperative Soil Survey. The limitation ratings should be related to the permeability of soil layers at and below depth of the tile line.

[2] Indicate by footnote where pollution is a hazard to water supplies.

[3] In arid or semiarid areas, soils with moderately slow permeability may have a limitation rating of moderate.

[4] Based on the assumption that tile is at a depth of 2 feet.

[5] For class definitions see *Soil Survey Manual*, pp. 216-223.

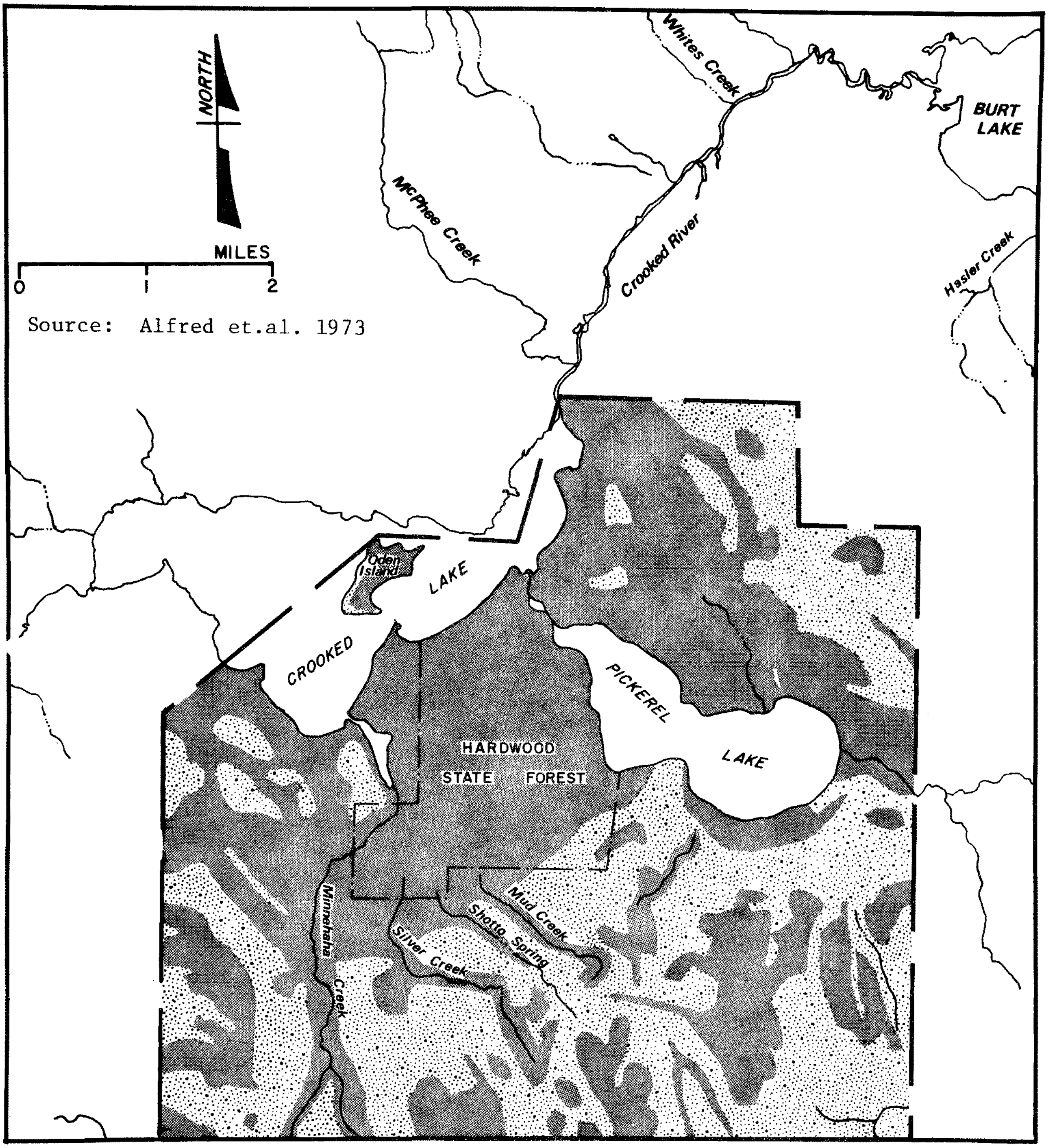


FIGURE II-4 SOIL SUITABILITY FOR ON-SITE WASTEWATER DISPOSAL IN THE CROOKED/PICKEREL STUDY AREA

LEGEND

SEVERE LIMITATIONS FOR ON-SITE WASTEWATER DISPOSAL

SLIGHT TO MODERATE LIMITATIONS FOR ON-SITE WASTEWATER DISPOSAL

Elevated sand mounds may offer safe and effective disposal of septic tank effluent where the seasonal high water table is at a depth greater than 26 inches (2/3m), but much of the shoreline cannot meet this criterion (Gold and Gannon 1979).

b. Soils Suitability for Land Application

General factors determining the suitability of soils for land application are similar, but specific criteria differ somewhat from those for on-site systems. Appendix A-2 summarizes the criteria for soils suitability for spray irrigation. Land application sites meeting these specific criteria were selected for alternative evaluation through an analysis of available soils information. Figure II-5 shows their location.

c. Prime Agricultural Soils

The Soils Conservation Service has prescribed guidelines for a national inventory of "prime and unique" farmlands. These are defined as high quality lands which can provide present and future food and fiber supplies, with the least use of energy, capital and labor and with minimal environmental impact (42 F.R. 163, August 23, 1977). Emmet County soils have received no such inventory. However, the SCS has designated soils capability classes to suggest soils suitability for crops. Class I and II soils are generally suitable for agriculture. Figure II-6 shows Study Area soils of these classes. Prime agricultural soils are scattered through the southwest and southeast corners of the Study Area. In general, Study Area soils have low natural fertility and require conservation measures to avoid erosion or drainage to eliminate wetness.

4. ATMOSPHERE

a. Climate

The presence of the Great Lakes dominates the Study Area climate, moderating temperatures. The area seldom has experiences prolonged hot humid weather in the summer or extreme cold in the winter.

Climatological data comes from the climatic monitoring stations of the National Oceanographic and Atmospheric Administration (NOAA) at Petoskey and Pellston, located about 15 miles southwest and northeast of the Study Area, respectively. Table II-3 summarizes data for these stations.

The mean annual temperature is about 43°F (6.1°C), the coldest being in December (about 25°F (-12.6°C)) and warmest in July (about 68°F (20°C)). The Study Area experiences an average of 15 days/yr. with temperatures below zero.

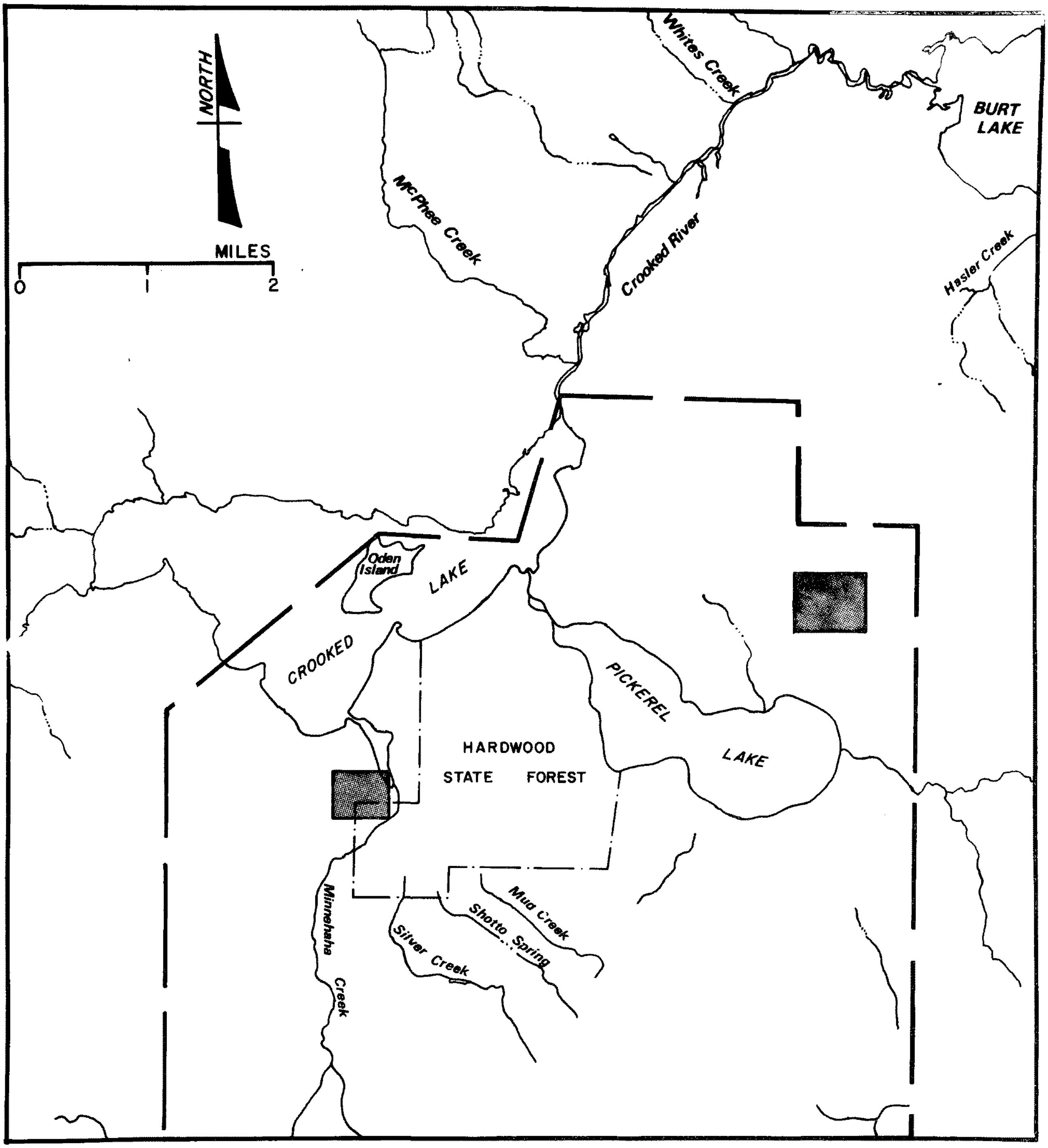


FIGURE II-5 LOCATION OF LAND APPLICATION SITES IN THE CROOKED/PICKEREL STUDY AREA

LEGEND

LAND APPLICATION SITES

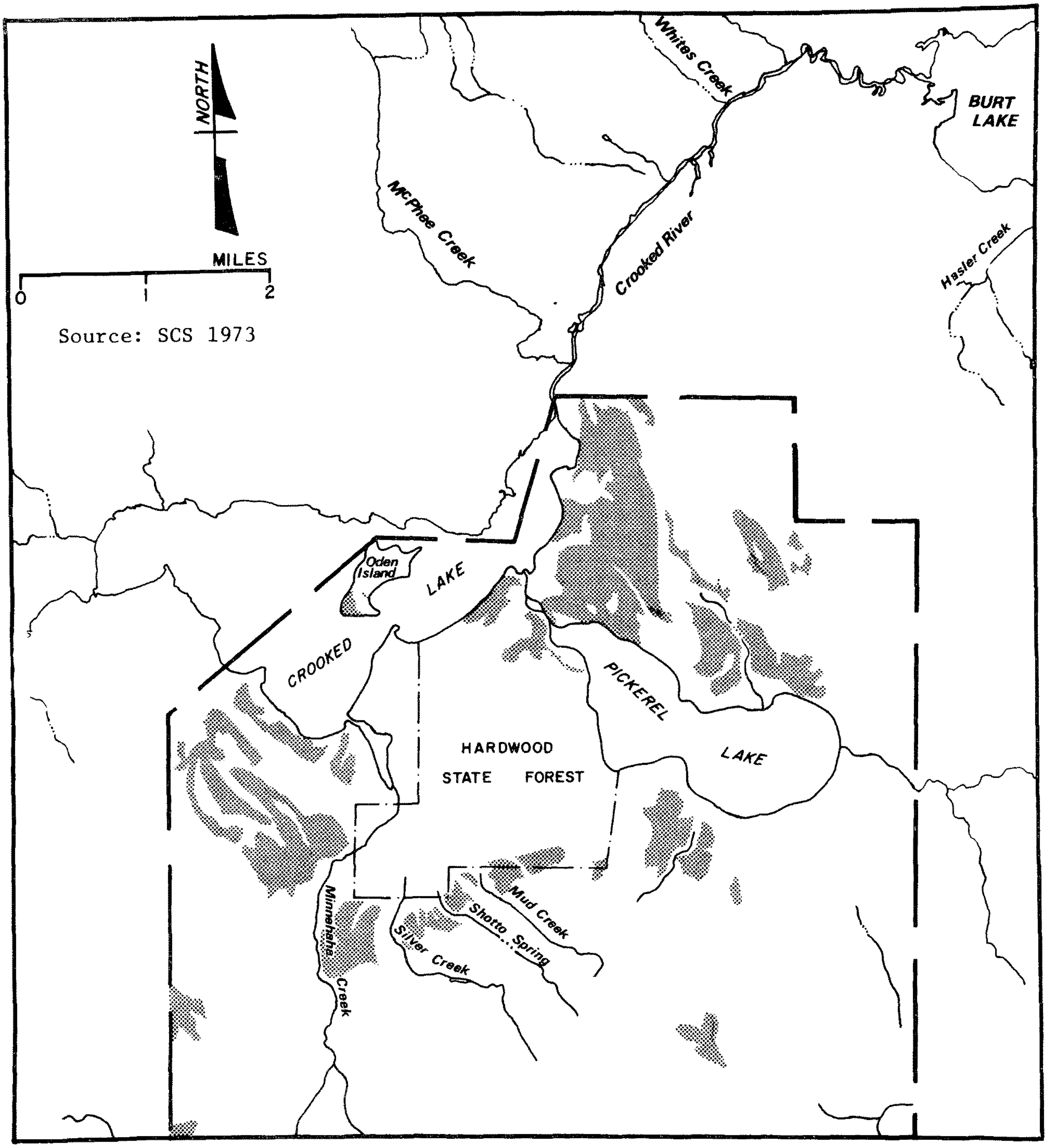


FIGURE II-6 PRIME AGRICULTURAL SOILS CAPABILITY CLASS I & II OF THE CROOKED/PICKEREL STUDY AREA

LEGEND

PRIME AGRICULTURAL SOILS (CAPABILITY CLASS I & II)

Table II-3

SUMMARY OF CLIMATOLOGICAL DATA FOR PETOSKEY* AND PELLSTON+

STATION	YEAR	MEAN TEMPERATURE oc (°F)	MINIMUM TEMPERATURE oc (°F)	MAXIMUM TEMPERATURE	MEAN PRECIPITATION cm (in)	MINIMUM PRECIPITATION cm (in)	MAXIMUM PRECIPITATION cm (in)
Petoskey	75	7.7(45.9)	- 3.6(25.6)	21.2(70.2)	96.5(38)	3.2(1.3)Oct	18.7(7.4)July
	76	5.0(41.0)	- 7.5(18.5)	19.2(66.6)	62.2(24.5)	2.7(1.1)Dec	11.2(4.4)March
Pellston	75	-	- 5.9(21.3)	20.3(68.6)	91.2(35.9)	2.7(1.1)Oct	13.1(5.2)July
	76	6.2(43.1)	-10.1(13.9)	18.9(66.1)	68.8(27.1)	2.9(1.2)Dec	11.6(4.6)March

*Petoskey: Latitude 45° 22'
Longitude 84° 59'
Elevation 610 ft.

+Pellston: Latitude 45° 34'
Longitude 84° 48'
Elevation 710 ft.

SOURCE: National Oceanic & Atmospheric Administration 1975 & 1976 Climatological Data, Michigan Annual Summaries, Ashville, NC.

Annual precipitation is about 31 inches (78.7 cm/yr.). Precipitation occurs mainly during the growing season about 140 days between May and October. Approximately 60% of the total rainfall comes in the form of afternoon showers and thundershowers. Snowfall averages 87 inches (220 cm./yr.).

b. Air Quality

The ambient air quality in Petoskey is generally good (see Appendix B). Suspended solids levels measured at two locations show compliance with both annual (75 ug/m^3) and short term (260 ug/m^3 in 24 hours) primary standards. Violations of the secondary 24-hour standard (150 mg/m^3) have occurred but such violations are infrequent. 1976 violations may be attributed to a dust storm which resulting from 50 mph wind during a severe drought.

Intermittent sulfur dioxide and nitrogen dioxide samplers were also operated. Appendix J data shows the levels considerably below applicable national ambient primary and secondary standards.

B. WATER RESOURCES

1. WATER QUALITY MANAGEMENT

Water resources management is a complex set of elements, in which the Federal government, the State and the locality all have an interest. Just naming such elements -- irrigation, municipal water supply, maintenance of navigable waters and protection of the productivity of the soil -- illustrates the broad range of activities under this heading. Among the most important, however, is preservation or restoration of the quality of US waters. In the Federal Water Pollution Control Act Amendments (P.L. 92-500, 1972) and the Clean Water Act that amended it in 1977 (P.L. 95-217), Congress outlined a framework for comprehensive water quality management which applied to groundwater as well as to surface waters.

a. Clean Water Act

Water quality is the responsibility of the United States Environmental Protection Agency (EPA) in coordination with the appropriate State Agency, in this case the Michigan Department of Natural Resources (DNR). However, the Clean Water Act instructed all Federal agencies to safeguard water quality standards in carrying out their respective missions. As the lead agency, EPA coordinates the national effort, sets standards, and reviews the work of other agencies. In the case of the Soil Conservation Service (SCS), these new responsibilities may be in addition to, or may dovetail with SCS programs to reduce soil erosion, or to construct headwaters impoundments for flood control.

In delineating the responsibilities of the various levels of government for water quality, Congress recognized the rights of the States with regard to their waters. It authorized funding for State in development of plans for control of pollution, and State water quality standards (which may be more restrictive than Federal standards), plus research. If a state meets certain criteria, it is certified by EPA as the entity responsible for administration of the activity in question. The EPA may deny certification, and it retains power of enforcement of established standards, State or Federal. The State of Michigan is one of the states which has been granted certification by EPA.

Among the goals and deadlines set in the Clean Water Act are these:

> "it is the national goal that the discharge of pollutants into the navigable waters be eliminated by 1985...
>
> an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water [is to] be achieved by July 1, 1983".

The legislation requires that publicly owned treatment works discharging effluent to surface waters must at least provide secondary treatment, i.e., biological oxidation of organic wastes. Municipalities must provide the "best practicable technology" by 1983 and that in appraising their options localities must address both the control of all major sources of stream pollution (including combined sewer overflows and agricultural, street and other surface runoff) and the cost effectiveness of various control measures. The use of alternative and innovative technologies must also be considered.

The key provisions on water quality planning stipulate that to receive aid a State must provide a continuing planning process. Part of Section 208 requires the State to inventory all the sources of pollution of surface and ground waters, both point* and non-point*, and to establish priorities for the correction of substantial water quality problems within a given area. The 208 plans are intended to provide an areawide and, taken together, a statewide, framework for the more local decisions on treatment facilities.

Section 201 of the Act (under which the Crooked/Pickerel Lakes area application for funds was made) authorizes EPA to make grants to localities toward the improvement or construction of facilities for treatment of existing water quality problems. EPA may determine whether an Environmental Impact Statement is required on a proposed project (see Section I.B). Where the State has been certified and assumes responsibility for water quality, EPA retains authority to approve or reject applications for construction funds for treatment facilities.

Local political jurisdiction, traditionally responsible for meeting the wastewater treatment needs of the community, now have the benefit of Federal and State assistance in meeting water quality standards and goals.

b. Federal Agency Responsibilities for Study Area Waters

The following Federal agencies are responsible for ensuring the maintenance of water quality in the Study Area:

- EPA:

  Administers the Clean Water Act;

  Sets Federal water quality standards;

- EPA Region V:

  Administers the grant program described above for the Great Lakes Region;

  Provides partial funding for preparation of the Springvale Bear Creek Area Segment Facility Plan. Region V's general and specific respon sibilities in the construction grant program are discussed in Section I.B;

- US Army Corps of Engineers:

  Grants or device permits required for dredging, filling and construction activities in navigable waters, their 100-year floodplains and adjacent wetlands;

- US Department of Agriculture:

  Under the Rural Clean Water Program will provide cost sharing for soil conservation practices designed to improve water quality. (This program will probably be assigned to SCS; haowever, it has not yet been funded;

- Soil Conservation Service (SCS):

  Agency's mission is to control wind and water erosion, to sustain the soil resource base and to reduce deposition of soil and related pollutions into the water system;

  Conducts soil surveys. Drew up guidelines for inventorying prime or unique agricultural lands;

  Works with farmers and other land users on erosion and sedimentation problems;

  Gathers information at the county level as part of program of study and research to determine new methods of eliminating pollution from agricultural sources;

- Fish and Wildlife Service:

  Provides technical assistance in development of 208 plans;

- US Geological Survey:

  Has in the past monitored surface water flows in the Study Area but does not do so at present.

c. State Responsibilities in the Crooked/Pickerel Lakes Study Area

The following Michigan laws affect water quality management in the Study Area:

- Environmental Protection Act (P.A. 127 of 1970). Provides for legal action by the Attorney General or any person or legal entity for protection of the air, water, and other natural resources and the public trust therein;

- Natural Rivers Act of 1970 (P.A. 231 of 1972). Protects the public trust in Michigan inland lakes and streams and protects riparian rights. Is implemented at the State level. For a discussion of pertinent provisions, see Section II.E.4;

- Soil Erosion and Sedimentation Control Act (P.A. 347 of 1972). Provides for control of soil erosion and sedimentation. (See Section II.E.5 for discussion of provisions.) Is administered at the county level. The Soil Conservation district administers the Act in the case of agricultural activities.

The following State agencies are responsible for water quality management in Michigan:

- Department of Natural Resources (DNR):

  Is responsible for establishing water quality standards for the surface waters of the State appropriate to several classifications, and for regulating discharges of waste that affect (See Appendix B-1 for classification of Study Area streams and lakes and Appendix B-2 for associated water quality standards.);

  Has authority to issue permits to discharge pollutants into surface waters under the National Pollutant Discharge Elimination System (NPDES). The Water Resources Commission, which reports to DNR, sets permissible discharge levels and may approve applications for permits;

  Administers Natural Rivers Act;

  Administers Inland Lakes and Streams Act;

- Northwest Michigan Regional Planning and Development Commission:

  Has prepared a water quality management plan for Michigan's Region X, which includes the Crooked/Pickerel Lakes Study Area, with guidance of EPA and DNR, pursuant to Section 208 of the Clean Water Act;

  "Clean Waters - A Water Management Plan for Northwest Michigan" has been approved by the State, subject to conditions centering around the need for more work. Within Emmet County, Crooked/Pickerel Lakes have been rated first as a "plan of study area" thus defining the area as having degraded water quality that is in need of further study. The Commission was named as Coordinator for Lake Management Activities in the region. It works with lake associations and develops tools to help them assess the problems of their lakes. The Commission plans some groundwater assessment and also some work on non-point sources of nutrients -- agricultural, stormwater, duck feeding, excessive lawn fertilization and on-site systems;

- Michigan Department of Public Health:

  Has authority to regulate on-site sewage disposal systems and makes initial determinations on subdivisions, campgrounds, commercial developments, etc.

d. Local Agencies

The following local agencies regulate water quality in the Study Area:

- Emmet County Health Department:

  Has authority to regulate individual residential on-site waste disposal systems. Has authority delegated by the State Health Department to regulate non-residential on-site disposal systems;

  See Section II.C.3 for discussion of sanitary code applicable in the Study Area;

- Emmet County:

  May enforce Soil Erosion and Sedimentation Control Act for non-agricultural activities.

2. GROUNDWATER

a. Hydrology

Mostly artesian* aquifers are found in the lake plain region stretching from the western part of the Crooked Lake east through Littlefield Township.

The glacial deposits referred to as drift, are loosely consolidated at the surface and succeeded by alternate and discontinuous layers of clay or somewhat consolidated sand and gravel. In many places the sand and gravel layers are porous enough to take in water.

Pickerel Lake. Near Pickerel Lake in Littlefield and Springvale Township, the depth of the first confining clay layer is variable, ranging from about 20 feet - 200 feet (DNR, Department of Public Health 1976-1977). The confining clay layer is an important protective barrier, preventing contamination of well water.

Based on data obtained from the Sanitary Survey (University of Michigan 1978), wells located along the north shore of Pickerel Lake range in depth from 20 feet to 200 feet, averaging 82 feet (University of Michigan 1978). South of Pickerel Lake in Springvale Township, the average well depth for shoreline homes is 100 feet but ranges from 15 feet to 200 feet.

Crooked Lake. Because of the shallow depth to bedrock along the south shore, many of the wells are located in rock. Nevertheless, wells are generally deep, averaging 134 feet and ranging from <20 feet to 220 feet (University of Michigan 1978).

Well yields north of Pickerel Lake in Littlefield Township range from 10-55 gallons per minute (gpm). In Springvale Township yields of 10-25 gpm are typical although up to 65 gpm have been reported (DNR, Department of Public Health 1977).

Yields from wells tapping the bedrock deposits located along the south shore of Crooked Lake are generally lower than from sand and gravel deposits (Leverette 1907).

Some continuity between groundwater and Crooked/Pickerel Lakes is known to occur. Inflowing surface streams of Pickerel Lake are small and the Lake is mostly fed by groundwater seepage. Although groundwater inflow is undoubtedly a significant source of water for Crooked Lake, inflow from Minnehaha Creek and other streams is important as well (Gannon & Mazur 1979).

b. QUALITY

Groundwater quality information for Springvale and Littlefield Townships is very limited. Available information has shown that north of Crooked Lake, in Oden and Conway, well water has traces of iron and sulphates. Well tappings in these aquifers ranged in hardness from 186-201 parts per million (ppm) and showed an average of 156 ppm of carbonates. Chloride concentrations ranged from 1-5 ppm. The groundwater quality is generally suitable for domestic uses although is too hard for certain industrial purposes (Leverette 1907).

The Emmet County District Health Department provided a single partial chemical analysis for Springvale Township and the nearby Townships of Little Traverse and Bear Creek which show low nitrate levels of 0.3, 0.1 and 0.4 milligrams per litre (mg/l), respectively (Department of Public Health 1977). Kerfoot (1978) reported that nitrate levels were quite variable in the interstitial groundwater along the lake shore, but that the highest value observed was only about .016 mg/l. These nitrate levels are well within the 10 mg/l limit established as a Public Health drinking water standard for nitrates.

Ammonia (NH_3-N) has been the dominant nitrogen form in the interstitial groundwater along the lake shores: 0.014 mg/l NH_3-N versus 0.010 mg/l nitrate nitrogen (NO_3-N) (Kerfoot 1978). The dominance of ammonia nitrogen is the result of saturated soils along the shoreline. Under these conditions the sediments are reduced and oxidation to nitrates does not occur. Ammonia is strongly sorbed to soil particles and should not present a hazard to nearby wells.

c. Use

Groundwater supplies water for domestic use for the entire Proposed Service Area. Most homeowners have private wells, although some community wells are located along the north shore of Pickerel Lake and in the Ellsworth Point area along the south shore (University of Michigan 1978).

3. SURFACE WATER HYDROLOGY

Crooked Lake, Pickerel Lake, the Crooked River, Cedar Creek, Minnehaha Creek, and local streams are the major surface water resources located in the Study Area (see Figure II-7). The lakes are the beginning of the Inland Water Route, a series of interconnecting lakes and rivers that eventually empty into Lake Huron through the Cheboygan River. The outflow of Spring, Mud, and Round Lakes via Rock Creek feeds Crooked Lake from the southwest. Minnehaha Creek enters the Lake, from the south. Pickerel Lake which is fed by Cedar Creek, flows into the northern end of Crooked Lake via the Crooked-Pickerel Channel. Water from Pickerel Lake is then discharged into Crooked River. Approximately 39% of the Crooked River flow comes from Pickerel Lake while the rest of the flow is from the Crooked Lake drainage basin proper. The water in the Crooked River eventually reaches Burt Lake.

The outflow of Pickerel Lake is primarily to Crooked Lake via the Crooked-Pickerel Channel, as mentioned above. However, reverse flow can sometimes occur depending on wind and current conditions. This is one rather unique hydrologic characteristic of the Crooked Lake and Pickerel Lake water system.

Physical characteristics pertaining to the hydrology of the surface waters serve to describe and differentiate the lakes and streams in the Study Area. Specific hydrologic and morphologic characteristics of the lake or stream not only form the surface water system in which chemical and other factors operate and interact but are themselves major factors in that interaction. Characteristics such as size of drainage basin, tributary flow, lake volume and hydraulic retention time directly influence the quantity and quality of surface water resources.

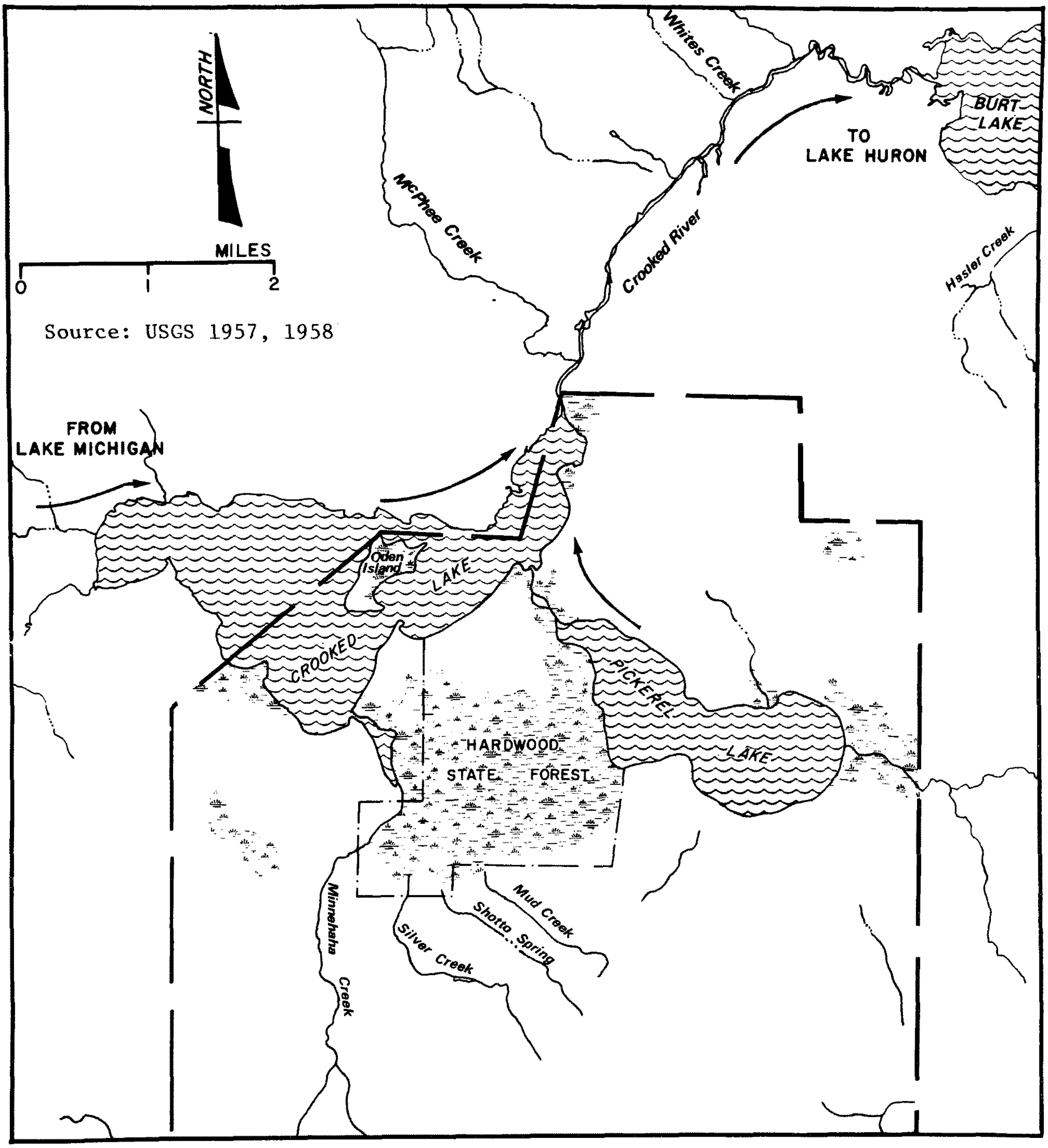


FIGURE II-7 SURFACE WATER HYDROLOGY OF THE CROOKED/PICKEREL STUDY AREA

LEGEND

WETLANDS

FLOW DIRECTION

a. Size of Drainage Basins

Pickerel Lake's drainage basin (34,150 ac. 13,660 ha) is larger than Crooked Lake's immediate drainage (29,750 ac. 11,900 ha). However, the waters in Spring, Mud, Round and Pickerel Lakes all flow into Crooked Lake. This means that Crooked Lake's total watershed consists of a much larger area (62,925 ac. 25,170 ha), encompassing its immediate watershed and drainages of these lakes. Watershed boundaries of Crooked/Pickerel Lakes are shown in Figure II-8.

b. Tributary Flow

Minnehaha Creek, Cedar Creek, Fish Hatchery Creek, and Round Lake Creek are the major tributaries in the watershed. The average flow in these streams during water year 1975 can be summarized as follows (Gannon and Mazur 1979): Minnehaha Creek (1.0 cms/35.5 cfs), Cedar Creek (0.52 cms/18.5 cfs), Fish Hatchery Creek (0.27 cms/9.5 cfs), and Round Lake Creek (0.18 cms/6.4 cfs). Outflow from the Crooked/Pickerel Lakes watersheds into the Crooked River is 4.0 cms/142 cfs (Gannon and Mazur 1979).

c. Lake Hydraulic Retention Time

Assuming complete mixing, the retention time of a lake is the time required for natural processes to replace the entire volume of its water. It is calculated by dividing the average lake volume by the total inflow. In most cases, the tributary flow represents a significant portion of the inflow and is used in the calculation. As a result, the hydraulic retention times of Crooked Lake and Pickerel Lake are 4.7 months and 4.2 months, respectively, during the water year 1975 (Gannon 1978). That is, on the average, the lake water in both lakes will be replaced almost 3 times a year.

Table II-4 presents the drainage basin size, tributary flow, lake hydraulic retention time along with other physical characteristics of Crooked/Pickerel Lakes.

4. SURFACE WATER USE AND CLASSIFICATION

Crooked Lake and Pickerel Lake are considered recreational lakes with surface waters classified for Total Body Contact. The state of Michigan has classified its surface water resources, assigning appropriate uses for each. State water quality standards have been established to protect public health and to preserve the quality of the several water bodies for their designated uses. State water quality classifications are listed in Appendix B-1. Water quality standards listing these classifications and uses appear in Appendix B-2.

5. SURFACE WATER QUALITY

The water quality of Crooked/Pickerel Lakes will be considered herein the following order: nutrient budget, open water quality, lake trophic condition, and shoreline conditions. The discussion represents a comprehensive synthesis of the available data and information on the

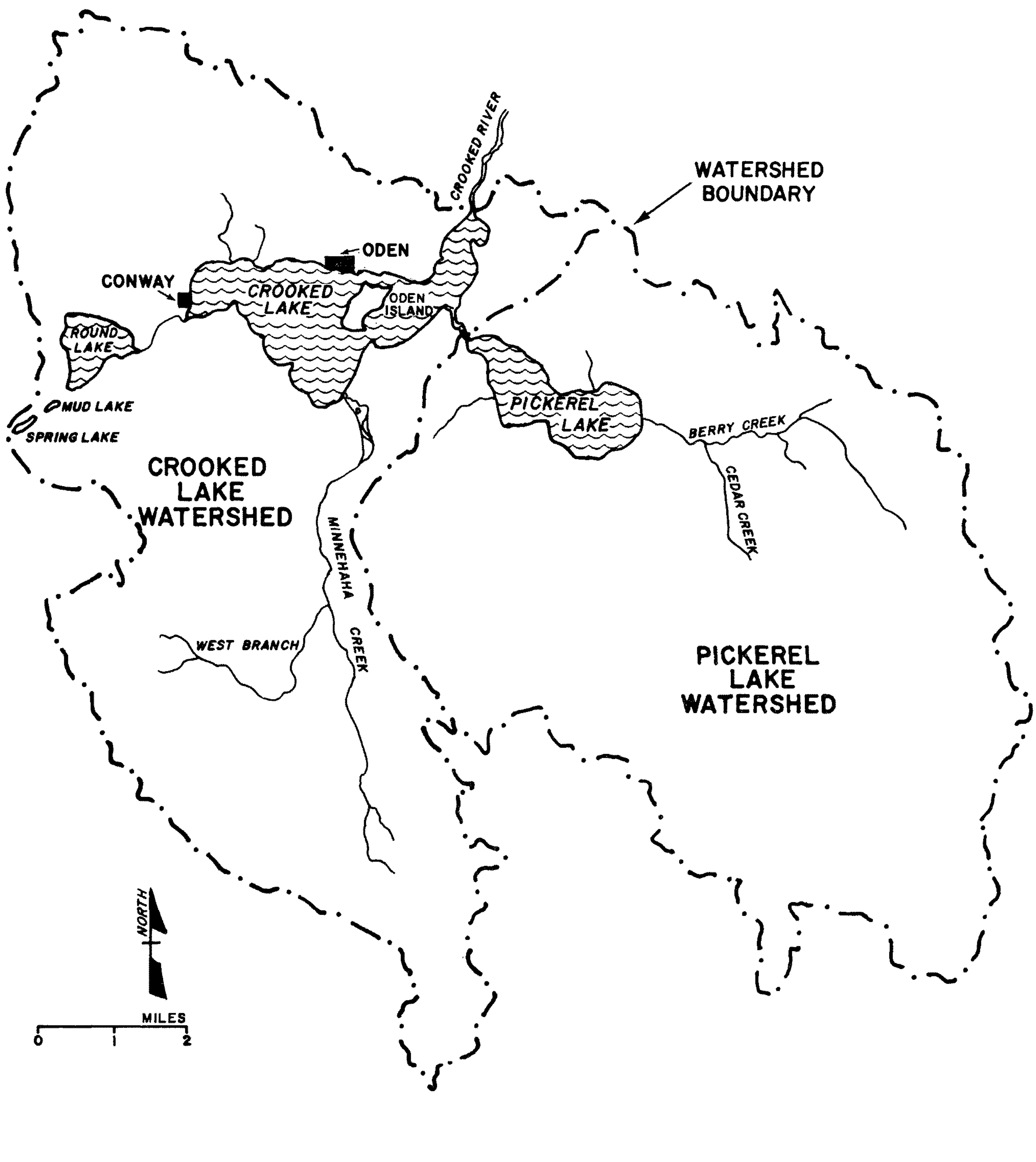


FIGURE II-8 WATERSHEDS OF CROOKED LAKE AND PICKEREL LAKE

Table II-4

PHYSICAL CHARACTERISTICS OF
CROOKED LAKE AND PICKEREL LAKE,
EMMET COUNTY, MICHIGAN

Parameter	Unit	Crooked Lake	Pickerel Lake
Lake Surface Area	Acres	2,371	1,055
Mean Depth	Ft (m)	9.8 (3.0)	12.8 (3.9)
Maximum Depth	Ft (m)	61 (18.6)	69.8 (21.3)
Volume	Ft^3 (m^3)	1,040 x 10^6(29.5 x 10^6)	605 x 10^6(17.2 x 10^6)
Drainage Area	Acres	27,649	33,750
Inflowing Streams			
Minnehaha Creek	cfs (cms)	35.5 (1.0)	
Fish Hatchery Creek		9.5 (0.27)	
Round Lake		6.4 (0.18)	
Cedar Creek			10.5 (0.52)
Outflowing Streams	cfs (cms)		
Crooked River		142 (3.99)	
Pickerel/Crooked Channel			55.6 (1.56)
Water Retention Time	Months	4.7	4.2

water quality of Crooked/Pickerel Lakes. Most of the information presented is summarized from two recent studies on the lake by Gannon and Mazur (1979) and Kerfoot (1979).

a. Nutrient Budget

Nutrient budgets for Crooked Lake and Pickerel Lake were derived from the studies by Gannon and Mazur (1979) and Kerfoot (1978). Table II-5 shows the budgets for total phosphorus and nitrogen using data from these studies. Gannon and Mazur's estimates were based on the surveys conducted in 1975 and 1976. Since then a sewer was installed to service dwellings on the north shore of Crooked Lake in the fall of 1976. In addition, Oden Fish Hatchery changed its fish culture operation to reduce nutrient loading to Crooked Lake. Gannon and Mazur (1979) estimated these changes would reduce the nutrient inputs from the fish hatchery and septic systems by a factor of three. The ban on phosphates in detergents went into effect in Michigan on October 1, 1977. Gannon and Mazur (1979) estimated that the ban would reduce phosphorus inputs to septic systems by 34%. The above events were incorporated into Table II-5 to represent the 1977 conditions.

As indicated, the non-point sources contribute a significant amount of nutrients into these two lakes. In contrast, the septic tanks only contribute a small portion of the nutrient into the lakes. The amount of phosphorus leaving the lakes via the outlets was calculated based on the hydraulic flushing rates of the lakes for the use of assessing the trophic status of the lakes. The output from Pickerel Lake at the Crooked/Pickerel Channel were not incorporated as the input to Crooked Lake due to the fact that flow from this channel is immediately flushed out of Crooked Lake into the Crooked River. As a result, this is not considered as a nutrient source for Crooked Lake.

b. Lake Water Quality (Open Water)

In 1974-76 water quality was surveyed by Gannon and Mazur (1979). Data were collected in the open water (offshore) areas of Crooked Lake and Pickerel Lake. Parameters of significance to the interpretation of lake water quality are total phosphorus, chlorophyll *a*, Secchi disc depth, hypolimnetic dissolved oxygen, alkalinity, and specific conductance. Analysis of these parameters has revealed water quality similarities as well as differences between Crooked Lake and Pickerel Lake. Results from these investigations are summarized in Tables II-6 and II-7. Seasonal variation of these parameters is plotted and presented in Appendix B-3.

In some respects, Crooked Lake and Pickerel Lake are similar in water quality characteristics. Both lakes are alkaline or hard water with high levels of specific conductance. Total phosphorus concentrations have occurred in low to moderate levels in water samples taken at the sampling stations in both lakes. Common to each lake is relatively low algal productivity, as measured by chlorophyll *a*; this level of vegetative growth reflects low nutrient concentrations and high lake water alkalinity. Corresponding with lower productivity have been transparent waters with low turbidity at the surface and high Secchi

Table II-5

PHOSPHORUS AND NITROGEN BUDGETS FOR CROOKED LAKE AND PICKEREL LAKE IN 1977--GANNON AND MAZUR (1979)

CROOKED LAKE*

	PHOSPHORUS		NITROGEN	
1. Inputs	KG/YR	%	KG/YR	%
Non-Point Sources (Tributaries)	1,135.3	71.9	47,942.7	82.1
Precipitation	321.7	20.4	7,973.3	13.7
Fish Hatchery	101.3	6.4	1,685.3	2.9
Septic Tanks	20.6	1.3	785.7	1.3
Total	1,579.3	100	58,387.0	100
2. Outputs				
Crooked River	710.7	45		
3. Retention	868.6	55		

PICKEREL LAKE

	PHOSPHORUS		NITROGEN	
1. Inputs	KG/YR	%	KG/YR	%
Non-Point Sources (Tributaries)	1,228.7	88.1	55,837.5	93.3
Precipitation	143.2	10.3	3,548.4	5.9
Septic Tanks	22.2	1.6	494.2	0.8
Total	1,394.1	100	59,880.1	100
2. Outputs				
Crooked/Pickerel Channel	655.2	47		
3. Retention	738.9	53		

*Reflecting the nutrient loading reduction by sewering the north shore of Crooked Lake and additional treatment of the Fish Hatchery Waste in 1977.

Table II-6

COLOR, LIGHT, AND DISSOLVED OXYGEN (D.O.) CHARACTERISTICS OF CROOKED LAKE AND PICKEREL LAKE, EMMET COUNTY, MICHIGAN. DATA FROM CENTRAL DEEP STATIONS.

Lake	Color (pt-co)	Secchi Disc Yearly Range (m)	1% T* Summer (m)	Near Bottom D.O. Summer (mg/1)	Near Bottom D.O. Winter (mg/1)
Crooked Lake	10	2.0-5.0	8.8	0	7.3
Pickerel Lake	20	2.5-6.0	8.5	0.1	6.8

*Depth of light penetration of 1% of surface illuminations.

Table II-7

CHEMICAL AND CHLOROPHYLL a FEATURES OF CROOKED LAKE AND PICKEREL LAKE AT DEEP CENTRAL STATIONS DURING SUMMER AND WINTER.*

	Crooked Lake		Pickerel Lake	
Variable	Summer	Winter	Summer	Winter
T.A. (mg/l)	141.0	158.6	136.4	163.8
Sp. Cond. (μmhos/cm)	289.5	314.9	285.0	326.1
pH	8.4	8.1	8.4	8.0
S-PO_4 (μg/l)	4.0	7.0	5.9	4.0
T-PO_4 (μg/l)	11.9	11.3	9.8	18.3
NO_3-N (μg/l)	44.2	356.5	62.1	320.0
NH_3-N (μg/l)	20.1	40.3	18.0	44.3
SiO_2 (μg/l)	2,578.8	3,475.8	2,665.3	3,686.8
CI (mg/l)	12.5**	2.5	10.9**	3.7
Ca (mg/l)	38.7	42.2	38.4	48.9
Mg (mg/l)	13.9	12.7	13.4	13.1
K (mg/l)	0.8	0.8	0.7	0.9
Na (mg/l)	2.1	2.2	2.2	2.5
Chl. a (μg/l)	3.3**	2.0	2.8**	0.7

*Data are means for the euphotic zone (>1% light transmittance) in Summer, 1972 and 1974 and Winter 1974 and 1975 except where otherwise indicated. T.A. is total alkalinity as $CaCO_3$ and Sp. Cond. is specific conductance corrected to 25C.

**1974 data only.

disc depth readings. In the summertime Crooked/Pickerel Lakes have shown low dissolved oxygen concentrations in the deeper lake strata.

In comparison, Pickerel Lake has exhibited slightly better water quality than Crooked Lake. Summer total phosphorus concentrations in the open waters have been slightly higher in Crooked Lake. Consequently, algal growth has been more significant and Secchi disc transparency can be read only at shallower depths. Maximum chlorophyll a concentrations were reported to be 8.9 μg/l in Crooked Lake (Fall, 1974) and only 4.2 μg/l in Pickerel Lake (Spring, 1974) by Gannon and Mazur (1979). Gannon and Mazur (1979) also observed that the lower lake strata of Crooked Lake were more depleted of dissolved oxygen than Pickerel Lake. (See Appendix B-4 for the complete Gannon and Mazur report.)

c. Trophic Conditions

It is apparent from water quality investigations that Crooked Lake and Pickerel Lake exhibit relatively good water quality. Having analyzed summer Secchi disc, total phosphorus, and chlorophyll a data, Gannon and Mazur (1979) concluded that both lakes border between oligotrophy and mesotrophy, with Crooked Lake somewhat more mesotrophic than Pickerel Lake.

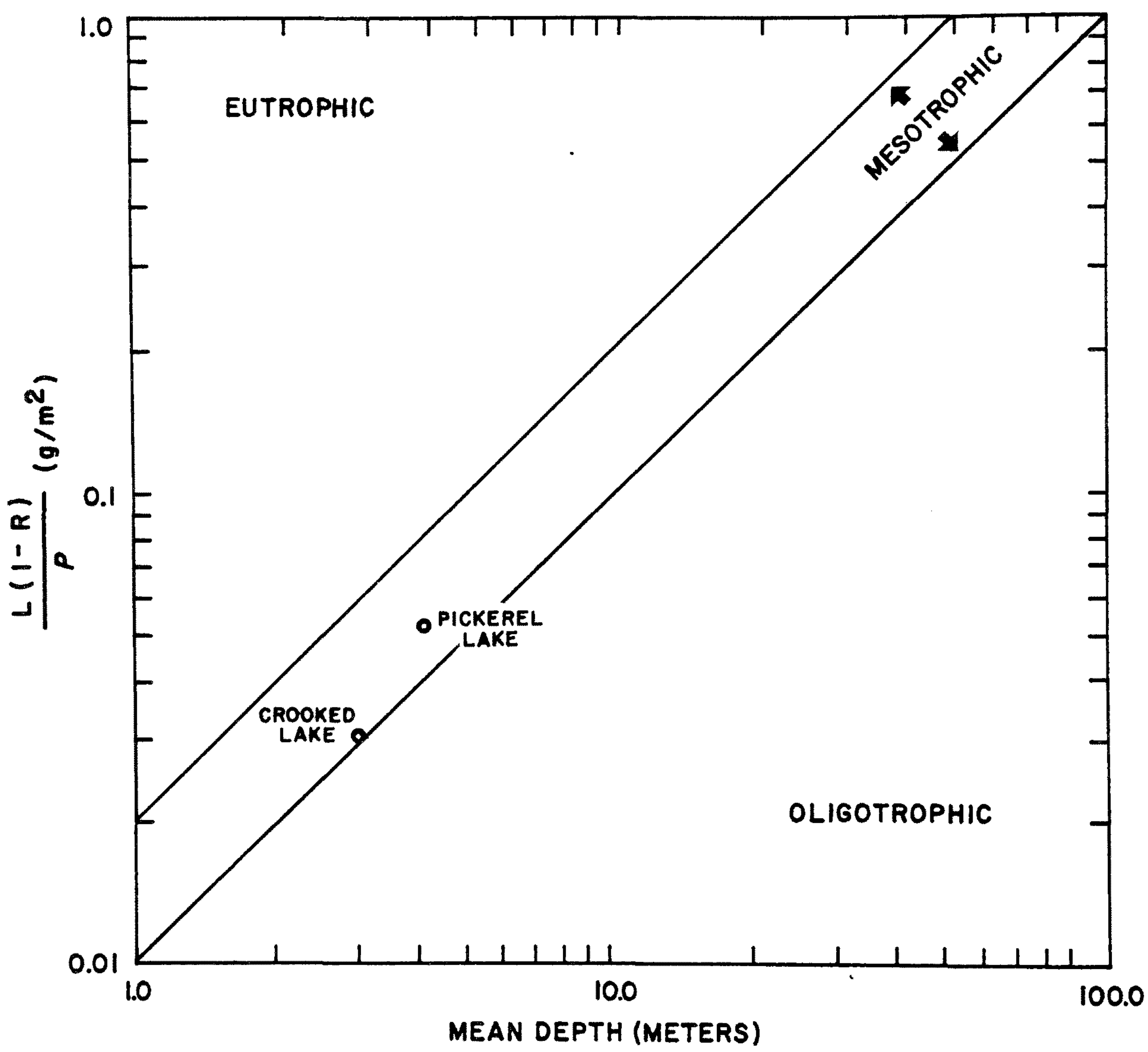
An evaluation of the relationship between phosphorus inputs and the resulting water quality is needed to predict trophic responses which would result from phosphorus loading scenarios associated with various wastewater management alternatives. A detailed description of the procedures required to examine these relationships using Dillon's computer model (1975) is presented in Appendix B-5. By applying Dillon's model to the lakes, it was demonstrated that the analysis by Gannon and Mazur is comparable to the model results (see Figure II-9). The model shows that Pickerel Lake is currently oligo-mesotrophic, while Crooked Lake is mesotrophic. comparable to the model results (see Figure II-9). The model shows that Pickerel Lake is currently oligo-mesotrophic, while Crooked Lake is mesotrophic.

d. Bacterial Contamination in Shoreline Area

Gannon and Mazur (1979) surveyed fecal coliforms in the nearshore and offshore areas of Crooked/Pickerel Lakes (July 1975). Results indicated insignificant bacterial contamination, except for one station in Crooked Lake near Conway which registered 1600 colonies/ 100 ml.

6. FLOOD HAZARD AREAS

The Department of Housing and Urban Development is responsible for mapping the 100 year floodplain for the purposes of the Flood Insurance Program. However, floodplain maps are not currently available through HUD or the USGS for the Study Area.



L= AREAL PHOSPHORUS INPUT ($g/m^2/yr$)
R= PHOSPHORUS RETENTION COEFFICIENT
P= HYDRAULIC FLUSHING RATE (yr^{-1})

FIGURE II-9 TROPHIC STATUS OF CROOKED LAKE AND PICKEREL LAKE BASED ON 1975-1976 DATA

C. EXISTING SYSTEMS

All of the existing development within the Study Area is served by on-site wastewater treatment systems. At the time that the Facility Plan was drafted, very limited information was available on the existing on-site systems in the Crooked/ Pickerel Lakes Service Area. It was known with certainty that many of the existing systems were constructed on sites with severe limitations resulting from high groundwater levels and poor soils permeability. However, the extent to which these limitations pose a threat to public health or to water quality was not known.

A number of studies were recently undertaken by EPA to determine the extent of these problems. The results of these studies, discussed in this section, are intended to identify problems with existing systems and to help provide a basis for evaluating a range of solutions for meeting wastewater treatment needs.

1. SUMMARY OF EXISTING DATA

Studies recently undertaken by EPA to evaluate existing Lakeshore systems and problems resulting from these systems include:

a. "Investigation of Septic Leachate Discharges into Crooked and Pickerel Lakes, Michigan" (Kerfoot, 1978)

This study was undertaken on November 18 to 23, 1978 to determine whether groundwater plumes from nearby septic tanks were emerging along the lakeshore and causing elevated concentrations of nutrients. Septic leachate plumes were detected with an instrument referred to as the "Septic Snooper." This instrument is equipped with analyzers to detect both organics and inorganics from domestic wastewater. This device was towed along the lakes and holes were drilled in ice covered areas to obtain a profile of septic leachate plumes discharging to surface waters. A total of 51 planes were observed along the southern shore of Crooked Lake and the Pickerel Lake shoreline. Areas with high numbers of plumes were found in the Pickerel Lake vicinity.

b. "Sanitary Systems of Crooked and Pickerel Lakes, Emmet County, Michigan: An On-Site Survey" (University of Michigan, 1978)

An on-site sanitary survey of the Crooked/Pickerel Lakes area was conducted during the period of August 29 through September 8, 1978. The survey provided information regarding the types of decentralized systems, the nature and extent of non-compliance with the Emmet County Sanitary Code and the nature and extent of problems with these systems. The Sanitary Survey is included in Appendix B-7.

The results of this survey indicated that more than 90% of the existing on-shore systems have been constructed on sites with severe site limitations (as defined by SCS). Several systems are also in violation of the existing code with respect to setback distances and undersized septic tanks.

These violations vary along different lakeshore areas. Only 9% of the existing lakeshore systems experience recurrent problem with backups and ponding. Cladophora growth was found associated with about 50% of the homes with suitable substrate*. Cladophora is a filamentous green algae which is commonly found where there is a continuous source of nutrients and suitable substrate for attached growth.

c. EPIC Survey (EPA, 1978)

An aerial photographic survey was conducted by EPA's Environmental Photographic Interpretation Center (EPIC) to determine the location of surface malfunctions within the Study Area. This survey was conducted on August 21, 1978. Figure II-10 shows the results of the survey. Surface malfunctions were not found to be widespread; 8 failing or marginally failing systems were observed in the Proposed Service Area.

2. TYPES OF SYSTEMS

Based on data obtained during the Sanitary Survey (University of Michigan, 1978) and summarized in Table II-8, 67% of the lakeshore residences have septic tanks accompanied by a drainfield. Septic tanks accompanied by a drywell, as well as a drainfield are also prevalent (14%). This type of system is widely used along the south shore of Pickerel Lake. Both drainfields and drywells provide final treatment of septic tank effluent by filtering out solids and bacteria and by adsorbing phosphorus. Drainfields generally perform a more adequate job of treating septic tank effluent.

In order to provide suitable treatment of wastewater in those areas with severe site limitations, 5% of the residences have elevated sand mound systems and 4% have cluster systems. Seven percent of the residences have no septic tank at all and are served only by pit privies or drywells. Pit privies are found mainly along the south shore of Crooked Lake (University of Michigan, 1978).

The Emmet County Sanitary Code was issued in the spring of 1968. The code requires issuance of a permit before design and construction of a sewage disposal system may proceed. However, issuance of permits did not come into full effect until 1971. The Health Department has rejected about 30 applications for a permit in the Study Area since 1971 and has issued more than twice the number of preliminary denials in the form of property evaluation reports. About 40 permits for repairs have been issued by the Health Department for the Study Area (By letter, William Henne, Sanitarian, December 1978). Under the Emmet County Sanitary Code, the health officer may reject an application for a permit on the following bases:

- The property to be served lacks sufficient area for proper isolation from existing water wells or surface waters (minimum of 50 feet);

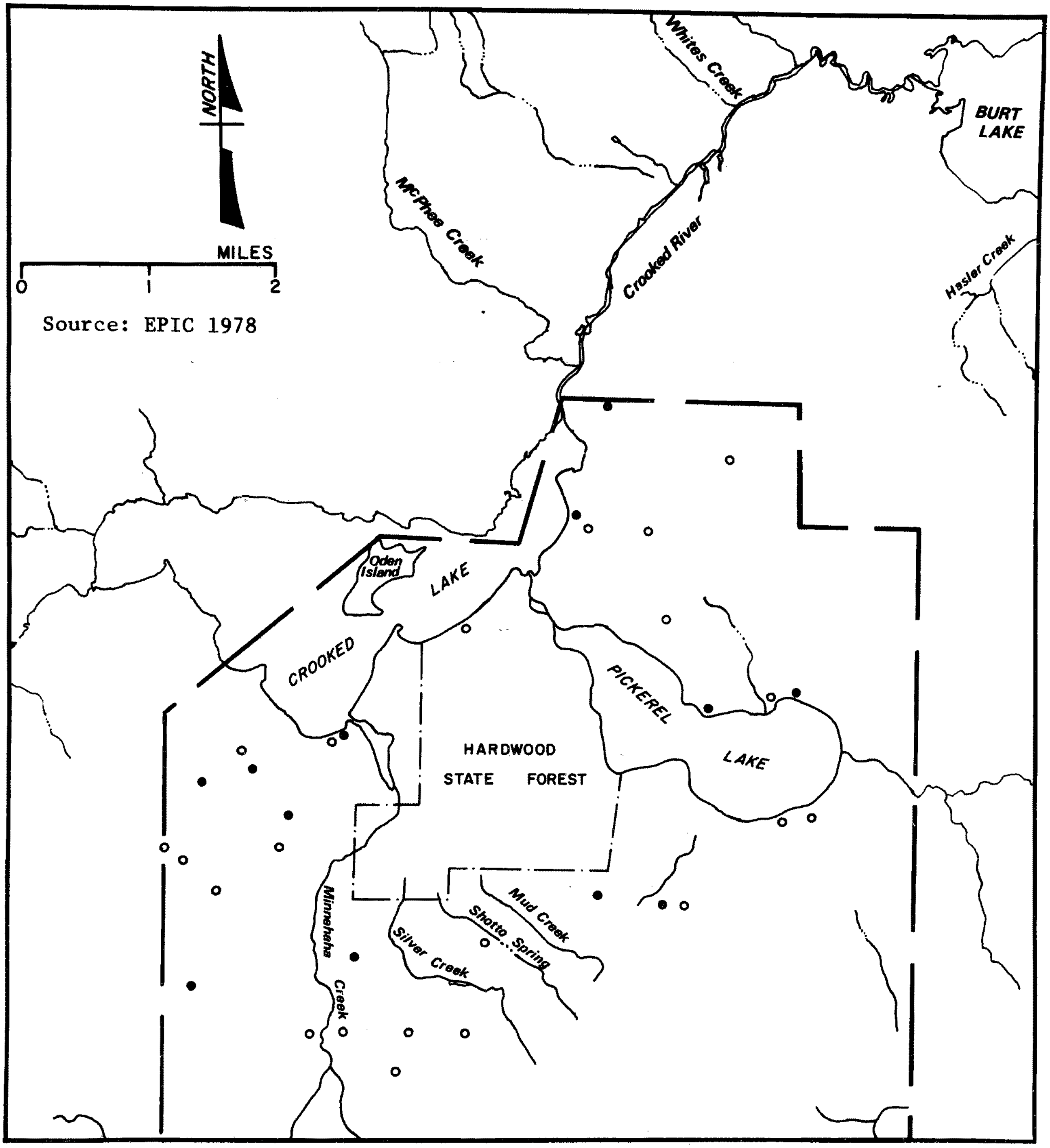


FIGURE II-10 LOCATION OF SURFACE MALFUNCTIONS DETECTED BY AERIAL PHOTOGRAPHIC SURVEY, 1978

LEGEND

o MARGINALLY FAILING

● FAILING

Table II-8

DISTRIBUTION OF ON-SITE TREATMENT SYSTEMS
(Based on Systems Surveyed)

Location	Total # of Systems	Septic Tanks & Drainfield	Septic Tank Drainfield & Drywell	Septic Tank & Mound	Septic Tank & Leachfield	Pit Privy	Cluster	Drywell Only	Septic Tank & Drywell	Unknown
<u>Crooked Lake</u> South Shore	47	35 1+	2	2	1	4 1*	0	1	0	1
Oden Island	16	14	0	2	0	0	0	0	0	0
Ellsworth Pt. Artesian Rd. Trails End	48	25	15	2	0	1*	2	1	1	1
<u>Pickerel Lake</u> Boltsford Landing	26	16 1+	3	1	0	0	0	1	2	2
<u>Pickerel Lake</u> North Shore	35	23	3	2	0	2	4	0	1	0
TOTAL	172	115	23	9	1	8	6	3	4	3

+ Fed by dosing rather than by gravity feed

* Accompanied by drywell

<u>Source</u>: Sanitary Systems of Crooked and Pickerel Lakes. Univ. of Mich., 1978.

- The percolation rate is less than 30 minutes/inch;

- The maximum groundwater level is less than 6 feet from ground surface or in the case of property adjoining lakes, lagoons, or rivers the finish grade is 6 feet above the high water mark; and/or

- Where an impervious stratum is found within 6 feet of the ground surface.

The specifications for minimum design criteria under the code are shown in Appendix B-8.

3. STATUS OF EXISTING SYSTEMS

Since many of the on-site systems were in existence prior to enforcement of the Sanitary Code in 1971 and because of severe site limitations throughout much of the Study Area, some of the existing systems are known to be out of compliance with the Sanitary Code. The Sanitary Survey (University of Michigan, 1978) investigated the frequency of these violations and a summary of these data is presented in Table II-9. The data indicate that a substantial number of existing systems are in violation of the code and that the type and frequency of violations vary depending upon the shoreline area. The residences on Oden Island are exceptional in having few violations of the code; Oden Island property owners have an active association and good septic system maintenance records (University of Michigan, 1978). Major violations of the code include:

- Lake setback distance. With the exception of Oden Island about 20% of the lakeshore systems violate the standard for set back distance from the lake. The setback distance is intended to minimize leaching of nutrients from systems to lake surface water.

- Well setback. A well setback distance of 50 feet is intended to provide adequate separation distance for removal of bacteria and nutrients from water which percolates into the well. Oden Island and part of Ellsworth Point (Ellsworth Road and Rupp Road) generally comply with this standard. Most of the violations of the well setback distance are found on sites along the south shore of Pickerel Lake; 50% of the systems surveyed in the area of Artesian Road and Trails End and 30% of the systems surveyed in the area of Botsford's Landing violate the well setback standard.

- Septic Tank Size. Undersized septic tanks can lead to several problems including house backups and poor solids removal. Poor solids removal may lead to clogging of the soil absorption system, causing surface ponding. Survey data indicate that septic tanks along part of Ellsworth Point (Ellsworth Road and Rupp Road) and on Oden Island are adequately sized. In contrast, 50% of the systems near Botsford's Landing, 30%

Table II-9

VIOLATIONS OF SANITARY CODE
(Based on number of homes surveyed)*

	Less than 50 Feet to Lake	Less than 50 Feet to Well	Septic Tank too Small	Site Limitation Depth to Groundwater; Less than	Site Limitation Permeability Less than 30 min./in.
South Shore Crooked Lake	8 (18%)	11 (25%)	5 (18%)	47 (100%)	43 (91%)
Oden Island	1 (7%)	0 (0%)	0 (0%)	16 (100%)	8+ (50%) maximum
Artesian Road Trails End	9 (24%)	18 (50%)	9 (35%)	29 (76%)	29 (76%)
Ellsworth Road Rupp Road	2 (22%)	1 (10%)	0 (0%)	10 (100%)	9 (90%)
Botsford Landing Camp Petosega	5 (20%)	6 (30%)	11 (50%)	16 (62%)	0 (0%)
Pickerel Lake North Shore	8 (23%)	4 (12%)	7 (30%)	35 (100%)	20 (57%)

* In several instances, information regarding violations was not known.

+ Soils are highly variable

Source: Sanitary Systems of Crooked and Pickerel Lakes, Emmet Co., Univ. of Mich., 1978.
Suitability of Soils for On-Site Waste Disposal, Pickerel and Crooked Lakes, Emmet Co., Mich., A. Gold and J. Gannon, 1978.

of the systems along the north shore of Pickerel Lake and 35% of the systems along Artesian Road and Trails End are undersized.

- Site limitation. In general the soils around Crooked/Pickerel Lakes are not well suited for on-site systems. As Figure II-4 indicates, the areas with suitable soils are along Botsford's Landing (Segment 14) and part of Ellsworth Point (Segment 16). (A segments map is included in Chapter IV.) Based on survey data provided by Gold and Gannon (1979) there are 30 homes located on suitable soils for on-site systems. All other lakeshore sites violate the Sanitary Code with respect to soils permeability and/or depth to groundwater. Soil absorption systems do not function properly under these conditions. Regardless of the size of the drainfield, 78% of the systems are in violation of the code as a result of severe site limitation. This percentage assumes that the few existing elevated sand mound systems have overcome site limitation and do comply with the eixsting code.

a. Public Health Problems Caused by Existing Systems

Generally unsuitable site conditions and numerous violations of the Sanitary Code have led to the question of whether existing systems along the lakeshore are causing public health or water quality problems. The distinction should be made between water quality and public health problems on the one hand and nuisance or community improvement problems on the other hand. On-site systems known to contribute to violations of water quality standards or changes in lake trophic status pose water quality problems. Public health problems may result from recurrent backups, ponding of effluent on the soils' surface or contamination of the groundwater supply in excess of the drinking water standards.

Backups/Ponding. Despite severe soils limitations and numerous violations of the Sanitary Code, relatively few systems pose public health problems based on sanitary survey data. Appendix B-9 summarizes the types and extent of problems associated with existing systems. Although 17% of the systems surveyed have experienced backups or ponding of effluent, the problems are recurrent with only about half of these systems. In several instances pumping of a poorly maintained system or replacement of an old drainfield has alleviated the problem. Systems with recurring problems with backups and ponding are few in number and are located mainly in that part of Ellsworth Point where a high seasonal groundwater level exists. Other areas where a small number of on-site systems have frequent problems with ponding and backups include the South Shore of Crooked Lake, segment 4 of Channel Road, and the Northwestern most part of Crooked Lake (Lakeview/Burley Road). Soils are unsuitable in all three locations. However, it is noteworthy that only half of 14 problem systems have been maintained properly and at least 6 systems have undersized septic tanks. Consequently, severe site limitations are not necessarily the cause of these problems.

The EPIC aerial photography (EPIC 1977) was also used to survey Study Area for surface malfunctions. This survey detected two marginally failing systems and one currently failing system along the south shore of Crooked Lake (Channel Road). Along the north shore of Pickerel Lake, two failing and one marginally failing systems were observed. Two marginally failing systems were also detected in the area of Botsford Landing.

Groundwater Contamination. There is no documented evidence of contamination of drinking water aquifers by on-site systems. As discussed in Section II.B.2 the Health Department has reported low groundwater nitrate levels in the limited number of samples analyzed. Most of the wells located along the Crooked Lake shoreline are deep and a protective clay overburden should prevent contamination of the drinking water supply. In the area of Ellsworth Point and Botsford's Landing some shallow wells are found (less than 25 feet). However, the average well depth exceeds 80 feet and no evidence exists for contamination of groundwater (see Section II.B.2).

b. Water Quality Problems

Nutrient budgets prepared for Crooked/Pickerel Lakes indicate that on-site systems contribute a small percentage of the total nutrient loads to Crooked/Pickerel Lakes and that water quality is not being significantly degraded by septic tank leachate (see Section II.B.1). Prior to enforcement of the phosphorus ban in 1977, septic tanks were estimated to contribute 9.4% of the total phosphorus load to Crooked Lake and 4.0% of the total load to Pickerel Lake. It was estimated that the phosphorus loads from septic tanks were reduced nearly 3 fold by enforcing the phosphorus ban (Gold and Gannon 1979). Based on Kerfoot's (1978) analysis of nutrient concentrations in septic leachate plumes, the contribution from on-site systems is significantly less than Gold and Gannon had estimated. Even assuming the worst case septic tanks are not contributing significantly to water quality degradation in terms of nutrient load. Similarly, there is no evidence that on-site systems are discharging significant bacterial loads. Both Gannon and Mazur (1979) and Kerfoot (1978) reported low counts of fecal coliform. Only one sampling station, near Conway, had high bacterial counts (1,600 colonies/100ml) (Gannon and Mazur 1979).

c. Other Problems

Some residents have experienced other problems related to on-site systems which do not pose a potential health threat or the potential for water quality degradation. Odors from on-site systems may be a nuisance to residents but they are not a health hazard. Only 9 residents or 5% of the total surveyed reported odors associated with their septic tanks.

Shoreline *Cladophora* growth may also be a nuisance since it is unsightly and interferes with some recreational activities (see Section II.D). *Cladophora* growth was associated with 54% of the residences with suitable substrate. All of the homes surveyed along Crooked Lake had suitable solid substrate for *Cladophora*, whereas only 46% of the sites along Pickerel Lake had suitable substrate. Heaviest growth was observed along Channel Road (segments 3-6) on the southeast shore of Crooked Lake and Ellsworth Point along the south shore of Pickerel Lake.

Kerfoot (1978) reported that Cladophora growth approach carpet-like thickness along segment 16 in Ellsworth Point. No information is available on the density of Cladophora growth along other lakeshore areas. However, Gannon and Mazur did not find filamentous blue-green algae to be a dominant species along most of the lakeshore. Limited groundwater samples taken in this area showed locally elevated soluble phosphorus levels of 0.088 mg/l (PO_4-P). Groundwater transport of phosphorus via subsurface plumes from individual septic units probably supplies sufficient nutrient loads to sustain Cladophora growth in areas with suitable solid substrate.

D. BIOTIC RESOURCES

1. AQUATIC BIOLOGY

Qualitative observations made by Gannon and Mazur (1979) on the biotic resources of Crooked and Pickerel Lakes indicate that both lakes have good water quality.

Aquatic Vegetation. A 1978 water quality report on Crooked/ Pickerel Lakes indicated that filamentous blue-green algae are present in both lakes, although they rarely form a predominant component of the algal community (Gannon & Mazur 1979). Although blooms of blue-green algae are often associated with high organic loads, sparsely distributed blooms such as those observed in Crooked/Pickerel Lakes are frequently found even in clean waters. Algal blooms, consisting largely of the diatom, Dinobryon Sp. have been observed in Crooked Lake only (Gannon and Mazur 1979). This species is generally associated with oligotrophic waters and is an indication of low nutrient loads.

Appendix C-1 lists submergent and emergent aquatic macrophytes* (water plants) found in Pickerel Lake. While similar plant species can be expected in Crooked Lake, DNR survey information on aquatic macrophytes was not available for Crooked Lake. Dense growth of submerged aquatic plants was observed along the northeast shoreline of Pickerel Lake in a 1971 survey. Common aquatic vegetation includes whitestem and sago pondweed, yellow water lily, chara and wild celery. Various species of pondweed were found along most of the Pickerel Lake shoreline in varying densities. The emergent species, Bullrush, was dense along the southern shore. (MDNR variously dated).

Aquatic Invertebrates. Gannon and Mazur observed a similar zooplankton and benthic invertebrate population in Crooked Lake and Pickerel Lake (see Appendix C-2). The diversity of benthic invertebrates, when used as an indicator of water quality, suggested that the lakes were oligotrophic or mesotrophic in trophic status. The concept of using species diversity as an aid in determining water quality status is summarized in Appendix C-3. The Shannon-Weiner species diversity index* was slightly higher in Pickerel Lake (0.57) than in Crooked Lake (0.43) and is interpreted to indicate slightly more oligotrophic conditions in Pickerel Lake than in Crooked Lake.

Fish. The Michigan Department of Natural Resources' (MDNR, variously dated) records showed that both Crooked Lake and Pickerel Lake contain fish populations indicative of good water quality conditions. Several species of game fish, coarse fish, and forage fish are prevalent in both lakes. Growth rates for game fish are near statewide averages and survey data indicate an excellent warm water game fish population. A list of species caught in a 1971 DNR fish survey for Pickerel Lake is presented in Appendix C-4. The latest fish survey for Crooked Lake was conducted in 1954; a listing of fish caught in this survey is shown in Appendix C-5.

2. WETLANDS

Wetlands are highly productive ecosystems which are inundated by surface or groundwater with a frequency to support primarily semi-aquatic vegetation. Figure II-7 shows that there are extensive wetland areas associated with the shallow bays of the lakes and slow-moving streams of the Study Area.

Virtually all of the southern shoreline of Crooked Lake and the south and western shorelines of Pickerel Lake are low-lying areas, often wet woodland. These wetlands are dense mixed hardwood - coniferous forest consisting of white spruce, white cedar, birch, alder, and willow. The woodlands are primary habitat for a large number of nesting birds, such as warblers and woodpeckers, and for ruffed grouse and white-tailed deer, two important game animals in Michigan.

Cattail marshes and wet woodlands are found on Oden Island in Crooked Lake. The shoreline, with noted macrophytes, including bullrushes, is an important habitat for breeding waterfowl. Cattail marshes are also prevalent on the northeastern shore of Crooked Lake, and this shallow embayment has many acres of emergent vegetation, which together with the slow-moving waters of the Crooked River are important feeding grounds for waterfowl.

These wetland areas serve several important ecological functions:

- They purify nearby surface water bodies by entrapping sediments and concentrating nutrients which have been washed off the landscape.

- They store storm and flood waters and absorb the impact of flooding, thereby reducing the erosion of adjacent land.

- They are prime natural recharge areas where surface and groundwater are directly connected.

- They are essential habitat for a wide variety of wildlife, and support biological functions such as nesting, breeding, and feeding areas.

- They produce plant and animal biomass at all trophic levels; except for the comparably productive tropical rainforest, no other land habitat is as rich in usable plant and animal material.

Wetland Protection. Michigan laws prevent the drainage of wetlands without State review. The Inland Lakes and Streams Act and the Great Lakes Submerged Lands Act provide guidelines for the protection and management of wetlands. An Executive Order on wetlands management (Exec. Order #11990) prevents the development of federally funded projects in wetlands unless there is no feasible alternative.

3. TERRESTRIAL BIOLOGY

The Crooked/Pickerel Lakes Study Area is largely wooded. Total forested land is about 80% of the total acreage. Northern hardwood forests largely of hard maple, white ash, red oak, white birch and beach. The Hardwood State Forest, south of Crooked/Pickerel Lakes makes up nearly 15% of the total acreage in the Study Area. Upland and swamp forests are largely coniferous and include white cedar, balsam, fir, tamarock, black spruce, aspen and alder. Wetland areas are more sparsely forested.

Study Area wildlife is typical of species common to northern hardwood forests, swamp forests and marshy wetlands. Birds and Mammals whose habitat range include the Study Area are shown in Appendix C-6 and C-7, respectively.

4. THREATENED OR ENDANGERED SPECIES

No mammals on the Federal List of Threatened or Endangered Species have been documented in the Study Area. However, Emmet County is within the range of several species on the Michigan list of rare and threatened species. These are listed in Appendix C-8. Specific information on habitat location is not available. "Rare" and "peripheral" species have no legal status under Michigan Endangered Species Act, only the "threatened" species. The Pine Vole and the Southern Bog Lemming are afforded State protection.

The bald eagle, Haliocetus leucocephalus, is the only species on the Federal list of Endangered or Threatened Species whose habitat range is known to include the Study Area. Two active bald eagle nesting sites are known to exist in the Study Area. One pair of bald eagles are known to be nesting and feeding northeast of the Crooked/Pickerel Channel in Littlefield Township. The other pair are found south of Crooked Lake near Minnehaha Creek (by telephone, George Kupp, June 4, 1979).

Michigan's threatened species list includes six birds species whose habitat range extends through Emmet County. Nesting sites for these species, listed in Appendix C-9, have not been documented in the Study Area.

Several species of plants found in the Study Area have been classified as rare or threatened by the Michigan DNR, (see Appendix C-10). None of these species is on the Federal List of Engangered and Threatened Plants.

E. POPULATION AND SOCIOECONOMICS

1. POPULATION

a. Introduction

Published information on the population characteristics of the Study Area is available for Emmet County and Littlefield and Springvale Townships. However, the areas proposed for sewering in the Springvale-Bear Creek Area Segment Facility Plan cover only a portion of these two Townships. Since only limited disaggregation of socioeconomic data is available, the published data do not precisely describe the population characteristics for the subareas of Springvale and Littlefield Townships to be directly affected by the wastewater management alternatives.

As a result, 1975 aerial photography was analyzed to determine the existing dwelling unit count and population levels. This information was supplemented through field surveys of the Study Area as well as the use of reports by Gannon and Gold and the Facility Plan. For analytical purposes, the Crooked/Pickerel Lakes Service Area was divided into 18 segments (see Figure II-11). Together, these segments define the Proposed Service Area.

b. Existing Population

The Proposed Service Area had a 1978 total population of 840 people comprised of 223 (26.5%) permanent residents and 617 seasonal residents (see Table II-10). The Springvale Township portion of the Service Area has the highest percentage of the total population (63.7%) and the highest percentage of permanent residents (72.2%). It also has the largest population concentrations: Segment 6 (89 people), Segment 14 (128 people) and Segment 16 (182 people). Several of the Proposed Service Area segments have relatively small population concentrations due primarily to environmental factors limiting development.

No data are available on either permanent or seasonal population levels within the Proposed Service Area prior to 1978. However, recent trends at the County and Study Area level indicate that the Proposed Service Area is a part of a rapidly growing portion of Michigan. From 1970 to 1975, there was a 12.4% increase in dwelling units in the Study Area (Vilican-Leman & Associates 1971) while the County and Littlefield and Springvale Townships have shown rapid population growth since 1960 (U.S. Bureau of Census 1970).

The EIS 1978 population estimate of 840 people, although equal to the Facility Plan estimate, is based on a different dwelling unit count (212 versus 259 in the Facility Plan) and different assumptions regarding the seasonal population. As discussed in Appendix D, the Facility Plan estimate does not include an accurate breakdown of permanent and seasonal dwelling units nor does it consider the larger household sizes common to seasonal residences. As a result, while the two estimates are equivalent, the different assumptions underlying each estimate may account for significant differences in the projections based on each estimate.

FIGURE II-11. SEGMENT MAP

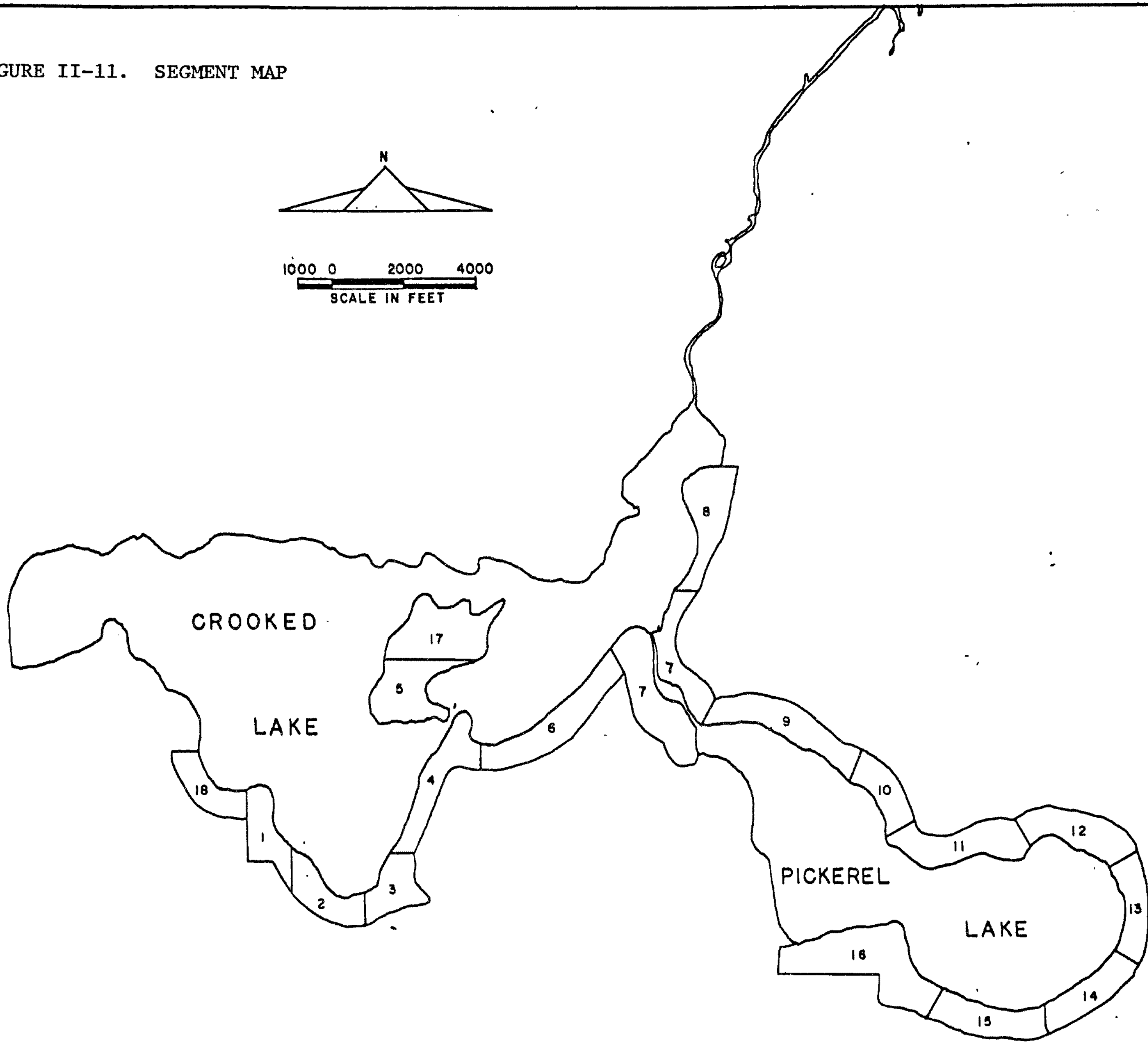


Table II-10

PERMANENT AND SEASONAL POPULATION OF THE
PROPOSED CROOKED PICKEREL LAKES SERVICE AREA (1978)*

Segment	Total	Permanent	Seasonal	Percent Permanent	Percent Seasonal
1	11	7	4	63.6	36.4
2	10	10	0	100.0	0.0
3	31	10	21	32.3	67.7
4	60	13	47	21.7	78.3
5	53	36	17	67.9	32.1
6	89	59	30	66.3	33.7
7	17	0	17	0.0	100.0
8	20	7	13	35.0	65.0
9	0	0	0	0.0	0.0
10	55	0	55	0.0	100.0
11	60	13	47	21.7	78.3
12	60	0	60	0.0	100.0
13	54	3	51	5.6	94.4
14	128	13	115	10.2	89.8
15	7	7	0	100.0	0.0
16	182	42	140	23.1	76.9
17	3	3	0	100.0	0.0
18	0	0	0	0.0	0.0
TOTAL	840	223	617	26.5	73.5

*The methodology utilized to develop these population estimates is found in Appendix D.

c. Population Projections

The population projections for the Crooked-Pickerel Lakes Service Area must consider three common growth factors:

- The rate of growth or decline of the permanent population;
- The rate of growth or decline of the seasonal population; and
- The potential conversion of seasonal to permanent dwelling units and the resultant effect on the permanent population.

Each of these represents a potential growth force significantly affecting future total population levels and the distribution of population between permanent and seasonal residents.

Permanent, seasonal, and total baseline population projections for the Crooked/Pickerel Lakes Facility Planning Area were projected for the year 2000 based on the best available information regarding these three growth factors (see Appendix D). As indicated in Table II-11, the total in summer population for the Proposed Service Area is projected to be 1,263. This total population will be comprised of 603 (47.7%) permanent residents and 660 (52.3%) seasonal residents. Springvale Township will maintain its position as the most populous portion of the Proposed Service Area with 791 people (62.6%) in 2000 and the Township will also have the highest percentage of permanent residents (64.4%) and seasonal residents (61.2%). Four of the five largest segments are also located in Springvale Township including Segment 4 (103 people), Segment 6 (159 people), Segment 14 (148 people) and Segment 16 (245 people). Segment 11 in Littlefield Township with 103 people is the only segment in this Township with more than 100 people.

The population projection is nearly 40% lower than the Facility Plan projection of 2,080 people. As discussed in Appendix D, the Facility Plan projection assumes a much higher growth rate for the Proposed Service Area based on the anticipation of future wastewater management improvements, whereas the projections done for this EIS are based on an analysis of past growth trends in the area which do not include the future introduction of a wastewater management system. The EIS projection, based solely on past growth trends in the Service Area, projected only a 50.4% increase in population which is more closely in line with the 208 planning agency's (Northwest Michigan Regional Planning Commission 1972) projected growth for Littlefield Township (43.2%) and Springvale Township (30.4%).

2. CHARACTERISTICS OF THE PERMANENT POPULATION

a. Income

The Crooked/Pickerel Lakes Study Area can be characterized as a moderate income area. During 1970, the median family income was $10,741 and the per capita income in 1974 was $4,152. These figures are higher

Table II-11

PERMANENT AND SEASONAL POPULATION OF THE PROPOSED CROOKED-PICKEREL LAKES SERVICE AREA (2000)[1]

Segment	Total	Permanent	Seasonal	Percent Permanent	Percent Seasonal
1	13	9	4	69.2	30.8
2	12	12	0	100.0	0.0
3	37	21	16	56.8	43.2
4	103	51	52	49.5	50.5
5	64	48	16	75.0	25.0
6	159	123	36	77.4	22.6
7	22	6	16	27.3	72.7
8	37	21	16	56.8	43.2
9	0	0	0	0.0	0.0
10	93	33	60	35.5	64.5
11	103	51	52	49.5	50.5
12	90	42	48	46.7	53.3
13	82	18	64	22.0	78.0
14	148	36	112	24.3	75.7
15	52	24	28	46.2	53.8
16	245	105	140	42.9	57.1
17	3	3	0	100.0	0.0
18	0	0	0	0.0	0.0
TOTAL	1,263	603	660	47.7	52.3

[1]The methodology utilized to develop these projections is found in Appendix D.

than the Emmet County figures and lower than state and national figures (see Tables II-12 and II-13). Within the Study Area, Littlefield Township reported both higher median family and per capita incomes than Springvale Township.

The distribution of family incomes during 1970 indicated that the Study Area had a higher percentage of families with incomes under $10,000 (57.3%) than the State (42.9%), but a lower percentage than the County (59.8%). However, the Study Area had a lower percentage of families below the Federally established poverty level than either the State or County (see Table II-14).

The moderate income levels in the Study Area are partly attributable to the agricultural and tourism orientation of the local economy (providing relatively low skill/low wage employment opportunities) and to the seasonal fluctuations in employment (high summer employment levels, low levels during off-season). However, the large elderly population (age 65 or older) of the Study Area living on limited or fixed incomes also greatly contributes to the moderate income levels. More than 33% of the elderly population in Littlefield Township had incomes below the poverty level (see Table II-15).

b. Retirement Age Population

Over 10% of the Study Area's 1970 population was 65 years of age or older. (see Table II-16). The percentage of retirement age population did not vary greatly between Littlefield (11.2%) and Springvale (10.1%) Townships. The Study Area is well suited for retirement living providing opportunities for boating, swimming, and fishing which allow retired persons to make productive and enjoyable use of their leisure time. Many former seasonal residents have converted their homes to permanent units upon retirement to take advantage of these opportunities.

c. Employment

Between 1940 and 1970, Emmet County has experienced major changes in its economic structure. During the 1940's agriculture was the primary source of employment accounting for over 28% of the total labor force. However, by 1970 agriculture represented only 3.4% of the total employment and had been replaced by services (33.0%), retail trade (21.4%), and manufacturing (20.7%) as the dominant employment categories (see Table II-17).

While manufacturing maintained a relatively constant share of total employment in the County during this period, increases in retail trade and service activities resulted from the increase in these sectors nationwide and from the growing importance of tourism in the Upper Great Lakes Region (Michigan Department of Commerce 1975). As indicated in Table II-18, Emmet County experienced greater economic impact from travel and tourism than either the region or the State in 1975. Only 3.6% of the State's employment and 9.2% of the region's employment was generated through travel activities compared to 33.9% in Emmet County. In addition, a large percentage of total retail sales in the County can be attributed to tourism. From 1967 to 1972, tourist expenditures as a

Table II-12

MEAN AND MEDIAN FAMILY INCOME

	Mean	Median
• United States	$10,999	$ 9,586
• Michigan	12,213	11,029
• Emmet County	10,128	8,608
• Socioeconomic Study Area	10,741	NA
– Littlefield Township Portion	11,382	NA
– Springvale Township Portion	9,529	NA

SOURCES: U.S. Census of Population and Housing, Fifth Count Summary Tapes, 1970.

U.S. Census of Population, 1970.

Table II-13

PER CAPITA INCOME

	1969	1974	Percent Change (1969-1970)
• State of Michigan	$3357	$4751	41.5
• Emmet County	2703	3814	41.1
• Socioeconomic Study Area	2845	4152	45.9
– Littlefield Township Portion	3036	4451	46.6
– Springvale Township Portion	2588	3712	43.4

SOURCE: U.S. Census, Population Estimates and Projections (Series P-25), May 1977.

Table II-14

PERCENT DISTRIBUTION OF FAMILY INCOME 1970

	State of Michigan	Emmet County	Socioeconomic Study Area
Under $ 1,000	1.8	2.1	2.5
$ 1,000 - 1,999	2.4	2.8	1.1
$ 2,000 - 2,999	3.3	7.1	5.1
$ 3,000 - 3,999	3.5	3.7	4.2
$ 4,000 - 4,999	3.7	6.1	3.8
$ 5,000 - 5,999	4.1	7.1	4.5
$ 6,000 - 6,999	4.6	9.1	15.8
$ 7,000 - 7,999	5.7	7.1	4.2
$ 8,000 - 9,999	13.8	14.7	16.1
$10,000 - 14,999	30.5	23.9	24.1
$15,000 - 24,999	21.4	11.7	13.6
$25,000 - 49,999	4.5	3.7	3.8
$50,000 and Over	0.8	1.0	1.1
Percent of Families Below Poverty Level	7.3	10.4	6.5

SOURCES: U.S. Census, General Social and Economic Characteristics, 1970.

U.S. Census of Population and Housing, Fifth Count Summary Tapes, 1970.

Table II-15

POVERTY STATUS--PERSONS 65 YEARS AND OLDER--1970

	Percent of Population 65 Years of Age and Older	Percent of Persons 65 Years and Older Below Poverty Level
• Michigan	12.2	24.1
• Emmet County	11.1	28.8
• Socioeconomic Study Area	10.7	25.4
- Littlefield Township Portion	11.2	33.9
- Springvale Township Portion	10.1	8.1

SOURCES: U.S. Census of Population and Housing, Fifth Count Summary Tapes, 1970.

U.S. Census of Population, 1970, Supplementary Report, Issued December 1975.

Table II-16

RETIREMENT AGE POPULATION 1970[1]

	Emmet County		Socioeconomic Study Area		Littlefield Township		Springvale Township	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Total Population	18,331	100.00	1,752	100.00	1,136	100.00	616	100.00
55-59	815	.12	96	5.48	54	4.75	42	6.82
60-64	898	4.90	105	5.99	56	4.93	49	7.95
65-74	1,374	7.50	123	7.02	82	7.22	41	6.66
75 and Over	851	4.64	166	3.77	45	3.96	21	3.41

SOURCES: U.S. Census of Population, 1970.

U.S. Census of Population and Housing, Fifth Count Summary Tapes, 1970.

Table II-17

EMMET COUNTY DISTRIBUTION OF EMPLOYMENT
BY INDUSTRIAL SECTOR 1940-1970

Industrial Sector	1940	1950	1960	1970	1940-1970 Percent Change
Agriculture, Forestry, Fishing	28.2	16.4	7.2	3.4	83.6
Mining	0.1	0.1	-	0.1	133.3
Construction	6.3	7.8	9.2	9.0	95.3
Manufacturing	20.4	23.9	20.4	20.7	39.6
Wholesale Trade	2.3	2.9	3.9	4.5	174.5
Retail Trade	15.6	19.5	24.5	21.4	88.7
Finance, Insurance, Real Estate	2.1	2.0	2.4	2.5	60.6
Services	22.2	23.7	28.7	33.0	103.9
Government	2.9	3.7	3.7	5.4	160.9
TOTAL					37.3

SOURCE: U.S. Department of Commerce, Bureau of Economic Analysis, Regional Employment by Industry, 1940-1970.

Table II-18

ECONOMIC IMPACT OF TRAVEL--1975

	Michigan	Upper Great Lakes Region	Emmet County
Travel Generated Expenditures	$3,366,766,221	$856,670,668	$98,289,916
Per Capita Expenditures	368	994	4,615
Travel Generated Personal Income	930,574,184	236,153,772	27,667,333
Percent of Total Personal Income	1.7	6.3	25.32
Travel Generated Employment	124,448	28,602	3,323
Percent of Total Employment	3.6	9.2	33.9

SOURCE: Michigan Department of Commerce, Travel Bureau, Tourist Industry Growth Study, 1975.

percentage of retail sales grew from 48% to 64%. (Northwest Michigan Regional Planning and Development Commission 1972). This unusually high dependence of the local economy on tourist-related expenditures indicates in part why income levels in the Study Area and the County are generally lower than State and national levels. Most tourism and travel employment opportunities are low wage jobs which fluctuate greatly during the time of the year. As a result, the high proportion of tourism jobs in comparison to manufacturing and other higher wage jobs depresses the total income levels.

d. Financial Characteristics

Financial characteristics of the local governments in the Crooked/Pickerel Lakes Study Area are sketched in Table II-19. This information is necessary in evaluating the various alternatives available to the local governments for financing wastewater management improvements.

In Michigan, counties, townships, and villages collect property taxes. All property owners in the county pay property taxes to the county as well as to their township or village of residence. Revenues are also generated from Federal revenue sharing and special fees and taxes. From these revenues, expenditures for general government and capital expenditures are made.

All local government units are enabled by the State of Michigan with the power to take on debt in the form of general obligation bonds. Certain debt limitations have been established based on the assessed valuation of real property in the governmental unit. The debt limit on county general obligation bonds is set at 10% of assessed valuations. Unchartered townships have no established debt limit. Chartered townships, cities and villages have a 10% debt limit on bonds; however, the following types of bonds are excluded from this limit:

- Special assessment bonds,
- Revenue bonds,
- Motor vehicle highway bonds,
- Court ordered bonds, and
- Pollution abatement bonds.

At the end of fiscal year 1974, Emmet County had no outstanding debt. Littlefield Township had an outstanding debt of $110,000 in general obligation bonds. The bonds were issued in 1973 to finance the cost of acquiring and constructing a fire house and community building. During 1973, the Township of Littlefield also entered into a contract with the Harbor Springs Area Sewage Disposal Authority to construct a sewer system for a portion of the Township. Although control and ownership of the sewage facilities belong to the Authority, the Township has pledged to pay a share (53.1%) of the bonds issued by the Authority. While it is expected that the Township's share will be generated from tap fees and monthly service charges, the full faith and credit of the Township stands behind the bonds. Annual payments by the Township are approximately $50,000. The combined financial capabilities of the two Townships appear to be more than adequate to finance future wastewater management improvements.

Table II-19

FINANCIAL CHARACTERISTICS OF THE LOCAL GOVERNMENTS IN THE CROOKED/PICKEREL LAKES STUDY AREA

	Emmet County (1)	Littlefield Township (2)	Springvale Township (3)
State Equalized Valuations	$202,942,911	$10,850,481	$6,766,800
Total Revenues	4,310,588	449,869	240,397
Total Expenditures	4,020,529	411,628	244,834
Current Expense	3,926,993	N/A	N/A
Capital Outlay	93,536	N/A	N/A
Total Long Term Debt	-0-	110,000	N/A

Notes: (1) State of Michigan, Department of Treasury, Michigan County Government Financial Report, for the year ended December 31, 1974.

(2) Hill, Woodcock and Distel, Certified Public Accounts, Audited Financial Statements - Littlefield Township, March 23, 1976.

(3) Hill, Woodcock and Distel, Certified Public Accountants, Audited Statements of Cash Receipts and Disbursements, Springvale Township, March 22, 1977.

3. CHARACTERISTICS OF THE SEASONAL POPULATION

No published information on income, age, employment, or other socioeconomic characteristics is available for the seasonal residents of the Study Area. It can generally be assumed that the seasonal population has a relatively high mean family income which allows them to own and maintain a permanent as well as a seasonal home. Past trends regarding seasonal residents indicate that the majority are married couples with families. However, recent indications point toward more singles and married couples without children purchasing second homes, resulting in smaller seasonal resident occupancy rates (persons per unit). In addition, while seasonal dwelling units are generally used only 25% to 50% of the year, they are more intensively used (by more people per unit) during this period than permanent residences.

The higher income level of seasonal residents typically allows them to be relatively mobile in regard to their choice of a location for retirement. As a result, it is difficult to ascertain whether their seasonal residence would be their likely place of retirement. However, past trends in the Study Area indicate that some conversion of seasonal to permanent residences is occurring, at least a portion of which can be attributed to the permanent use of previously seasonal residences by retirement age people.

4. HOUSING CHARACTERISTICS

To develop an adequate data base for the analysis of wastewater management alternatives, the number of existing dwelling units within the Crooked/Pickerel Service Area was determined from 1975 aerial photographs and field surveys. The total number of dwelling units for the Service Area in 1978 was 212, comprised of 66 (31.1%) permanent units and 146 (68.9%) seasonal units. None of the dwellings has centralized sewer service. Most of the existing dwelling units can be characterized as single-family dwellings situated on 1/4 acre to 1/2 acre lots.

During the planning period, it is projected that approximately 154 dwelling units will be added. Of this increase, 94 dwelling units will be constructed in Springvale Township and 60 units in Littlefield Township. By the year 2000, the permanent units in the Proposed Service Area will increase to 54.9% of the total housing stock (see Table II-20) even though the number of seasonal dwelling units will also increase.

The median value of owner-occupied units and the median gross rent for rental units in the Crooked and Pickerel Lakes area were considerably lower than the national and state medians (Table II-21). Median value in the Study Area in 1970 was $14,557, $3,033 below the state median.

The lower values and rents in the Study Area are largely attributable to the rural location of the area, the structural condition and amenities of the individual units, and large number of seasonal homes which are typically of lower value than permanent units (see Table II-21).

Table II-20

EXISTING AND PROJECTED DWELLING UNITS
FOR THE CROOKED/PICKEREL SERVICE AREA

Township Comprising Service Area	1978			2000		
	Total	Permanent	Seasonal	Total	Permanent	Seasonal
Littlefield	76	19	57	136	72	64
Springfield	136	47	89	230	129	101
TOTAL	212	66	146	366	201	165

Table II-21

MEDIAN HOUSING VALUE--1970

United States	17,130
Michigan	17,590
Emmet County	14,557

SOURCE: U.S. Bureau of the Census, County and City Data Book, 1972

Age characteristcs of the permanent housing stock provide an indication of structural conditions and construction trends in the area. A substantial portion (21%) of the units in Springvale Township were constructed after 1965, indicating a recent increase in residential construction. On the other hand, Littlefield Township experienced little new construction between 1965 and 1970. It is anticipated that Springvale Township will continue to have significant residential construction activity during the planning period while Littlefield Township will show more substantial residential development than was evident during the last ten years.

No substantive information regarding the characteristics of seasonal dwelling units is available. Seasonal units by their nature as part-time residences are generally smaller in size, lower in value, and lacking many of the amenities common to permanent units. Nationally, more recently constructed seasonal units have been found to be of higher quality, representing permanent units which are used on a seasonal basis. In addition, there has been a continuing conversion of seasonal units to permanent residences by successive owners. This has been a result not only of conversions by retirement age people, but also of other second home owners converting their seasonal home to a permanent residence in an effort to move away from larger urban areas.

5. LAND USE

a. Existing Land Use

The predominant land uses within the Study Area include agriculture, open space and State forest land. No towns or villages exist within the Proposed Service Area. Concentrations of residential development have occurred adjacent to Crooked/Pickerel Lakes (see Figure II-12). Development is also scattered along major highways and section line roads. Most homes existing along Crooked/ Pickerel Lakes are for seasonal use. No major commercial activities are located directly within the Service Area.

The project regions role, as one of the major year round resort/ recreation areas in Michigan has strongly influenced the pattern of urban development. Resources influencing development patterns and attracting tourists include fresh water lakes and streams, excellent snow-ski resorts, and hundreds of acres of uninhabited State forests for hunting, nature appreciation and snowmobiling.

The area is served by a number of transportation systems, none designed for a large volume of traffic. US-131 (a two-lane highway) is the only major highway which directly connects the Study Area to a large metropolitan area. The nearest scheduled airline terminal is at Pellston, four miles northeast of the Study Area. Two railroad systems, the Penn Central and the Chesapeake & Ohio, serve the area. In the past (75 to 100 years ago), these railroads transported people to this area. Presently, they are being used primarily for freight.

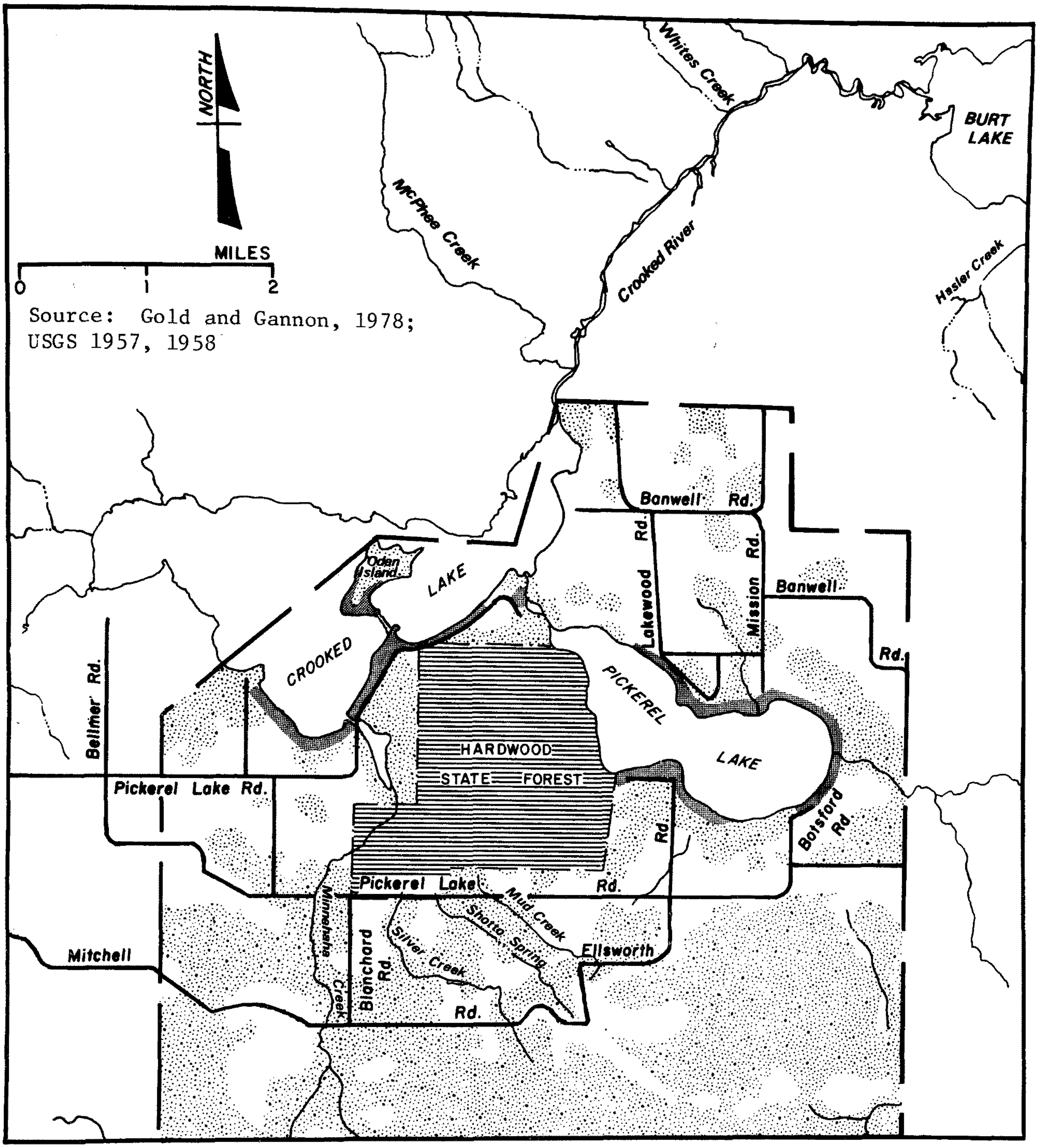


FIGURE II-12 EXISTING LAND USE OF THE CROOKED/PICKEREL STUDY AREA

LEGEND

- SINGLE FAMILY RESIDENTIAL
- MICHIGAN STATE FOREST
- WETLAND/VEGETATED AREAS
- AGRICULTURAL

b. Future Land Use

Emmet County's Future Land Use Plan designates Crooked/Pickerel Lakes' shoreline acreage for recreation homes (existing and potential), water frontage with scenic and recreation resource potential (the Crooked/Pickerel Lakes Channel), and broad scale resource management. Noting development constraints imposed by poorly drained soils throughout the Crooked/Pickerel Lakes area (particularly along the shoreline where development pressures are greatest) the County land use plan recognizes the serious water pollution hazards generated by overintensive or inappropriate land development patterns. The following planning deficiencies were identifed by the Emmet County Department of Planning:

- Carrying capacity of soils and land resources;
- Substandard and outmoded development standards;
- Inadequate traffic routes to serve local and regional traffic;
- Disregard for land use relationships (mixed uses); and
- Failure to implement central utility services prior to intensive use of land.

Littlefield Township's General Development Plan designates land adjacent to the north shore of Pickerel Lake as lakeside-resort residential. Demand for lakeside property is expected to generate continued development pressure for relatively higher-density residential development in this area. Proposed Township development controls are likely to be limited to those provided in the Preliminary Littlefield Township Zoning Ordinance.

Littlefield and Springvale Townships have attempted to obtain funding under the Kammer Recreational Land Trust Fund Act (Michigan Act 204, 1976) to purchase land adjacent to the Crooked/Pickerel Lakes Channel. The Crooked/Pickerel Lakes Channel constitutes a connecting link in an inland waterway which extends from Crooked Lake to Lake Huron. The objective of public land acquisition is "to preserve the waterway and adjoining lands for recreation, wildlife, environment and community character reasons." Public acquisition of channel acreage has been supported by the Emmet County Office of Planning and Zoning. Efforts to obtain State funding have been unsuccessful thus far.

Consistent with local efforts to protect acreage adjoining the Crooked/Pickerel Lakes Channel, Springvale Township recently enacted an amendment to the Township zoning ordinance designed to limit development along the south shore of the channel. The establishment of this special district imposes more rigorous development restrictions. The amendment expressly prohibits mobile homes, except for temporary occupancy during construction dislocation (a permit is required for occupancy under these conditions). Single-family dwellings are restricted to a minimum lot size of 40,000 square feet. As a result, prospective residential development along the channel cannot exceed a maximum density of approximately one dwelling unit per acre.

c. Growth Management

Land development in acreage adjacent to the southern shore of Crooked Lake and around Pickerel Lake is subject to restrictions imposed by state, county, and local ordinances. The following regulatory measures directly concern the lakeshore jurisdictions:

- Michigan State Act 346 (1972): The Inland Lakes and Streams Act;

- Michigan State Act 347 (1972): The Soil Erosion and Sedimentation Control Act;

- Emmet County Zoning Ordinance (1972); and

- Springvale Township Zoning Ordinance.

The Inland Lakes and Streams Act requires issuance of a permit for development activity in submerged lands (areas lying below the ordinary high water mark). Any dredge and fill operations are therefore subject to a public review process. Administrative action to issue or deny a permit which meets general guidelines provided in the Act must explicitly consider site-specific environmental constraints in reaching a final decision.

The Soil Erosion and Sedimentation Control Act governs construction activity occurring within 500 feet of the shore of a lake, river, or stream. The Act established a permitting process administered by designated county agencies, in this case the Emmet County Community Development Department. It limits tree cutting, removal of vegetative cover, and cut and fill operations. Mitigating measures must be adopted to control runoff from construction sites.

The Emmet County Zoning Ordinance regulates land development within Littlefield Township, which has not yet adopted its own ordinance. Land adjacent to the north shore of Pickerel Lake is zoned RR-1 (Recreation Residential) which includes the following permitted uses: (1) cottages and recreation homes; (2) single-family detached dwellings (including mobile homes); (3) public parks, playgrounds, recreation lands, and forests; (4) historical restoration and renovation projects; and (5) farms and farmlands. Additional uses subject to Planning Commission approval include: (1) utility and public service facilities; (2) boat launching pads and minor accessory facilities; (3) golf courses and country clubs; and (4) public, private, or semi-private schools or educational programs (see Figure II-13).

Dwellings constructed within a recreation residential district must comply with the following restrictions:

- Minimum Lot Size = 22,000 square feet;
- Minimum Lot Width = 100';
- Maximum Structure Height = 30'; and
- Maximum Lot Coverage (All Structures) = 30%.

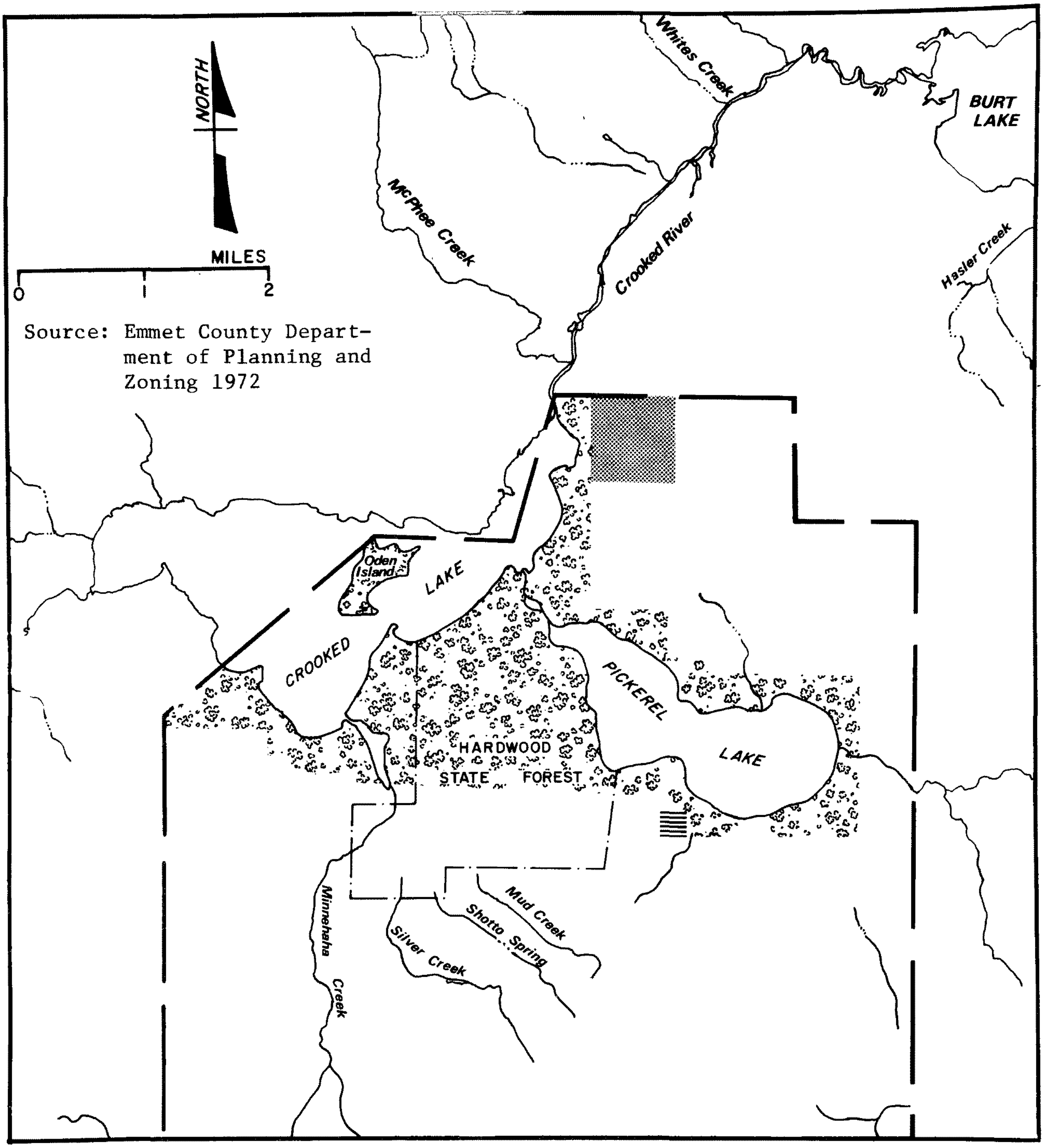


FIGURE II-13 EXISTING ZONING OF THE CROOKED/PICKEREL STUDY AREA

LEGEND

SINGLE FAMILY RESIDENTIAL

LOCAL-TOURIST BUSINESS

RECREATION RESIDENTIAL

Since the minimum lot size permissible in this district is approximately 1/2 acre, a maximum residential density of 2 dwellings per acre is possible.

Littlefield Township is considering adoption of its own zoning ordinance, which would supersede the Emmet County Zoning Ordinance if adopted. The Preliminary Littlefield Township Zoning Ordinance designates acreage adjacent to the north shore of Pickerel Lake as SR-2 (Scenic Resource District). The purpose of the scenic resource district is to preserve natural resources considered vital to the tourism and recreation sectors of the local-regional economy.

Permitted uses and conditional uses subject to approval by the Township Planning Commission are essentially the same as those identified in the Emmet County Zoning Ordinance for recreation residential districts, although mobile homes appear to be excluded. More stringent density restrictions are proposed for the scenic resource district. A minimum lot size of 30,000 square feet and minimum lot width of 150 feet would be required for residential development along the north shore of Pickerel Lake.

The Preliminary Littlefield Township Zoning Ordinance provides a subdivision development option allowing increased densities for clustered residential development when integrated with approved plans for open space reservation, natural resource conservation, and recreation. Both year-round and seasonal subdivisions are eligible for planned unit status under the terms of this provision. With an approved open space subdivision plan, minimum lot sizes in scenic resource districts would be reduced to 20,000 square feet without sewer or water utilities (in which case Health Department approval is required); 12,000 square feet with sewer services; and 9,600 square feet with both water and sewer services.

Land development along the south shores of Crooked/Pickerel Lakes is regulated by the Springvale Township Zoning Ordinance. Land within 1,000 feet of the lakeshore is designated District C (Lakeshore District). The following uses are permitted in this district:

- Single-family dwellings and cottages;
- Gardening and farming (excluding the raising of livestock);
- Offices or studios for professional or service people residing on premises;
- Any other structure or use clearly accessory and incidental to a permitted use; and
- Parks (subject to discretion of the Township Board).

No explicit density restrictions accompany provisions for the Lakeshore District. Satisfaction of minimum lot width (65 feet) and setback provisions would permit residential densities in excess of 10 dwellings per acre.

d. Recreation

The vacation home is an important economic factor in tourism-recreation. Because Emmet County has vast areas of land oriented to water resources, the vacation home is and will continue to represent an important factor in tourism-recreation. Because Emmet County has vast areas of land oriented to water resources, the vacation home is and will continue to represent an increasingly important element of local recreation both for working and retirement families. Other recreational activities such as boating, fishing, and camping are related to the lakes and natural features of the area.

Public access to Crooked/Pickerel Lakes is relatively limited (see Table II-22). Although there is a total of 21.4 miles of lake shoreline in the Study Area, less than 2% is available for public access.

6. HISTORICAL AND ARCHAEOLOGICAL RESOURCES

The location of the historic sites and potentially important archaeological sites identified in the Springvale-Bear Creek Area Segment were compared to the location of proposed facilities in the EIS Study Area.

There are no historic sites within the EIS area or in other locations which might be affected by facilities proposed by any of the alternatives.

One potentially important archaeological site is located in the Study Area near facilities proposed for the north shore of Pickerel Lake. The Section described as potentially important is shown in Figure II-14. All other potentially important archaeological sites are outside the Study Area at locations not affected by proposed collection, treatment, and disposal of wastewaters in the EIS Study Area.

According to the Michigan State Historic Preservation Officer (SHPO), a potentially important site must be investigated for archaeological artifacts prior to construction of any facilities. Since the SHPO reviewed only the proposed facilities in the Facility Plan for archaeological importance, any facilities related to additional alternatives developed, such as a land application site or a cluster soil absorption site would also need to be reviewed.

Table II-22

PUBLIC ACCESS TO LAKES WITHIN THE SERVICE AREA

Municipality	Lake	Facility-Description	Approximate Shoreline Frontage
Littlefield Township	Crooked Lake	Swimming beach, no boating	300 ft.
Springvale Township	Crooked Lake	Swimming beach, small boats only	900 ft.
Springvale Township	Crooked Lake	Public fishing site, boat launching	250 ft.
Littlefield Township	Pickerel Lake	Public fishing site	66 ft.
Littlefield Township	Pickerel Lake	Boat launch--unofficial located at end of road	Very small

SOURCE: By telephone, M. Putters, Emmet County Zoning Administration, March 14, 1978.

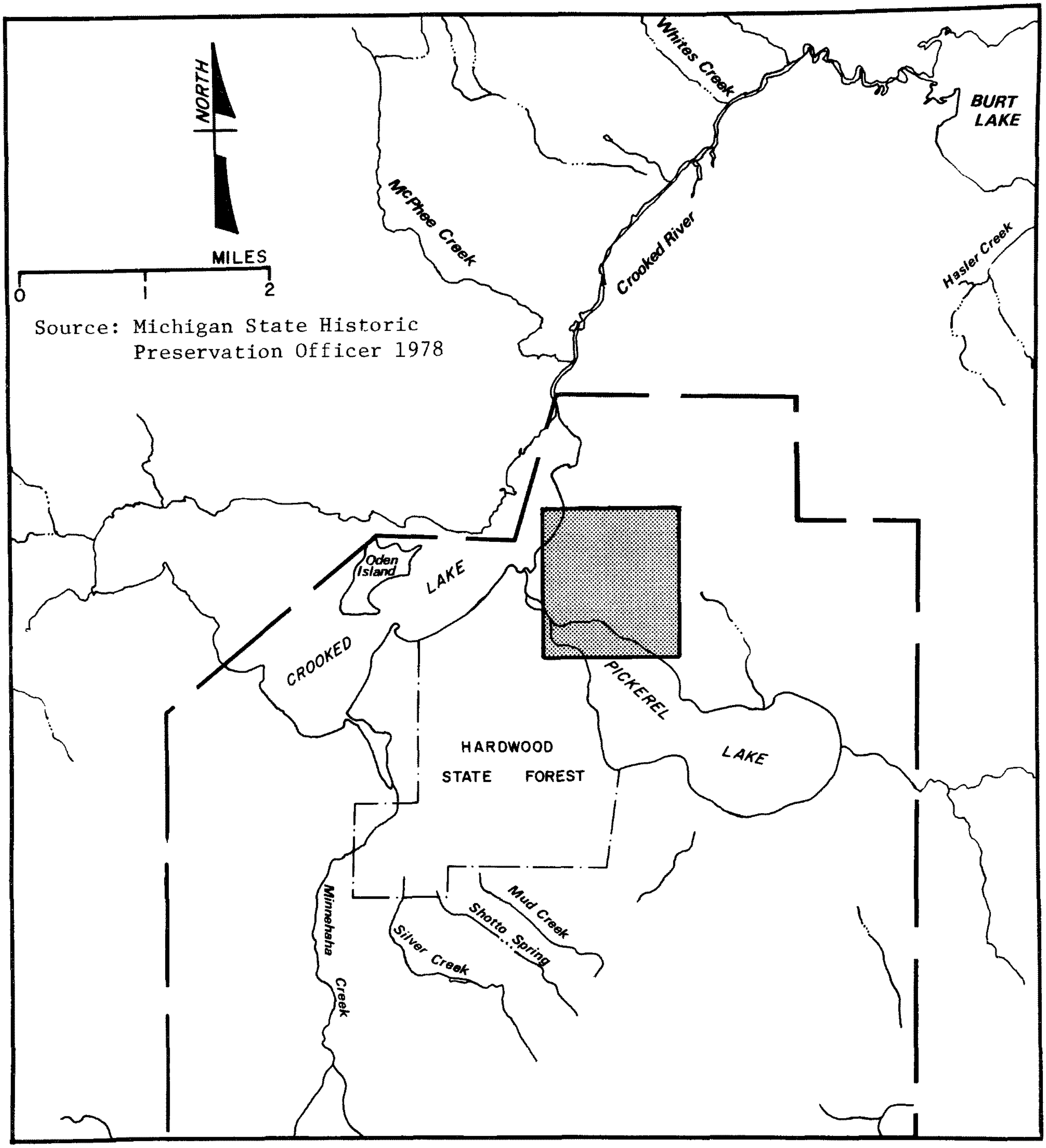


FIGURE II-14 POTENTIAL ARCHAEOLOGICAL SITE MAP OF THE CROOKED/PICKEREL STUDY AREA

LEGEND

POTENTIALLY IMPORTANT ARCHAEOLOGICAL SITE

CHAPTER III

DEVELOPMENT OF ALTERNATIVES

A. INTRODUCTION

1. GENERAL APPROACH

This chapter presents alternative systems for wastewater collection and treatment in the Proposed Crooked/Pickerel Lakes Service Area. Chapter IV, describes and compares the alternatives in terms of cost-effectiveness, with the Proposed Action in the Little Traverse Bay Area Facility Plan Springvale-Bear Creek Area Segment (Williams and Works, et. al. 1976). Chapter V assesses the environmental and socioeconomic impacts of all these systems.

EIS alternative development has focused on those aspects and implications of the proposed wastewater management plan for the Proposed Service Area which (a) have been identified as major issues or concerns, or (b) were not adequately addressed in the Facility Plan. The high cost of the Facility Plan Proposed Action and the potential impact on area residents make the cost-effectiveness of proposed facilities a major concern. Since the collection system accounts for more than 80% of the Proposed Action, the extent of servicing necessary, along with alternative wastewater treatment systems and the use of newer technologies for wastewater collection are investigated in detail. New alternatives were produced by matching available technologies, both conventional and alternative or innovative, to the site conditions, such as soil characteristics and housing density in the Proposed EIS Service Area.

Chapter I of this EIS emphasized the importance of proving overall need for the project proposed in the Facility Plan. Documenting a clear need for new wastewater facilities may, sometimes, be difficult, requiring evidence that the existing on-lot systems are directly related to water quality and public health problems. Such a need is clearly shown when one or more of the following conditions exist:

- Standing pools of septic tank effluent or raw domestic sewage in yards or public areas where direct contact with residents is likely.
- Sewage in basements from inoperable or sluggish sewage disposal systems.
- Contaminated private wells clearly associated with sewage disposal systems.

The Proposed Service Area exhibits some indirect evidence of the unsuitability of site conditions for on-site soil disposal systems. The evidence includes high groundwater, slowly permeable soils, small lot sizes, proximity to lakeshores and substandard setback distances between wells and private wastewater facilities. Available information on these factors was, in fact, used early in the preparation of this EIS to develop decentralized alternatives.

Indirect evidence is insufficient to justify Federal funding, especially for sewered collection. Decentralized approaches, such as repair and upgrading of on-site systems, also require the evidence described above or documentation of other substantial impacts on the swimmability or fishability of lakes or streams. Federal water pollution control legislation and regulations require documentation of actual water quality or public health problems. Section II.C summarizes the extensive efforts mounted during the preparation of this EIS to document and quantify the need for improved facilities around Crooked/Pickerel Lakes.

The dollar cost of the Facility Plan Proposed Action and its impact on area residents make cost-effectiveness as serious an issue as needs documentation. Since the collection system accounts for the major share of the construction costs in the Facility Plan Proposed Action, the extent of sewer lines needed and the use of newer technologies for wastewater collection have been investigated in detail here, as have alternative wastewater treatment systems. The technologies assessed are listed below:

WASTEWATER MANAGEMENT COMPONENTS AND OPTIONS

Functional Component	Options
Flow and Waste Load Reduction	- household water conservation measures - ban on phosphorus
Collection of Wastewaters	- limited service area - pressure sewers - vacuum sewers - gravity sewers
Wastewater Treatment Processes	- Conventional centralized treatment plus chemical phosphorus concentrations - land application - on-site treatment - cluster systems
Effluent Disposal	- subsurface disposal - land application - discharge to surface waters
Sludge Handling	- anaerobic digestion - dewatering

Sludge Disposal

- land application
- landfilling
- composting

Next, appropriate options were selected and combined into alternative systems described in Chapter IV. The last section of this chapter considers implementation, administration and financing of the alternatives.

2. COMPARABILITY OF ALTERNATIVES: DESIGN POPULATION

The various alternatives for wastewater management in the Service Area must provide equivalent or comparable levels of service if their designs and costs are to be properly compared. The design population of 1,263 is that population projected by this EIS to reside in the Proposed Service Area (see Figure I-2) in the year 2000. The methodology used to develop this estimate is presented in Appendix D. In the following comparison of alternatives a design population of 1,263 was assumed (see Section II.D.1.c and Appendix D). In the Facility Plan the design population was assumed to be 2,080; this figure may exceed the actual carrying capacity of the area. Although the EIS alternatives were designed using the lower population, the Facility Plan Proposed Action was designed using both the original and revised figures.

In the interests of comparability, the same population projections have been incorporated into design and costing of all alternatives. In fact, however, the type of sewer service provided, that is, whether it is centralized or decentralized, may influence the actual design year population. Chapter V discusses the importance of this factor, and presents likely population and land use figures for each alternative.

3. COMPARABILITY OF ALTERNATIVES: FLOW AND WASTE LOAD PROJECTIONS

Design flows for centralized treatment facilities and for the cluster systems are based on a design domestic sewage flow of 60 gallons per capita per day (gpcd) in residential areas for both permanent and seasonal residents. Infiltration and inflow (I/I) into gravity sewers was added to the calculated sewage flow in appropriate alternatives.

The design flow used in the Facility Plan for the Proposed Action ranged from 100 gpcd for permanent residents, to 60 gpcd for seasonal users, including I/I. To compare costs properly in this EIS, flows developed for the EIS alternatives were used to re-calculate flows for the Proposed Action.

The domestic sewage generation rate depends upon the mix of residential, commercial, and institutional sources in the area. Studies on residential water usage (Siegrist, Witt, and Boyle 1976; Bailey et al. 1969; Cohen and Wallman 1974) reported individual household water consumptions varying widely between 20 and 100 gpcd. However, average values reported in those studies generally ranged between 40-56 gpcd. For communities with populations of less than 5,000, EPA regulations allow design flows in the range of 60 to 70 gpcd where existing per capita flow data is not available.

Water consumption by seasonal users varies much more than consumption by permanent residents. The actual consumption rates depend upon such factors as type of accommodations in the area and type of recreation areas available. EPA regulations (EPA 1978) suggest that seasonal population can be converted to equivalent permanent population by using the following multipliers:

Day-use visitor	0.1 to 0.2
Seasonal visitor	0.5 to 0.8

A multiplier of 1.0 was applied to the projected seasonal population to account for both day-use and seasonal visitors. Considering the possible error in projecting future seasonal populations, the preponderance of present seasonal visitors using well-equipped private dwellings and the lack of data on day-use visitors, this multiplier was thought conservative, i.e., it probably overestimates flows to some degree.

The design flow figure of 60 gpcd does not reflect reductions in flow from a program of water conservation. Residential water conservation devices, discussed in Section B.1.a, could reduce flows by 16 gpcd.

B. COMPONENTS AND OPTIONS

1. FLOW AND WASTE REDUCTION

a. Residential Flow Reduction Devices

A variety of devices which reduce water consumption and sewage flow are available. A list of some of the devices is presented in Appendix E-1 with data on their water saving potential and costs. Most of these devices will require no change in the user's hygienic habits and are as maintenance-free as standard fixtures. Others, such as compost toilets, may require changes in hygiene practices and/or increased maintenance. The use of any of these devices may be justified under certain conditions, as when no other device can provide adequate sanitation or when excessive flows cause malfunctions of conventional on-site septic systems. In most cases, however, the justifications for flow reduction devices are economic (see Appendix E-2).

Table III-1 lists proven flow reduction devices and homeowner's savings resulting from their use. Data on the devices listed in Appendix E-1 and local cost assumptions listed beneath the table were used to develop these estimates. The homeowner's savings include savings for water supply, water heating and wastewater treatment. A combination of shower flow control insert device, dual cycle toilet and lavatory faucet flow control device could save approximately $333 per year (see Appendix E-3).

If all residences in the Proposed EIS Service Area were to install these flow reduction devices, they could not all save the $7.03/1000

Table III-1

ESTIMATED SAVINGS WITH FLOW REDUCTION DEVICES

	First Year Savings (or Cost)	Annual Savings After First Year
Shower flow control insert device	$ 71.38	$ 73.38
Dual cycle toilet[a]	$118.74	$138.74
Toilet damming device	$ 66.12	$ 69.37
Shallow trap toilet[a]	$ 64.37	$ 69.37
Dual flush adapter for toilets	$ 53.81	$ 57.81
Spray tap faucet	$(50.53)	$ 24.80
Improved ballcock assembly for toilets	$ 43.35	$ 46.25
Faucet flow control device	$ 14.00	$ 17.00
Faucet aerator	$ 4.58	$ 7.08

[a]First year expenditure assumed to be difference in capital cost between flow-saving toilet and a standard toilet costing $75.

Assumptions

Household:	Four persons occupying dwelling 328 days per year. One bathroom in dwelling.
Water Cost:	Private well water supply. Cost of water = $0.02/1000 gallons for electricity to pump against a 100-foot hydraulic head.
Water Heating Cost:	Electric water heater. Water temperature increase = 100°F. Electricity costs $0.03/kilowatt-hour. Cost of water heating = $7.50/100 gallons.
Wastewater Cost:	Assumed that water supply is metered and sewage bill is based on water supply at a constant rate of $7.03/1000 gallons. Rate is based on 1978 Study Area sewage flow of 005 mgd and local costs of $129,000 in 1978 for Alternative 4 as estimated in this EIS.

gallons in wastewater treatment costs (see assumption in Table III-1). This is due to the fact that a substatial portion of this charge goes to pay off capital, operation and maintenance costs which will remain constant even if flow is reduced. For all to benefit fully from flow reduction then wastewater collection, treatment and disposal facilities would have to be designed with flow capacities that reflect the lower sewage flows. Use of the three types of devices cited above would reduce per capita sewage flows by approximately 16 gpcd. To calculate the cost-effectiveness of community-wide flow reduction, EIS Alternative 4 (see Section IV.B.2) was redesigned and recosted using a design flow based on 44 gpcd instead of 60 gpcd.

The estimated savings in project capital cost (1980) would be $80,800 and the operation and maintenance cost savings would be approximately $4,800 per year. To achieve this savings, approximately $20,400 worth of flow reduction devices would be necessary (see Appendix E-4). The total present worth* of savings over the 20-year design period would be $120,400 or 3% of the total present worth of EIS Alternative 4.

These economic analyses of homeowner's saving and total present worth reduction assumed sewering of all dwellings. However, for dwellings which continue to use on-site systems the economic benefits of flow reduction devices cannot be readily estimated. State regulatory agencies generally do not allow a reduction in the design of conventional on-site systems based upon proposals to use flow reduction devices. However, it is likely that reduced flows will prolong the life of soil absorption systems, saving money in the long run.

Some decentralized technologies may require substantial flow reductions regardless of costs. Holding tanks, soil absorption systems which cannot be enlarged, evaporation or evapotranspiration systems and sand mounds are examples of technologies which would operate with less risk of malfunction if sewage flows could be reduced to the minimum. Sewage flows on the order of 15 to 30 gpcd can be achieved by installation of combinations of the following devices:

- Reduce lavatory water usage by installing spray tap faucets.
- Replace standard toilets with dual cycle or other low volume toilets.
- Reduce shower water use by installing thermostatic mixing valves and flow control shower heads. Use of showers rather than baths should be encouraged whenever possible.
- Replace older clothes washing machines with those equipped with water-level controls or with front-loading machines.
- Eliminate water-carried toilet wastes by use of in-house composting toilets.
- Recycle bath and laundry wastewaters for toilet flushing. Filtering and disinfection of bath and laundry wastes for this purpose has been shown to be feasible and aesthetically

acceptable in pilot studies (Cohen and Wallman 1974; McLaughlin 1968). This is an alternative to in-house composting toilets that could achieve the same level of wastewater flow reduction.

- Recycle bath and laundry wastewaters for lawn sprinkling in summer. The feasibility of this method would have to be evaluated on a trial basis in the Study Area because its general applicability is not certain.

- Commercially available pressurized toilets and air-assisted shower heads using a common air compressor of small horsepower would reduce sewage volume from these two largest household sources up to 90%.

b. Michigan Ban on Phosphorus

Phosphorus is frequently the nutrient controlling algae growth in surface waters and is thus an important influence on lake or stream eutrophication. Enrichment of the waters with nutrients encourages the growth of algae and other microscopic plant life; decay of the plants increases biochemical oxygen demand, decreasing dissolved oxygen in the water. Addition of nutrients encourages higher forms of plant life, thereby hastening the aging process by which a lake evolves into a bog or marsh. Normally, eutrophication is a natural process proceeding slowly over thousands of years. Human activity however, can greatly accelerate it. Phosphorus and other nutrients, contributed to surface waters by human wastes, laundry detergents and agricultural runoff, often result in over-fertilization, over-productivity of plant matter, and "choking" of a body of water within a few years. Appendixes B-3 and B-4 discuss the process and data pertinent for the Crooked/Pickerel Lakes Study Area.

In 1971 the Michigan legislature limited the amount of phosphorus in laundry and cleaning supplies sold in Michigan to 8.7% (MI Public Act 226, Cleaning Agent Act). To reduce phosphorus concentrations in wastewater further, the Michigan Department of Natural Resources subsequently banned statewide the use and sale of all domestic laundry detergents containing more than 0.5% phosphorus. By May 1978, according to monitoring data, influent phosphorus concentrations at 20 wastewater treatment plants had decreased from an average of 6.5 mg/l before the ban to 4.3 mg/l afterward (by telephone, Mr. Mike Stiffler, DNR, Water Quality Division, August 1, 1978). Preliminary analysis indicated that these figures corresponded to a 35% reduction in phosphorus entering the plants. Figure III-1 illustrates these data.

Treatment plants and on-site disposal facilities in the Study Area could experience a similar reduction in phosphorus concentration. However, such characteristics of the Crooked/Pickerel Lakes area as the number of residential laundry facilities may differ from those in the communities where data were collected. Clearly, the extent of phosphorus reduction could only be determined by a more indepth survey of the characteristics of the Study Area.

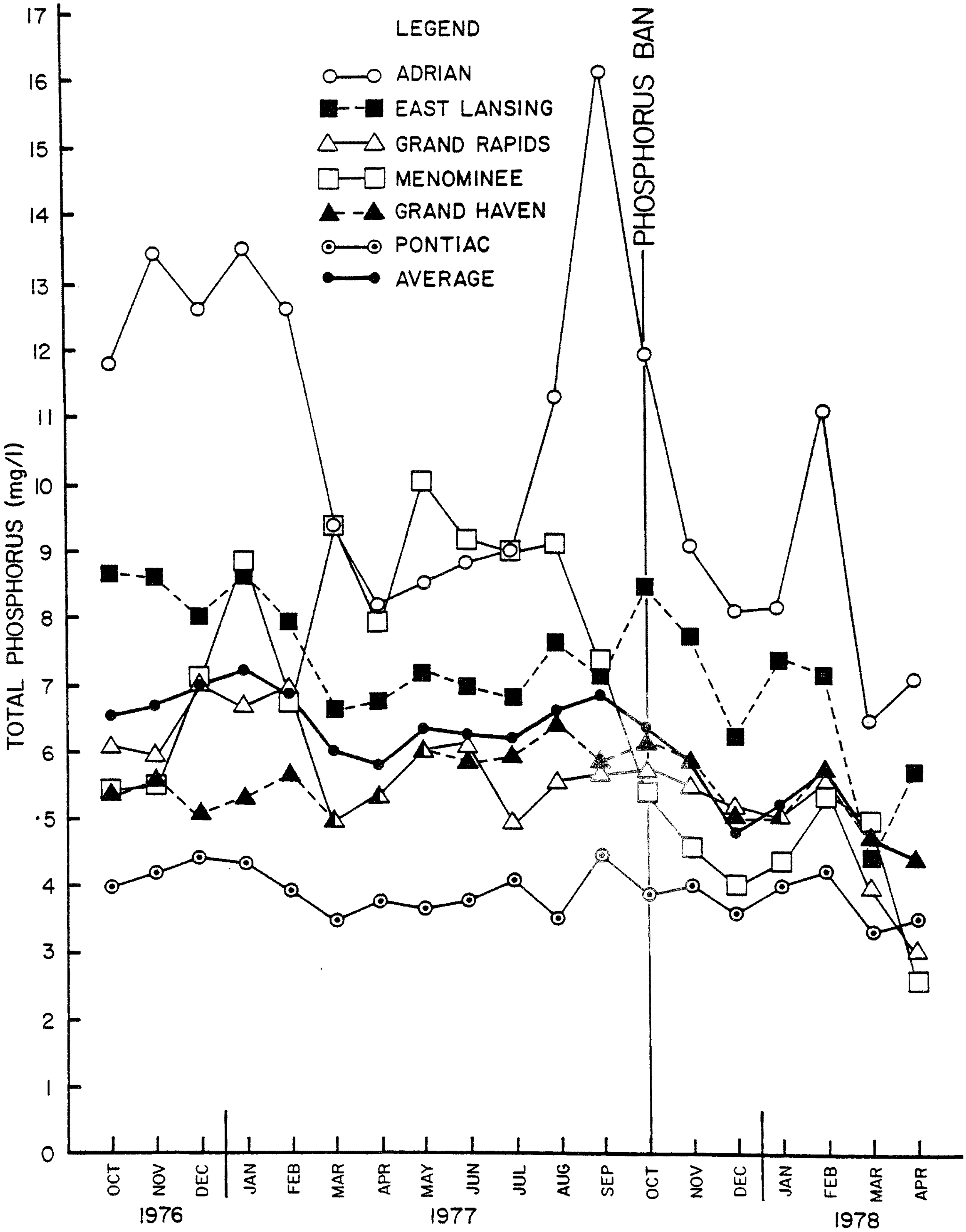


Figure III-1: Phosphorus Loadings at Michigan Treatment Plants

2. COLLECTION

The collection system proposed in the Facility Plan is estimated to cost $8.4 million -- 84% of the total cost of the Proposed Action -- and is the single most expensive portion of the sewerage facilities. Since not all parts of collection systems are eligible for Federal and State funding, the costs of the collection system impact the local community more than other components of the project. There is, therefore, considerable incentive at local, state and national levels to choose less expensive alternatives to conventional sewer systems.

Alternative means of wastewater collection are:

- pressure sewers (including grinder pumps or STEP systems);
- vacuum sewers; and
- small diameter gravity sewers (Troyan and Norris 1974).

An alternative collection system may economically sewer areas with site conditions that increase the cost of conventional sewerage, such as shallow depth to bedrock, high groundwater table, or hilly terrain. Housing density also affects the relative costs of conventional and alternative wastewater collection techniques.

The alternative most extensively studied is collection by a pressure sewer system. The principles behind the pressure system and a water distribution system are opposite to each other. The water system consists of a single point of pressurization and a number of user outlets. Conversely, the pressure sewer system has several inlet points of pressurization and a single outlet. Pressurized wastewater is generally discharged to the treatment facility or to a gravity sewer.

The two major types of pressure sewer systems are the grinder pump (GP) system and the septic tank effluent pumping (STEP) system. The differences between the two systems are in the on-site equipment and layout. The GP system employs individual grinder pumps to convey raw wastewater to the sewer. In the STEP system septic tank effluent from individual households is pumped to the pressure main.

The advantages of pressure sewer systems are:

- elimination of infiltration/inflow;
- reduction of construction cost; and
- use in varied site and climatic conditions.

The disadvantages include relatively high operation and maintenance cost, and the requirement for individual home STEP systems or grinder pumps.

Vacuum sewers provide similar advantages. Their major components are vacuum mains, collection tanks and vacuum pumps, and individual home valve connection systems. A recent review of vacuum sewer technology, however, noted significant differences among design of four major types of current systems (Cooper and Rezek 1975).

As a third alternative to conventional gravity sewers, small diameter (4-inch) pipe can be used if septic tank effluent, rather than raw waste, is collected. Such pipe may result in lower costs of materials, but the systems retain some of the disadvantages of larger sewers. The need for deep excavations and pump stations is unaffected.

The reliability, site requirements, and costs of the alternative sewer systems considered for the Crooked/Pickerel Lake area have been analyzed in this document. As a result of that analysis the STEP-type low-pressure sewer system was determined to be the most advantageous of the three alternatives. A preliminary STEP system serving residents around Crooked/Pickerel Lake was, therefore, designed in order to compare the differences in project costs if the STEP system were substituted for the gravity system specified by the Facility Plan. Assumptions regarding the design and cost of the low pressure sewer system are listed in Appendix F-1. Figure III-2 illustrates the arrangement of the STEP system house pump and sewer line connection.

3. WASTEWATER TREATMENT

Wastewater treatment options comprise three categories: centralized treatment prior to discharge into surface water; centralized treatment prior to land application; and decentralized treatment.

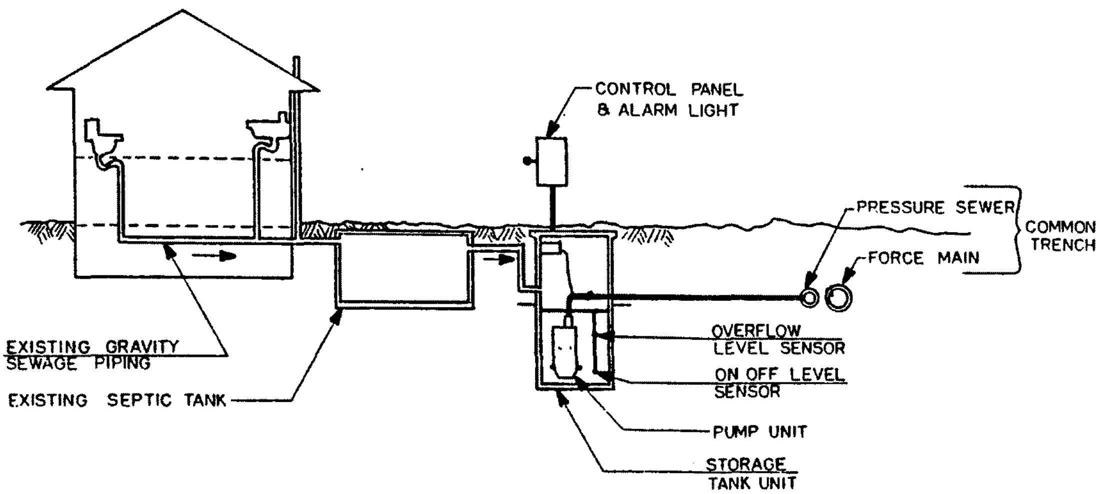
Centralized treatment involves the treatment at a central site of wastewater collected by a single system and transported to a central location. Centralized treatment systems may serve all or a part of the service area. Centrally treated effluent may be discharged to surface waters or applied to the land; the method and site of application affect the treatment process requirements.

"Decentralized treatment" defines those systems processing a relatively small amount of wastewater. Decentralized treatment can be provided on-site or off-site. Typically, effluent disposal occurs in close proximity to the source of sewage eliminating the need for costly transmission of sewage to distant disposal sites.

A major purpose of this EIS is to assess the technical feasibility, relative costs, environmental impacts, and implementation problems associated with these three aproaches to wastewater treatment in the proposed Crooked/Pickerel Lakes EIS Service Area.

a. Centralized Treatment --Discharge to Surface Water

The Facility Plan evaluated four treatment options prior to disposal of wastewaters by discharge to a stream. Sites considered for treatment plant were located along Tannery Creek, or near Little Traverse Bay south of Petoskey State Park. However, discharge to Tannery Creek was ruled out, by the potential adverse effect of chlorinated effluent on migration and spawning of anadromous fish.



TYPICAL PUMP INSTALLATION FOR PRESSURE SEWER

Figure III-2

Based on effluent limitations for discharge into Little Traverse Bay, a minimum of secondary treatment (plus a long, submerged outfall) would be required. The four types of processes considered for treatment were: activated sludge; rotating biological contactor (RBC); aerated lagoons; and chemical precipitation, filtration, and carbon adsorption. Because of the requirements for large (and costly) areas of land, and the potential for nuisances to nearby residences, the aerated lagoon was not evaluated further in the Facility Plan. Similarly physical-chemical treatment plus carbon adsorption was ruled out due to the high costs of regenerating the carbon.

The two biological treatment processes were estimated to have similar capital costs and levels of treatment. The Facility Plan judged the RBC system to be more stable and lower in operating cost, and thus was chosen over activated sludge.

In the RBC system, settleable solids would be removed and wastewater would flow through a series of tanks containing rotating plastic discs that support the treatment microorganisms. Excess sludge removed in the secondary settling tank, would be recycled to the primary settling tank. Combined primary and secondary sludges would be pumped to anaerobic digesters, stabilized, dewatered on sand beds, and used for landfill. Phosphorus would be precipitated with ferric chloride or alum and disposed of as sludge. The effluent would pass through a holding pond and be chlorinated prior to discharge. The system would be expected to achieve 90 - 95% removal of BOD and 80% removal of phosphorus.

b. Centralized Treatment -- Land Application

Land treatment of municipal wastewater uses vegetation and soil to remove many constitutents of wastewater. Several processes are available that can achieve many different objectives of treatment: water reuse, nutrient recycling and crop production. The three principal types of land application systems are:

- Slow rate (irrigation);
- Rapid infiltration (infiltration-percolation); and
- Overland flow. (EPA 1977).

The irrigation technique is illustrated in Figure III-3. The quality of effluent required for land application in terms of BOD and suspended solids is not so high as that for stream discharge. Preliminary wastewater treatment is needed to prevent health hazards, maintain high treatment efficiency by the soil, reduce soil clogging, and insure reliable operation of the distribution system. Generally the equivalent of secondary treatment prior to land applicaton is required (Great Lakes Upper Mississippi River Board of State Sanitary Engineers 1978).

A recent memorandum from EPA (PRM 79-3) may alter the requirements for pretreatment prior to land application. To encourage land treatment of wastewater, EPA has indicated that:

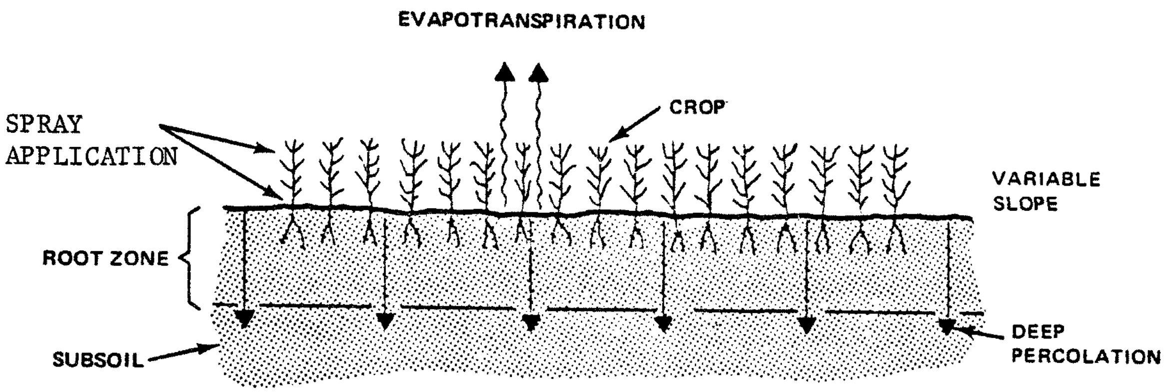


FIGURE III-3

LAND APPLICATION METHOD (SPRAY IRRIGATION)
EVALUATED FOR THE CROOKED/PICKEREL STUDY AREA

"A universal minimum of secondary treatment for direct surface discharge... will not be accepted because it is inconsistent with the basic concepts of land treatment.

...the costs of the additional preapplication increment needed to meet more stringent preapplication treatment requirements [than necessary] imposed at the State or local level would be ineligible for Agency funding and thus would be paid for from State or local funds." (EPA 1978)

The EPA policy has important ramifications for land treatment alternatives. By allowing Federal funding of land used for storage and by underwriting the risk of failure for certain land-related projects the policy promotes their consideration.

Land treatment systems require wastewater storage during periods of little or no application caused by factors such as unfavorable weather. In Michigan, six months of winter storage facilities are necessary.

The land application system evaluated by the Facility Plan consists of two aerated lagoons (total area 1.1 acres) equipped with floating aerators, a holding lagoon (approximately 31 acres) for solids settling and winter storage (November through April), pumps to transport effluent to the irrigation field, and irrigation sprayers. Flow (0.13 mgd) would pass through a flow meter and comminutor to the lagoons, where the wastewater would be mixed and bacterial decomposition of organic matter would take place. For seven days the wastewater would be aerated and the overflow would pass into a holding lagoon. The holding lagoons would have enough capacity to store sludge over the life of the facility without affecting the storage capacity for wastewater. The distance from the lagoons to the nearest dwelling would be 950 feet.

The proposed treatment plant site, occupying 540 acres, would be located in Sections 8 and 17 of Springvale Township. The spray field iteslf would occupy 155 acres. To protect against contamination of the groundwater, wells would be located such that renovated effluent would be pumped from the ground (at a rate of three times that of the applied effluent) and discharged to surface waters.

c. Decentralized Treatment and Disposal

A number of technologies are available which can provide decentralized treatment either on-site or at sites near the point of sewage generation. Disposal of treatment wastewaters can be to the air, soil or surface waters and normally occurs near the treatment site. Some of the available technologies are:

- Alternative toilets:

  Composting toilets

  Toilets using filtered and disinfected bath and laundry wastewater

  Waterless toilets using oils to carry and store wastes

  Incineration toilets

- On-lot treatment and disposal:

  Septic tank and soil absorption systems (ST/SAS)

  Septic tank and dual, alternating soil disposal system

  Aerobic treatment and soil disposal system

  Septic tank or aerobic treatment and sand filter with effluent discharge to surface waters

  Septic tank and evapotranspiration system

  Septic tank and mechanical evaporation system

  Septic tank and sand mound system

  Rejuvenation of soil disposal fields with hydrogen peroxide (H_2O_2) treatments

- Off-lot Treatment and Disposal:

  Holding tanks

  Cluster systems (multiple houses served by a common soil disposal system)

  Community septic tank or aerobic treatment and sand filter with effluent discharge to surface water

  Small scale lagoon with seasonal effluent discharge to surface waters

  Small scale lagoon with effluent discharge at rapid infiltration land application site

Small scale lagoon with seasonal effluent discharge at slow rate land application site

Small scale, preconstructed activated sludge (package) treatment plants with effluent discharge to surface waters.

Because all of the developed portions of the Study Area are located along lakeshores, decentralized technologies which discharge to surface waters were not further considered here. All of the remaining technologies, used alone or in combination with each other or with flow reduction devices, could be useful in individual situations within the Study Area. It is expected that, if the decentralized approach to wastewater management is selected, technologies selected for each dwelling will be appropriate to the problem being remedied (or lack of problem) to the soil and groundwater site characteristics, and to the expected use of the systems.

Lacking necessary information to select appropriate technologies on a site-by-site basis, this EIS assumes that the best known and most reliable decentralized technologies will be used. Continued use of on-site septic tanks and soil absorption systems is the technology of choice where acceptable public health and environmental impacts are attainable with them. Where on-site systems (including alternatives to ST/SAS) are not economically, environmentally or otherwise feasible, cluster systems are assumed to be used. The assumption that only these two technologies will be used is made here to form the basis for cost and feasibility estimates and is not meant to preclude other technologies for any site(s). Estimates of their frequency of repair and construction are conservative to reflect the possibility that other, more appropriate technologies may be more expensive.

Continued use of septic tank-soil absorption systems for most dwellings in the Proposed EIS Service Area would perpetuate violations of the Emmet County Sanitary Code as discussed in Section II.C.2. However, the substantial amount of field investigation undertaken for this EIS has indicated that most existing systems are operating with acceptable environmental and public health impacts. More detailed site investigations may indicate that renovation or replacement of some existing on-site systems is necessary. To estimate the investment this might require, it is assumed that 50% of on-site systems will be replaced with new septic tanks and soil absorption systems.

Detailed site evaluations may show that for some dwellings continued use of on-site systems is not feasible or that repairs for a number of dwellings is more expensive than joint disposal. Cluster systems are subsurface absorption systems similar in operation and design to on-site soil absorption systems but are large enough to accommodate flows from a number of (approximately 20) dwellings. Because of the need to collect and transport wastes, cluster systems include limited collection facilities using pressure sewers, small diameter sewers and/or pumps and force mains. Generally, existing septic tanks would continue to be used for settling and stabilization of wastewater.

As indicated in Section II.A.3.a, soils along the shorelines of Crooked/Pickerel Lakes are generally unsuitable for on-site disposal systems. The size and distribution of apparently suitable sites is such that Crooked/Pickerel Lakes shorelines could be completely served by cluster systems, if necessary. Before use of sites for this purpose, additional analysis of soils and groundwater would be necessary. Figure II-4 indicates the locations of soils suitable for cluster systems. A discussion of soil characteristics appears in Appendix A-1. The exact number and locations of dwellings requiring off-site disposal of wastewater would be determined after detailed evaluation of existing systems.

The cost for cluster systems were developed based on individual cluster systems designed for gropus of residences along the shoreline of Crooked/Pickerel Lakes. The costs include a 20% replacement of septic tanks. The total cost for cluster systems to serve 27% of existing residences was then based on the cost per residence from the typical cluster system design. Design assumptions for this cluster system design appear in Appendix F-2. Design criteria for the cluster systems recommended by the State of Michigan were considered in the development of the typical cluster system design. Presently, there are a number of successfully operating cluster systems in Otter Tail County, Minnesota (by letter, Larry Krohn, Department of Land and Resource Management, Otter Tail County, October 18, 1978) and at many other sites throughout the country.

4. EFFLUENT DISPOSAL

Three approaches exist for disposal of treated wastewater. Reuse, perhaps the most desirable of the three, implies recycling of the effluent by industry, agriculture or groundwater recharge. Land application takes advantage of the absorptive and renovative capacities of soil to improve effluent quality and reduce the quantity of wastewater requiring disposal. Discharge to surface water generally implies the use of streams or impoundments for ultimate disposal of treated effluent.

a. Reuse

Industry Reuse. There is no industrial development in the Study Area, consequently industrial reuse does not seem to be a feasible means of effluent disposal.

Agricultural Irrigation. The use of treated wastewaters for irrigation is addressed in Section III.B.3.b.

Groundwater Recharge. Groundwater supplies all of the potable water in the EIS Service Area. The availability of ample quantities of water from sand and gravel deposits is a significant resource of the area. There is no evidence that these resources are being depleted to the extent that supplemental recharge is necessary. Wastewater reuse by groundwater recharge has therefore not been evaluated.

b. Discharge to Surface Waters

The Facility Plan evaluated biological treatment and land application after which renovated wastewater would be collected. Discharge of treated effluent to surface waters would occur with both of these techniques. The location selected for effluent discharge from the RBC plant was Little Traverse Bay. The Facility Plan did not identify the location of surface water discharge of renovated wastewaters from proposed land application systems, but it would likely be a branch of Minnehaha Creek. Discharge to this tributary may have detrimental effects on Crooked Lake if satisfactory treatment levels are not maintained but there does not appear to be a more favorable location for the disposal of treated effluent in this part of the Study Area.

In the alternatives developed for this EIS discharge to surface waters would only occur if the Petoskey plant were employed for treatment of wastes. In that case, Little Traverse Bay, the existing discharge point, would receive treated wastes from part of the Study Area.

c. Land Application

Land application methods of wastewater treatment that are evaluated for potential use in the Study Area have been briefly described in Section III.B.3.b. The spray irrigation method is illustrated in Figure III-3. The locations of two land application sites evaluated in this EIS are shown in Figure II-5.

Soil suitability for renovation of wastewater at these locations was determined on the basis of a soils survey of Emmet County prepared by the Soil Conservation Service. Both sites have soils with moderate permeability for the most part, and have moderate limitations for wastewater disposal.

The proposed site for the land application system is a 155 acre tract of open land located on the north side of Greenwood road between the branches of Minnehaha Creek. The proposed land application system would have a maximum application rate of 1.6 inches per week over a 26 week period. The major considerations for the use of land application were the favorable soil characteristics in the area and the fact that treatment requirements prior to application would be less costly and complicated than those required for discharge of effluent to surface waters.

Please note that any serious consideration given to implementing an EIS alternative involving spray irrigation must be preceded by a detailed field investigation of the existing soil and groundwater conditions. The SCS soil survey is useful only as a planning tool for the development of wastewater management alternatives.

5. SLUDGE HANDLING AND DISPOSAL

Wastewater treatment options considered above would generate two types of sludges: chemical/biological sludges from the proposed RBC plant; and solids pumped from septic tanks. The residues from treatment by lagoons and land application are grit and screenings. In the land application alternative, the sludge from the biological treatment would settle in the holding lagoons. The holding lagoons would have enough capacity to store the sludge over the life of the facility without affecting the storage capacity for wastewater. Eventually the sludge would be removed and disked into the soil on the adjacent irrigation fields.

The additional sludge that would be produced at the Petoskey plant would be treated and disposed of along with existing sludge quantities. Sludge produced at the Petoskey treatment plant is buried on a 160 acre site approximately 5 miles southeast of the city. The site has been approved by the Department of Natural Resources and has enough capacity to handle the estimated sludge quantities over the life of the treatment facilities. Four monitoring wells are located approximately one mile east of the disposal site to measure any change in groundwater quality.

Sludge from the RBC system treatment alternative would be anaerobically digested and dried on a sludge drying bed. The dried sludge would then be disposed of by land filling in a new site or at the existing Petoskey sludge disposal site.

Alternatives using residential septic tanks for on-lot systems, cluster systems or STEP sewer systems must provide for periodic removal and disposal of sludge. For the purposes of designing and costing these alternatives, it was assumed that pumping would occur every 5 years and cost $50 per pumping. Local septage haulers are licensed to operate in Emmet County; farmlands are typical haul sites.

C. FLEXIBILITY OF COMPONENTS

Flexibility measures system ability to accommodate growth of future changes in requirements. This section examines the flexibility of the components within each alternative and the operational restraints on each and design of the facilities. These are discussed in terms of their impacts upon choices of systems and decisions of planning and design.

1. TRANSMISSION AND CONVEYANCE

For gravity and pressure sewer systems, flexibility is the ability to handle future increases in flow. The ability to handle flows greater than the original design flow is generally low, and an increase in capacity is an expensive process. Also, the layout of the system depends upon the location of the treatment facility. Relocation or expansion of a finished facility would require costly redesign and addition of sewers.

Both gravity and pressure sewers require minimum sewage velocities to prevent deposition of solids which could cause blockage. The velocity of the fluid in gravity sewers depends mainly upon pipe slope. Contour of the ground surface largely determines pipe slope and depth, and consequently, construction costs. Pressure sewers, however, can carry sewage uphill under pressure, not depending upon slope to maintain the flow velocity; they offer the designer somewhat more flexibility than gravity flow pipe.

2. CONVENTIONAL WASTEWATER TREATMENT

Ability to expand a conventional wastewater treatment plant depends largely upon the process being used, layout of the facility, and availability of additional land for expansion. Compared to many systems for land application, conventional treatment processes require little land, thus increasing the flexibility for expansion. However, unless the layout of the plant was designed for future additional capacity, expansion may be hindered. Establishment of a facility such as a sewage treatment plant will reduce flexibility for future planning decisions within the affected municipalities.

Because operators can, to some extent, vary treatment parameters, most conventional processes have good operational flexibility. By altering the amounts and types of chemicals, flow rates, detention times, or even process schemes, the required effluent quality can usually be obtained.

Rotating Biological Contactor (RBC). The use of rotating biological contactors to treat wastewater is relatively new in the United States. The RBC rotates circular discs covered with a film or aerobic bacteria in a basin through which wastewater flows. The disc is usually 40% submerged for aerobic treatment.

RBC's are simple to operate. They are similar in theory to trickling filters, which have been used in the United States since 1908. The RBC units do not require sludge recycling, nor maintenance of a suspended microbial culture as in ativated sludge treatment. The relatively simple operation, therefore, makes operational flexibility high for RBC plants.

The modular nature of RBC reactors makes expansion or upgrading of the plant relatively easy. With proper design of other components of the treatment plant, and proper planning of the facility layout, the cost and effort required for expansion may be relatively small. RBC's are therefore well suited for projects to be constructed in phases over an extended period.

RBC's require relatively shallow basin depths (6-8 feet) which is another advantage. Less structural strength is required for the basin because water volume per square foot of basin area is reduced. Therefore, there is more leeway in choosing a site because structural requirements are lower, and a greater variety of soil types and ground conditions are available from locating the RBC units.

There are several disadvantages to the RBC reactor. The large number of discs usually required in RBC plants limit design flows to the range of 0.1 to 20 mgd. This limitation results from the large requirements for land. The mechanical components have relatively low salvage value, and converting the RBC units to another type process may be costly if these components can not be reused or sold.

3. ON-SITE SEPTIC SYSTEMS

Septic systems are flexible in that they can be custom designed for each user. As long as spatial and environmental parameters are met, the type of system can be chosen according to individual requirements. This flexibility is useful in some rural areas where centralized treatment would be neither cost effective nor desirable.

Existing septic systems can be expanded by adding tank and drainfield capacity, if suitable land is available. Flow can then be distributed to an added system with little disturbance of the existing one.

Cluster systems are septic systems treating wastewater from more than one house, usually 15 to 24. The flexibility for design and expansion of such a system is somewhat less than for a standard septic system. Sizes of cluster systems range from one-quarter to one acre, a substantial increase compared to a standard septic system (of about 1000 square feet). Right-of-way requirements for piping must be considered because the system crosses property boundaries and may cross public property. The location of other underground utilities such as water, electricity, gas, and telephone must also be considered in the design.

An alternative system for on-site sewage treatment, such as an elevated sand mound, is required where siting restrictions prohibit the use of standard septic system and centralized collection of sewage is not available. In these cases future expansion may be difficult or impossible. Stipulations of the health codes restrict the potential of the alternative systems for alteration or expansion.

4. LAND APPLICATION

To be flexible, a land application system should operate efficiently under changing conditions, and should be easily modified or expanded. These factors depend largely upon geographical location.

The ability to handle changes in treatment requirements and wastewater characteristics is a specific measure of flexibility for a land application facility. Furthermore, the level of treatment provided by the land application system will in part determine whether it can handle possible increases in flows in the future. Wastewater in the Crooked/Pickerel Lakes Study Area consists primarily of domestic sewage and future changes in composition of the wastewater are not likely to occur. If industrial wastewater were added in the future, pretreatment at the industrial source may be required.

Expandability is an important element of flexibility. Efficient and economical land acquisition for future flow increases depends upon the proximity of the facility to populated areas, design and layout of the system, additional transmission requirements, and the type of application system used. A number of application mechanisms are available -- spray, overland flow, or rapid infiltration. Sites can be forest land, cropland, or open fields. Attention must be paid, however, to characteristics of the surrounding land, and to possible future changes in land use. Also, requirements are strict concerning the hydraulic and geologic conditions of the proposed site. When initially planning the facility, all of the above mentioned conditions should be taken into consideration if maximum flexibility for future expansion is desired.

Land itself accounts for much of the capital cost for a land application facility, and greatly affects the possibility of expansion or ease of discontinuing the site. Because land normally appreciates in value, the final salvage value of the site may be very high after the expected 20-year design life. If the site is abandoned, much of the initial capital cost of the facility may be recovered by reselling the land at the appreciated price. Note, however, that the public may be reluctant to use the land because of its former use; this would depend largely upon the appearance of the land at the time of resale.

Finally, operational flexibility of land application systems is highly dependent upon climate. When heavy rains saturate the soil or flooding occurs, treatment efficiency is greatly reduced. Where cold temperatures might make land application unusable, storage facilities are required. Very cold climates require up to six months of storage capacity. Rapid infiltration is the only land application technique used successfully in very cold temperatures.

D. RELIABILITY OF COMPONENTS

Reliability measures the ability of a system or system component to operate without failure at its designed level of efficiency. It is particularly important to have dependable operation in situations where adverse environmental or economic impacts may result from failure of the system. This section examines the reliability of components used in EIS alternatives.

1. SEWERS

Gravity Sewers. When possible, sewer systems allow wastewater to flow downhill by force of gravity. This type of system, known as a gravity sewer, is highly reliable. Designed properly, such systems require little maintenance. They consume no energy and have no mechanical components to malfunction.

Problems associated with gravity sewers include clogged pipes, leading to sewer backups; infiltration/inflow, increasing the volume of flow beyond the design level; and broken or misaligned pipes. Major contributors to these problems are improperly jointed pipes and the intrusion of tree roots into the sewer, which tend to be more prevalent in older systems.

Where ground slope is opposite to the direction of sewage flow, it may be necessary to pump the sewage through sections of pipe called force mains. The pumps add a mechanical component which increases operation and maintenance (O&M) requirements and decreases the system reliability. To assure uninterrupted operation of the system, two pumps are generally installed, providing a backup in case one malfunctions. Each is usually able to handle at least twice the peak flow. A standby generator is usually provided to ensure operation of the pumps in case of a power failure.

Because the flow through force mains is intermittent, solids may be deposited during periods of no flow. In addition, when the pumps shut off, the sudden cessation of flow may cause the hydraulic conditions known as "water hammer" in the force main, a phenomenon marked by sudden sharp surges in water pressure that may result in burst pipes. However, both deposition of solids and water hammer may be controlled through proper design procedures. The reliability of properly designed force mains is comparable to that of gravity sewers.

Pressure Sewers. Pressure sewers transmit wastewater uphill when ground topography does not allow gravity flow. Because the system is always under pressure pumping is required to force the wastewater into the sewer.

Grinder Pumps. Grinder pumps are used primarily to grind and pump raw domestic sewage from an individual house to the collection system and occasionally for small lift stations. They are either of the semi-positive displacement or the centrifugal type, depending upon the mode of operation. The reliability of both types is high.

One problem may arise during a power failure. Standby power for a grinder pump would not usually be available at an individual house and the residence would be without sewage removal. This is a lesser problem than might be supposed, for a power failure would curtail many operations that generate wastewater.

There were problems in the operation of the first generation of grinder pumps when pressure to pump wastewater or power to grind solids was insufficient. Modifications have been made in their design and construction, and the second generation of these pumps is appreciably more reliable. Periodic maintenance is required to clean or replace parts of the grinder pump.

Septic Tank Effluent (STEP) Pumps. It is sometimes desirable to pump wastewater from an existing septic tank rather than directly from the house, using septic tank effluent pumps* (STEP) rather than a grinder pump. In this way difficulties associated with suspended solids are largely avoided. STEP pumps are relatively simple modifications of conventional sump pumps.

The reliability of STEP pumps made by experienced manufacturers is good. Newer entries into the field have not yet accumulated the operating experience necessary to demonstrate conclusively the reliability of their products. In the event of failure of a STEP system, an overflow line may be provided, which permits passage of the septic tank effluent to the old drainfield for emergency disposal.

Pipes. Pressure sewer pipes are subject to the same problems as force mains, discussed above. As with force mains, proper design can prevent clogging and breaking of pipes, the most common cause of sewer problems. Because pressure sewer piping has no mechanical components, the reliability is high.

2. CENTRALIZED TREATMENT

Conventional. The reliability of conventional wastewater treatment has been tested by time. Most unit processes have been used for many years, and there is consequently much information on their design and operation in nearly all climates. In general, the larger the treatment facility, the more reliable its operation, because the large volumes of flow require multiple units per treatment process. For instance, a large facility will have several primary clarifiers, and if one malfunctions, the remaining units can handle the entire load. Therefore, difficulties that arise as a result of failure of a single unit process, or of severe weather conditions such as heavy rain or very cold temperatures, are less likely to affect operations. Conventional wastewater treatment plants can be designed to handle most problems.

Land Application. Application of treated sewage effluent to the land is defined by EPA as an alternative or innovative technology. The use of this technology is growing steadily and is gaining acceptance throughout the United States. Local climatic conditions such as heavy rains or very low temperatures may make the technique less suitable in a particular area.

Potential problems with land application include: groundwater contamination; dispersal of microbial mass by airborne transport; odors; surface water contamination; accumulation of metals in the vegetation; and possible toxic effects upon local animals. These problems can be managed to achieve an acceptable level of risk with proper design, operation and maintenance.

3. ON-SITE TREATMENT

Septic Tanks. The design and operation of modern septic tanks have benefited from long experience. Properly designed and maintained, septic systems will provide satisfactory service with minimum maintenance. Care must be taken not to put materials in the system that may clog it. The principal maintenance requirement is periodic pumping of the tank.

Problems of septic systems include heavy rain saturating the ground, clogged drainfields caused by full septic tanks, clogged or frozen pipes, and broken pipes. Current environmental laws restricting sites according to such factors as soil suitability, depth to groundwater and bedrock, limit the cases where septic systems can be used.

Sand Mounds. Elevated sand mounds four or five feet above original ground level, are an alternative drainage mechanism where siting restrictions do not allow the use of standard drainfields. Because they do not always provide satisfactory service and are considerably more expensive than conventional drainfields, they have not been universally accepted. However, if properly designed, constructed, and maintained elevated sand mounds can provide adequate service.

4. CLUSTER SYSTEMS

Cluster systems are localized wastewater disposal mechanisms servicing several residences. The reliability is similar to that of a septic system, except that a malfunction affects not just one, but a number of residences. Because a cluster system requires more piping to connect individual houses to the treatment tank than does a series of individual systems, there is a greater chance for pipes to break or clog, or for I/I to occur during heavy rain. If pumping is required, the reliability of the system declines because of the mechanical nature of the pumps and their dependence upon electricity for power.

E. IMPLEMENTATION

The method by which a wastewater management plan is to be implemented depends upon whether the selected alternative relies primarily upon centralized or decentralized components. Since most sanitary districts have in the past been designed around centralized collection and treatment of wastewater, there is a great deal of information about the implementation of such systems. Decentralized collection and treatment is, however, relatively new and there is little management experience on which to draw.

Regardless of whether the selected alternative is primarily centralized or decentralized, four aspects of the implementation program must be addressed:

- There must be legal authority for a managing agency to exist and financial authority for it to operate.

- The agency must manage construction, ownership and operation of the sanitary district.

- A choice must be made between the several types of long-term financing that are generally required in paying for capital expenditures associated with the project.

- A system of user charges to retire capital debts, to cover expenditures for operation and maintenance, and to provide a reserve for contingencies must be established.

In the following sections, these requirements are examined first with respect to centralized sanitary districts, then with respect to decentralized districts.

1. CENTRALIZED DISTRICTS

a. Authority

The Little Traverse Bay Area Facility Plan identified the Springvale-Bear Creek Sewage Disposal Authority as the legal authority for implementing the Plan's Proposed Action. According to the Plan, the Authority would have the legal and financial capability to finance, construct, operate and maintain the proposed wastewater collection and treatment system. Under Act 233 of the Michigan Public Acts of 1975 as amended, the Authority has the power to implement the Proposed Action contract with the villages and townships for services.

b. Managing Agency

The role of the managing agency has been well defined for centralized sanitary districts. In general, the agency constructs, maintains and operates the sewerage facilities. Although in fact different contractual relationships exist between the agencies and their service areas, for the purposes of this document ownership of the facilities may be assumed to reside with the agency. For gravity sewers, such ownership has traditionally extended to the private property. For STEP or grinder pump stations connected to pressure sewers several options exist:

- The station may be designed to agency specifications, with the responsibility for purchase, maintenance and ownership residing with the homeowner.
- The station may be specified and purchased by the agency, with the homeowner repurchasing and maintaining it.
- The station may be specified and owned by the agency, but purchased by the homeowner.
- The station may be specified, purchased and owned by the agency. Regardless, however, of the option selected, all residences are treated equally.

c. Financing

Capital expenses associated with a project may be financed by several techniques. Briefly, they are:

- pay-as-you-go methods;
- special benefit assessments;
- reserve funds; and
- debt financing.

The Facility Plan indicated that the Proposed Action would be funded in part by Federal and State grants, and recommended that revenue bonds be issued to pay the local share. The Farmers Home Administration would purchase the bonds, which would bear interest of 5% and mature in 40 years.

d. User Charges

User charges are set at a level that will provide for repayment of long-term debt and cover operating and maintenance expenses. In addition, prudent management agencies frequently add an extra charge to provide a contingency fund for extraordinary expenses and replacement of equipment.

The implementation program proposed by the Facility Plan is an example of a scheme calling for an Authority to recover the costs of wastewater management from the local municipalities. The municipalities would, in turn, charge the users of the system. Because of the potential economic impacts, the charges must be carefully allocated among various classes of users. Recognized classes of users might include:

- Permanent residents/Seasonal residents;
- Presently sewered users/Newly sewered users; and
- Low- and fixed-income residents/Active income producers.

Each class of user imposes different requirements on the design and cost of each alternative, receives different benefits, and has different financial capabilities. To illustrate the allocation techniques that are available, three possible user charge schemes have been examined in Appendix I-1.

2. SMALL WASTE FLOW DISTRICTS

Regulation of on-lot sewage systems has evolved to the point where most new facilities are designed, permitted and inspected by local health departments or other agencies. After installation, local government has no further responsibility for these systems until malfunctions become evident. In such cases the local government may inspect and issue permits for repair of the systems. The sole basis for government regulation in this field has been its obligation to protect public health. Rarely have governmental obligations been interpreted more broadly to include monitoring and control of other effects of on-lot system use or misuse. The lack of knowledge of the operation of on-site system has consequently been coupled with a general absence of information concerning impacts of septic systems on ground and surface water quality.

Methods of identifying and dealing with the adverse effects of on-lot systems without building expensive sewers are being developed. Technical methods include both the wastewater treatment and disposal alternatives discussed in Section III.B and improved monitoring of water quality. Managerial methods have already been developed and are being applied in various communities as discussed in Appendix G-1.

As with any centralized district, the issues of legal and fiscal authority, agency management, project financing, and user charges must all be resolved by small waste flow districts.

a. Authority

Michigan presently has no legislation which explicitly authorizes governmental entities to manage wastewater facilities other than those connected to conventional collection systems. However, Michigan Statutes Sections 123.241 et seq. and 323.37 et seq., and Chapter 116A have been interpreted as providing cities, townships, villages and counties, sufficient powers to manage decentralized facilities (Otis and Stewart 1976).

California and Illinois, to resolve interagency conflicts or to authorize access to private properties for inspection and maintenance of wastewater facilities, have passed legislation specifically intended to facilitate management of decentralized facilities. These laws are summarized in Appendix G-2.

b. Management

The purpose of a small waste flow district is to balance the costs of management with the needs of public health and environmental quality. Management of such a district implies formation of a management agency and formulation of policies for the agency. The concept of such an agency is relatively new. Appendix G-3 discusses this concept in detail.

The range of functions a management agency may provide for adequate control and use of decentralized technologies is presented in Table III-2. Because the level of funding for these functions could become an economic burden, their costs and benefits should be considered in the development of the management agency. Major decisions which have to be made in the development of this agency relate to the following questions:

- Should engineering and operations functions be provided by the agency or by private organizations under contract?
- Would off-site facilities require acquisition of property and right-of-way?
- Would public or private ownership of on-site wastewater facilities be more likely to provide cost savings and improved control of facilities operation?

Table III-2

SMALL WASTE FLOW MANAGEMENT FUNCTIONS BY OPERATIONAL COMPONENT AND BY BASIC AND SUPPLEMENTAL USAGE

Component	Basic Usage	Supplemental Usage
Administrative	User charge system Staffing Enforcement	Grants administration Service contracts supervision Occupancy/operating permits Interagency coordination Property and right-of-way acquisition Performance bonding requirements
Engineering	Adopt design standards* Review and approval of plans* Evaluate Existing systems/ design rehabilitation measures Installation inspection* On-site soils investigations* Acceptance for public management of privately installed facilities	Design and install facilities for public ownership Contractor training Special designs for alternative technologies Pilot studies of alternative technologies Implementing flow reduction techniques
Operations	Routine inspection and maintenance Septage collection and disposal Groundwater monitoring	Emergency inspection and maintenance Surface water monitoring
Planning		Land use planning Public education Designate areas sensitive to soil-dependent systems Establish environmental, land use and economic criteria for issuance or non-issuance of permits

* Usage normally provided by local governments at present.

- Are there environmental, land use, or economic characteristics of the area that would be sensitive to operation and construction of decentralized technologies? If so, would special planning, education and permitting steps be appropriate?

Five steps are recommended to implement an efficient, effective program for the management of wastewater in unsewered areas:

- Develop a site-specific environmental and engineering data base;

- Design the management organization;

- Agency start-up;

- Construction and rehabilitation of facilities; and

- Operation of facilities.

Site Specific Environmental and Engineering Data Base. The data base should include groundwater monitoring, soils and engineering studies, and a survey of available technologies likely to function adequately in the area. This baseline information will provide the framework for the systems and technologies appropriate to the district.

A program for monitoring groundwater should include sampling of existing wells and possibly additional testing of the aquifer. Such monitoring should be instituted early enough to provide data useful in selecting and designing wastewater disposal systems.

Detailed site analyses may be required to evaluate operation of the effluent disposal fields and to determine the impacts of effluent disposal upon local groundwater. These studies may include probing the disposal area; boring soil samples; and installating shallow groundwater observation shafts. Sampling of the water table downhill from leach fields aids in evaluating the potential for transport of nutrients and pathogens through the soil. Soil classifications near selected leach fields may improve correlations between soils and leach field failures. An examination of the reasons for the inadequate functioning of existing wastewater systems may avoid such problems with the rehabilitation or construction of new systems.

Design the Management Organization. Both the Facilities Plan and the EIS have recommended the Springvale-Bear Creek Sewage Disposal Authority as the agency best suited to managing wastewater facilities in both unsewered and sewered areas of the Study Area. An analysis of the Authority's technical and administrative capabilities as outlined in Table III-2, should proceed concurrently with development of the environmental and engineering data base. The role of organizations such as the Department of Health should be examined with respect to avoiding interagency conflicts and duplication of effort and staffing.

Determination of the basic and supplementary management functions to be provided will be influenced by the technologies appropriate to the Study Area. In this respect, the questions raised earlier regarding formulation of management policies must be resolved.

The product of these analyses should be an organizational design in which staffing requirements, functions, interagency agreements, user charge systems and procedural guidelines are defined.

Agency Start-Up. Once the structure and responsibilities of the management agency have been defined, public review is advisable. Additional personnel required for construction and/or operation should be provided. If necessary, contractual arrangements with private organizations should be developed. Acquisition of property should also be initiated.

Construction and Rehabilitation of Facilities. Site data collected for the environmental and engineering data base should support selection and design of appropriate technologies for individual residences. Once construction and rehabilitation begin, site conditions may be revealed that suggest technology or design changes. Since decentralized technologies generally must be designed to operate within site limitations instead of overcoming them, flexibility should be provided. Personnel authorized to revise designs in the field would provide this flexibility.

Operation of Facilities. The administrative planning, engineering, and operations functions listed in Table III-2 are primarily applicable to this phase. The role of the management agency would have been determined in the organizational phase. Experience gained during agency start-up and facilities construction may indicate that some lower or higher level of effort will be necessary to insure long term reliability of the decentralized facilities.

c. Financing

The financing of a small waste flows district is similar to that of a centralized district. Such financing was discussed in Section III.E.1.c.

d. User Charges

Although renovation and replacement costs for on-site systems owned by permanent residents are eligible for Federal funding, such costs incurred by seasonal residents are not. The major difference in the financing of the two systems arises from the question of seasonals' ownership of on-site systems. With respect to the Study Area, where a significant proportion of the users would be seasonal, the absence of Federal funding would transfer a large fraction of the project costs to the local users. This would be reflected in either 1) capital outlays by the users for construction, 2) increased user charges covering increased local costs or 3) both.

User charges and classes have been discussed in Section III.E.1.d. The significance of decentralized districts lies in the creation of an additional class of users. Since residents of such districts may be differentiated in terms of centrally sewered areas and decentralized areas, user charges may differ. As a result many different management functions are conjoined. For example, permanent users on septic systems may be charged less than those on central sewers. Seasonal users on pressure sewers may have high annual costs associated with amortization of capital expenses; permanent users of pressure sewers may be charged less than seasonal users, because Federal funding reduced their share of the capital costs. Alternatively, the management agency may choose to divide all costs equally among all users. For the analyses in this EIS, public ownership of permanent and seasonal on-site systems has been assumed.

Problems such as these have not been adequately addressed by the historical sources of management information. Development of user charges by small waste flows districts will undoubtedly be complicated by the absence of such historical records. EPA is preparing an analysis of equitable means for recovering costs from users in small waste flow districts and combined sewer/small waste flow districts.

CHAPTER IV

EIS ALTERNATIVES

A. INTRODUCTION

The preceding chapter described options for the functional components of wastewater management systems for the communities in the Study Area. This chapter examines alternative wastewater management plans -- alternative courses of action for the Study Area, including a No Action Alternative.

The Proposed Action developed in the Facility Plan (described earlier) provided for centralized collection and treatment of wastewater. In response to questions about the need for and expense of the Proposed Action, the development of EIS alternatives emphasized decentralized and alternative or innovative technologies: alternative collection systems, decentralized treatment and land disposal of wastewaters. The EIS alternatives would manage wastewaters in the same Service Area as the Facility Plan Proposed Action, but four of the EIS alternatives use decentralized treatment to partly avoid the costs of sewers.

Analysis of decentralized treatment technologies and site conditions showed feasible alternatives to sewering the entire Crooked/ Pickerel Lakes shoreline. It would be possible to combine multi-family filter fields (cluster systems) with rehabilitated and new on-site treatment systems to meet the wastewater treatment needs in parts of the Study Area.

Because of the high cost of collection in the Proposed Action, the cost-effectiveness of pressure sewers, vacuum sewers, and small-diameter gravity sewers was compared. The Facility Plan Proposed a combination of pressure and gravity sewers and the choice was generally affirmed for decentralized EIS Alternatives.

Where site conditions such as soils and topography are favorable, land application of wastewater offers advantages over conventional biological treatment systems that discharge to surface waters: the land acts as a natural treatment facility; relatively simple operations may reduce operation and maintenance costs. Savings in capital costs are also possible. Four of the EIS Alternatives exploit these advantages and have incorporated land treatment as part of the action.

Appendix H-2 presents the assumptions used in design and costing of the alternatives. Section 2 lists the major features of the Proposed Action, and the EIS Alternatives.

B. ALTERNATIVES

1. SUMMARY OF MAJOR COMPONENTS

Table IV-1 summarizes major components of alternatives, as discussed in Chapter III. Table IV-2 lists flow and residential information for each segment in the Study Area (see Figure IV-1).

2. ALTERNATIVES

Chapter I summarized the wastewater management alternatives developed in the Facility Plan. The Facility Plan divided the Springvale-Littlefield area into three sections. Sections 1 and 2 are in the western parts of the region, and Section 3 includes the Springvale and Littlefield Townships area, around the shores of Crooked/ Pickerel Lakes. The Facility Plan proposed regional collection system with centralized treatment. EPA approved this plan for Sections 1 and 2, but not Section 3. The need for consideration of alternatives was due primarily to the high cost of the regional collection/centralized treatment wastewater management system. Therefore, this EIS concentrate on the decentralized, less expensive approaches to wastewater management.

The alternatives include a No Action Alternative, the Facility Plan Proposed Action, at two different flows, and six new alternatives based on combinations of the components and options discussed in the previous chapter. The new alternatives are based on the following factors:

- Increased use of low-pressure sewers. In rural areas such as the Study Area, the collection of wastewater comprises much of the project cost. To reduce costs, the use of pressure sewers, rather than gravity sewers, therefore, forms a major part of the collection facilities in the new alternatives.

- Decentralized wastewater treatment . The EIS alternatives include continued use of on-site treatment facilities (upgraded where necessary), the use of multi-family drain fields (cluster systems), and the use of smaller central collection systems with effluent disposal within the Study Area.

- Use of land treatment systems. If soil and other site conditions are favorable, treatment of wastewater by land application offer advantages over centralized mechanical-type or biological treatment systems discharging plant effluent to surface waters. Operation may be simpler and thus saving money. Conventional treatment systems, on the other hand, require less land, and may provide a more consistent quality of effluent. The EIS alternatives included the continued use of septic tanks with soil absorption systems on individual lots, the use of subsurface disposal systems for clusters of residences, the use of land application by irrigation after pre-treatment, and the use of the conventional/ biological system at the Petoskey Treatment Plant.

Table IV-1

EIS ALTERNATIVES - SUMMARY OF MAJOR COMPONENTS

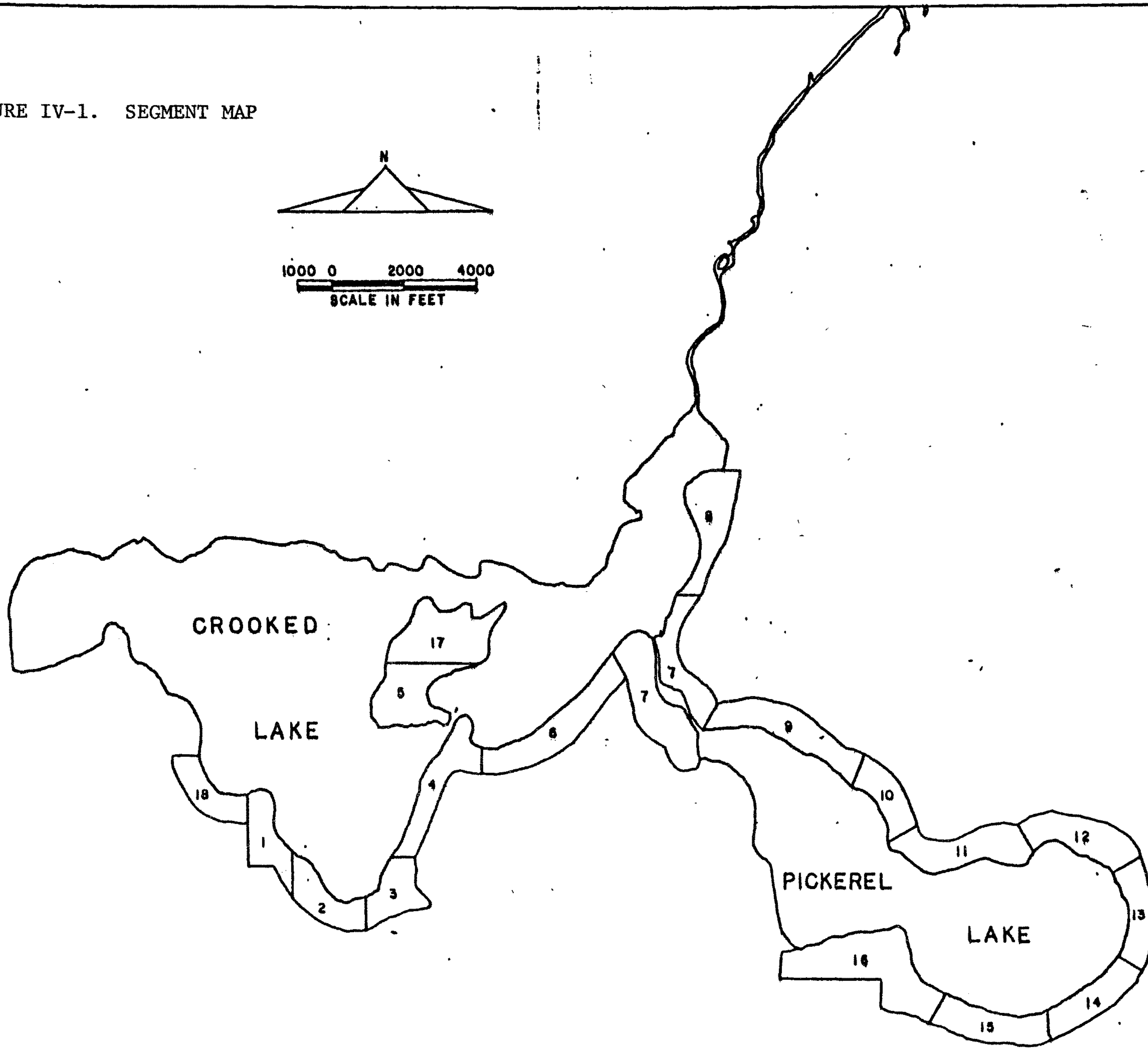
ALTERNATIVE	CENTRALIZED TREATMENT	CENTRALIZED SERVICE AREA	EFFLUENT DISPOSAL	ON-SITE & CLUSTER SYSTEMS	ALTERNATIVE CENTRALIZED COLLECTION SYSTEM
Facility Plan Proposed Action	Existing Petoskey Treatment Plant (0.08 mgd)	Total Proposed Service Area	Petoskey Plant discharges to Little Traverse Bay	No	Small numbers of grinder pumps
EIS Alternative 1	No	-	-	Total Proposed Service Area (clusters)	-
EIS Alternative 2	Facultative Lagoon (0.02 mgd)	South Shore Crooked Lake	Land Application by spray irrigation	Oden Island and corridor between lakes (clusters)	Collection for both centralized systems by combination STEP pressure sewers, gravity sewers and force mains
	Facultative Lagoon (0.06 mgd)	Pickerel Lake	Land Application by spray irrigation		
EIS Alternative 3	Existing Petoskey Treatment Plant (0.02 mgd)	South Shore Crooked Lake and Oden Island	Petoskey Plant discharges to Little Traverse Bay	Pickerel Lake and corridor between lakes (clusters)	Combination STEP pressure sewers, gravity sewers and force mains
EIS Alternative 4	Facultative Lagoon (0.08 mgd)	Total Proposed Service Area	Land Application by spray irrigation	No	Combination STEP pressure sewers, gravity sewers and force mains
EIS Alternative 5	Facultative Lagoon (0.02 mgd)	South Shore Crooked Lake	Land Application by spray irrigation	Oden Island, Pickerel Lake and corridor between lakes (clusters)	Combination STEP pressure sewers, gravity sewers and force mains
EIS Alternative 6	No	-	-	Total Proposed Service Area (On-site and clusters)	-

Table IV-2

POPULATION YEAR 2000

SEGMENT	SEASONAL	PERMANENT	TOTAL	FLOW (MGD)
1	4	9	13	.00078
2	0	12	12	.00072
3	16	21	37	.00222
4	52	51	103	.00618
5	16	48	64	.00384
6	36	123	159	.00954
7	16	6	22	.00132
8	16	21	37	.00222
9	0	0	0	0
10	60	33	93	.00558
11	52	51	103	.00618
12	48	42	90	.0054
13	64	18	82	.00456
14	112	36	148	.00888
15	28	24	52	.00312
16	140	105	245	.0147
17	0	3	3	.00018
18	0	0	0	0
	TOTAL		1,263	.07578

FIGURE IV-1. SEGMENT MAP



a. No Action

The EIS process must always evaluate the No Action Alternative. This would consist of EPA providing no Federal funds for construction of wastewater collection and treatment systems in Section 3 of the Study Area. If this course of action were followed, all existing on-site systems in the Study Area would presumably continue to be used in their present condition.

b. Facility Plan Proposed Action

For the Springvale/Littlefield area, the Facility Plan proposes a regional collection system, centralized treatment at the existing Petosky plant, and discharge of treated effluent to Little Traverse Bay. A system of gravity sewers and 10 pump stations would collect regional wastewater; 29 additional homes would be connected to the system by pressure sewers. Figure IV-2 diagrams the collection system. The cost of this action was initially computed based upon the flow from a population of 2,080 and recomputed based upon the flow from the EIS baseline figure of 1,263 persons.

c. EIS Alternative 1

EIS Alternative 1 proposes decentralization using cluster systems to serve almost the entire Study Area. Figure IV-1 shows the Study Area divided into 18 segments, which have been used throughout this study to plan the various alternatives. Figure IV-3 shows the arrangement of the clusters which have been selected for evaluation as EIS Alternative 1. Table IV-3 shows the number of dwellings used in the design of the cluster systems, indicating the growth expected in the various areas.

Holding tanks would be required for 4 existing and 2 future dwellings in Segment 7, because soils in that segment are too wet for cluster systems. These holding tanks could be associated with compression type low flow toilets holding only human waste and requiring pumping only once in 6 months; greywater could be treated by septic tank/soil absorption systems. Other innovative systems, including composting toilets and greywater recycling may be appropriate if the area were developed, but these approaches have not been investigated in this EIS. Within each cluster, septic tanks from individual homes would discharge effluent into gravity sewers that terminate at a pump station; wastewater would then be pumped to the cluster drainfield. The drainfields for each cluster would occupy twice the area calculated to be necessary for the number of houses in the design year, thus providing a safety factor of 100%. In addition, hydro-geologic surveys would be required in the drainfield areas to show that the soil and groundwater could assimilate the amount of effluent discharged. Each drainfield would have three monitoring wells to detect any contamination of groundwater.

The locations of the drainfields were selected on the basis of available soil and groundwater information. If this alternative were

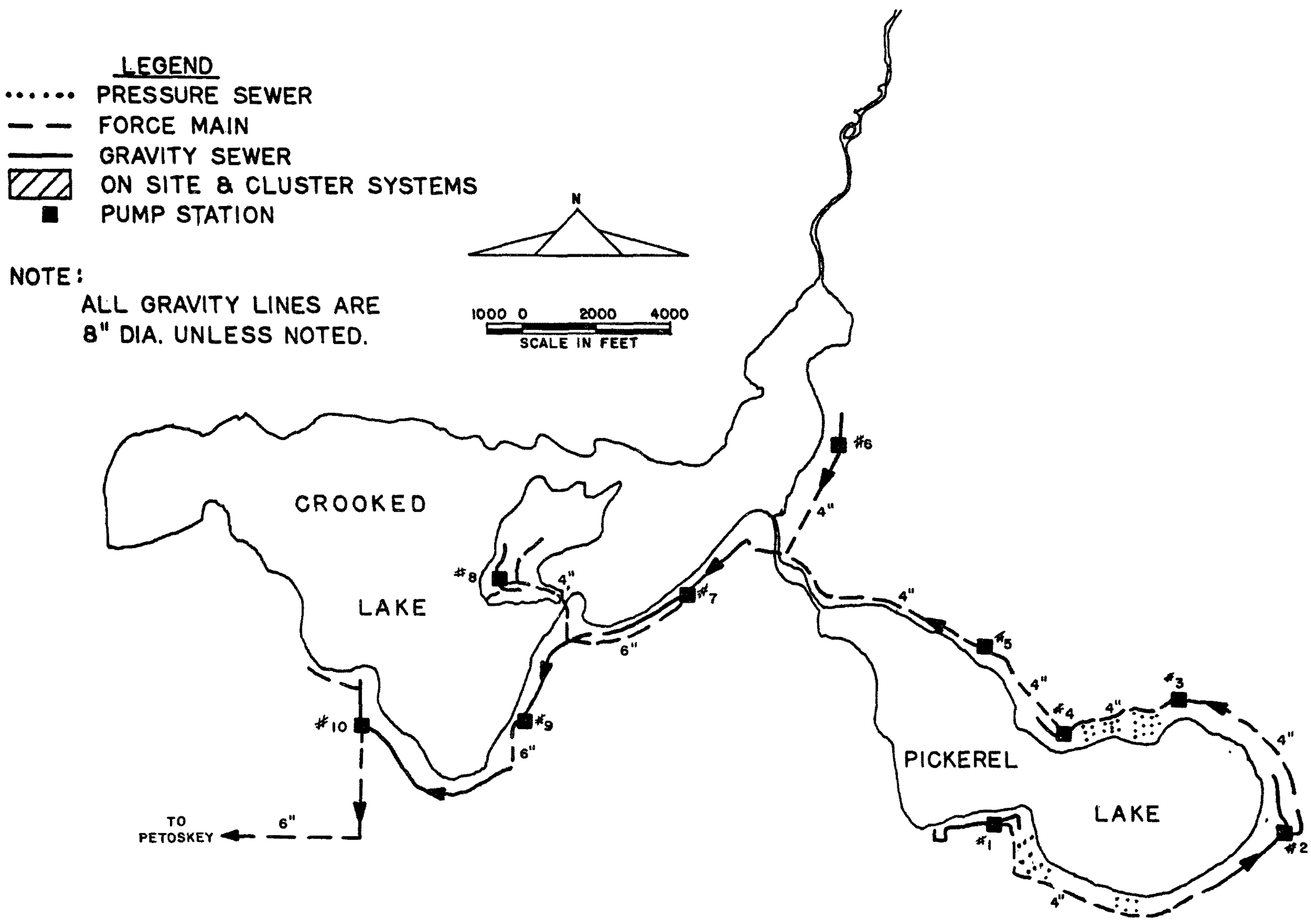


FIGURE IV- 2 FACILITY PLAN PROPOSED ACTION

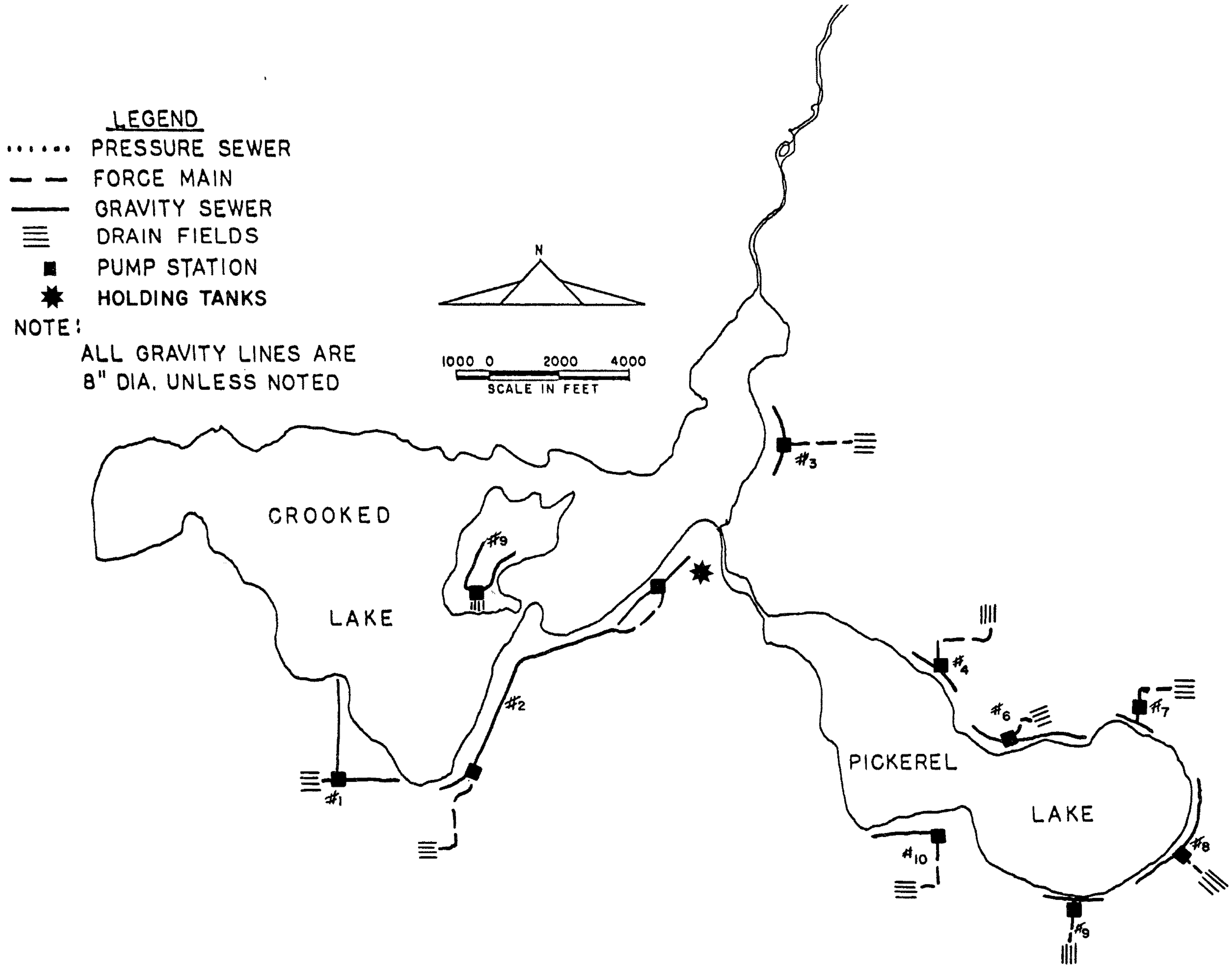


FIGURE IV- EIS ALTERNATIVE 1

Table IV-3

CLUSTER DESIGN VALUES

CLUSTER	SEGMENTS	DWELLING UNITS 1978	DWELLING UNITS 2000
1	1,2,18	6	8
2	3,4,6	48	91
3	8	5	11
4	10	13	26
5	5,17	16	21
6	11	15	30
7	12	14	26
8	13,14	52	62
9	15	3	15
10	16	46	70
11	7	4	6
12	9	0	0

chosen for detailed design study, more precise information would be necessary in order to determine the exact locations of suitable sites.

To make all alternatives comparable, the areas served by the collection systems were chosen so as to cover the area designated as the "20-year service area" in the Facility Plan. If EIS Alternative 1 were chosen, it is possible that some of the cluster systems shown might not be built or could be modified, due to particular site conditions. Cluster systems are readily adaptable to the service of discontinuous areas, and are thus suitable for protection of environmentally sensitive areas.

d. EIS Alternative 2

This alternative would employ central collection and land application of wastewater for a portion of the area around each lake. Figure IV-4 the remaining segments that would be served by cluster systems. Each central collection system would use both pressure (STEP system) and gravity sewers to serve their respective areas. The centralized treatment would include a waste stabilization lagoon for primary treatment and storage followed by land application of wastewater by spray irrigation, as shown in Figure IV-5.

The Crooked Lake central collection system, serving Segments 1, 2, 3, 4, and 6, would contribute a design flow of 0.02 mgd. Finding a suitable 20-acre spray irrigation site sufficiently distant from existing developments, requires the use of land in Hardwood State Forest. State representatives did not eliminate the possibility of using these lands, but further discussions and approval would be necessary if this alternative were selected.

The Pickerel Lake collection system serving Segments 10, 11, 12, 13, 14, 15, and 16, which would contribute a design flow of 0.05 mgd. Suitable spray irrigation site (35 acres) would apparently be available within reasonable distances. The remaining Segments, 5, 17, and 8, would be treated by cluster systems, corresponding to clusters 5 and 3 of EIS Alternative 1. Segment 7 would be served by holding tanks, or other innovative systems as discussed under EIS Alternative 1.

e. EIS Alternative 3

For the Crooked Lake and Oden Island areas, this alternative proposes a centralized collection system with wastewater treatment at Petoskey. Cluster systems would serve Pickerel Lake, as shown in Figure IV-6. A combination of gravity and pressure sewers (STEP) collects the Crooked Lake area, in a manner somewhat similar to the Facility Plan Proposed Alternative. The Pickerel Lake cluster systems would resemble those in EIS Alternative 1. Segment 7 would be served by holding tanks, or other innovative systems discussed under EIS Alternative 1.

f. EIS Alternative 4

This alternative proposes centralized collection of the entire service area (design flow of 0.08 mgd) and land application, as shown in

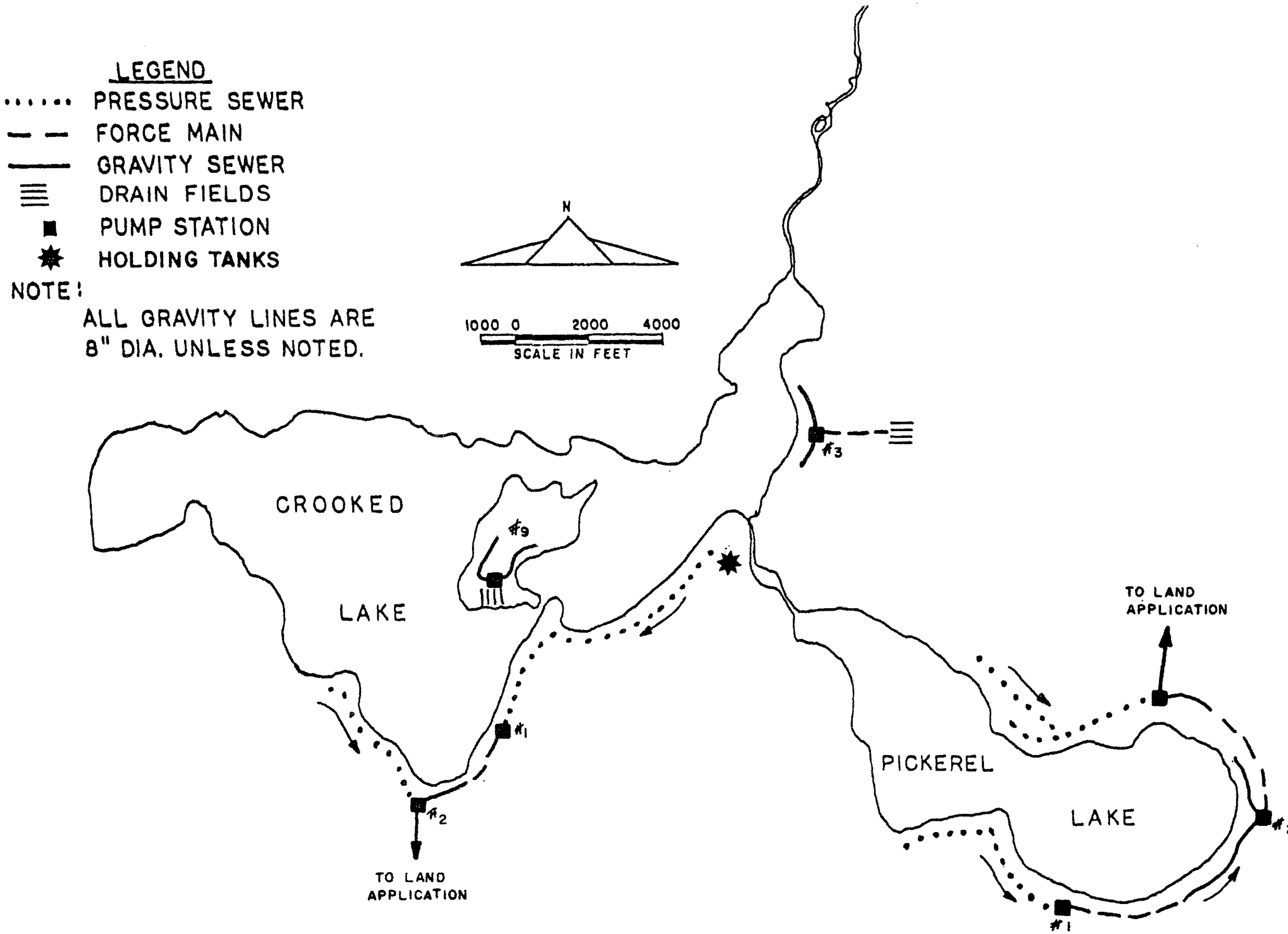


FIGURE IV- 4 EIS ALTERNATIVE 2

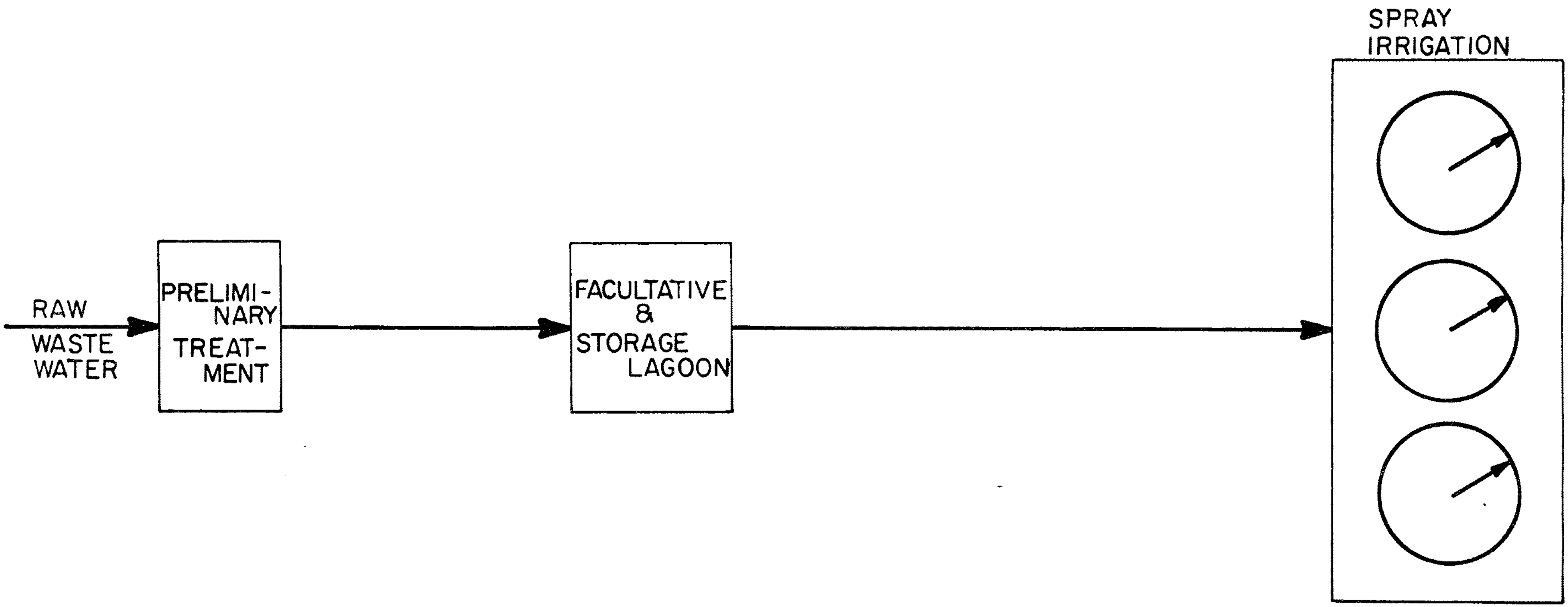


FIGURE IV-5. LAND APPLICATION

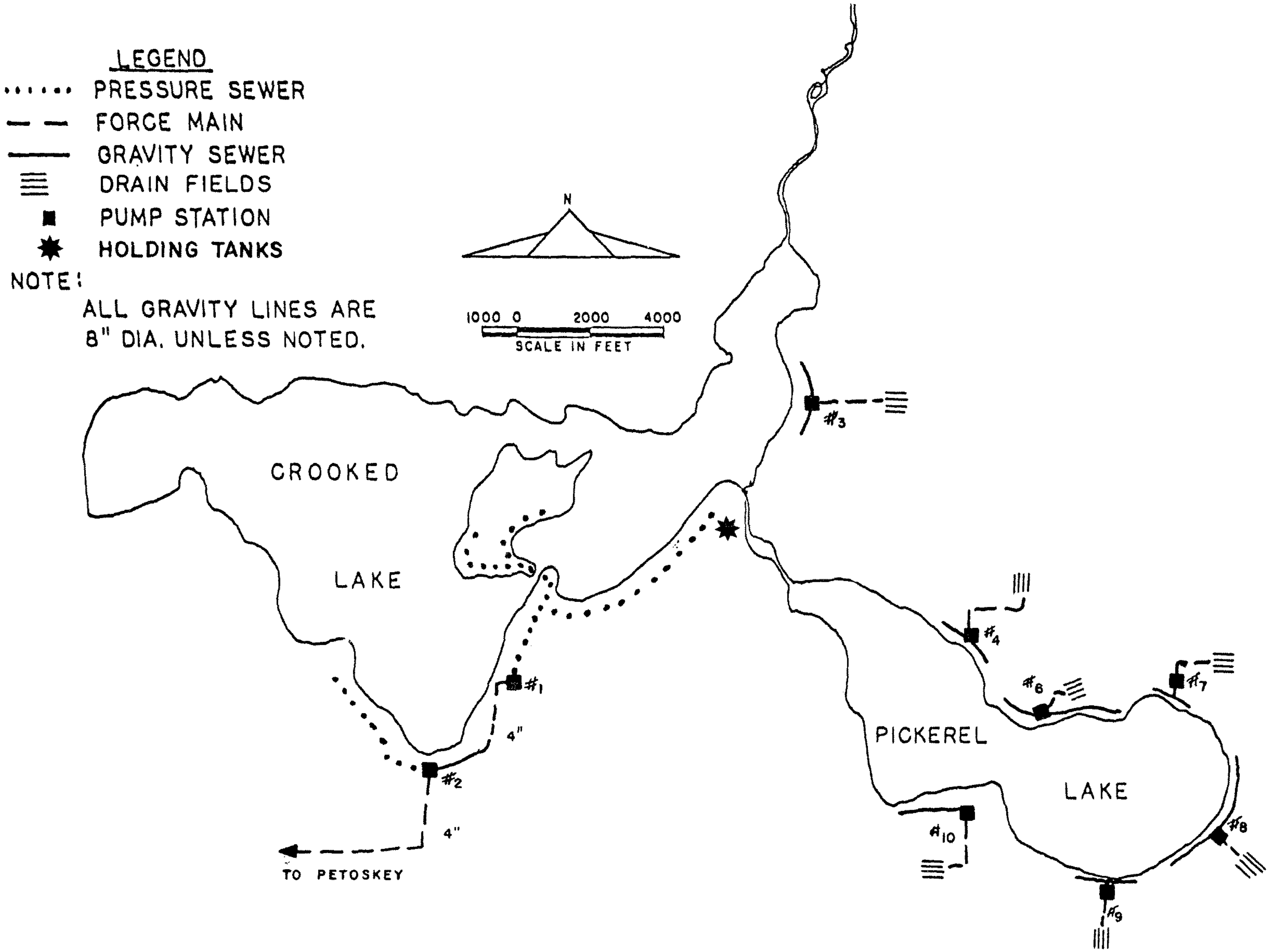


FIGURE IV- 6 EIS ALTERNATIVE 3

Figure IV-7. A combination of gravity sewers and pressure sewers using the STEP system would be used for collection. As in EIS Alternative 2, wastewater would be treated in a waste stabilization lagoon prior to land application, according to the scheme outlined in Figure IV-5. Suitable spray irrigation areas (80 acres) are available north of Pickerel Lake.

g. EIS Alternative 5

This alternative, shown in Figure IV-8, resembles EIS Alternative 3, proposing centralized collection for the Crooked Lake area and cluster systems for the Pickerel Lake area. The major difference between the two alternatives is that in EIS Alternative 5, treatment of the 0.02 mgd of flow would be provided by a waste stabilization lagoon followed by land application at a 30-acre site in the Hardwood State Forest. This site was previously suggested in EIS Alternative 2 and the comments regarding the use of state forest lands apply to this alternative as well. Another difference from EIS Alternative 3 is that Oden Island now would be served by a cluster system rather than pressure sewers. As in EIS Alternative 3, the Segment 7 dwellings would be served by holding tanks.

h. EIS Alternative 6

EIS Alternative 6 constitutes the "limited-action" alternative. This alternative differs considerably from the Facility Plan Proposed Action and the five previous EIS alternatives. The intention of this action is to eliminate all centralized collection and treatment by making maximal use of existing on-site systems. This Alternative proposes upgrading of most of the present on-site septic tank/soil absorption systems; cluster systems would serve only those areas unsuited for on-site systems on the basis of soil and groundwater limitations, and associated with the presence of large quantities of shoreline algae (Cladophora).

Figure IV-9 shows how, cluster systems would be provided for parts of Ellsworth Point and Botsford Landing. The remaining parts of the Study Area would continue to use on-site ST-SAS systems, upgraded as necessary. Since the condition of each existing system is not known, the following assumptions were made as to the replacement and rehabilitation that would be necessary for the remaining on-site systems.

Current Residences	Percent	Number of Homes
Replace Septic Tank	20	42
Replace Drainfield	36	77
Mound Drainfield Systems	12	26
Holding Tanks*	2	4
Hydrogen Peroxide Renovation of Drainfield*	10	21
Cluster Systems**	27	57

*Percents were assumed
**Two cluster systems; 1 with 39 homes, 1 with 18 homes

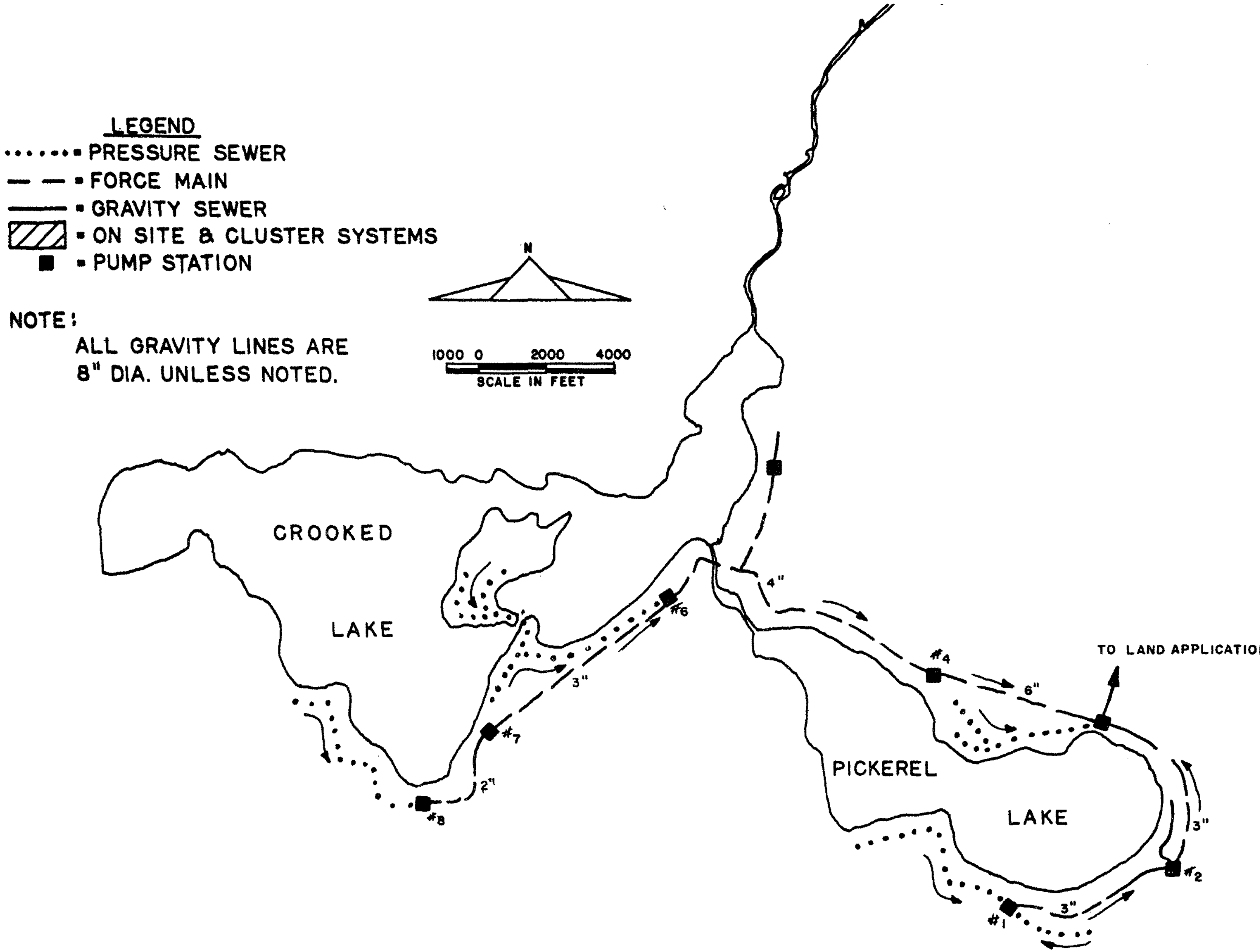


FIGURE IV-7 EIS ALTERNATIVE 4

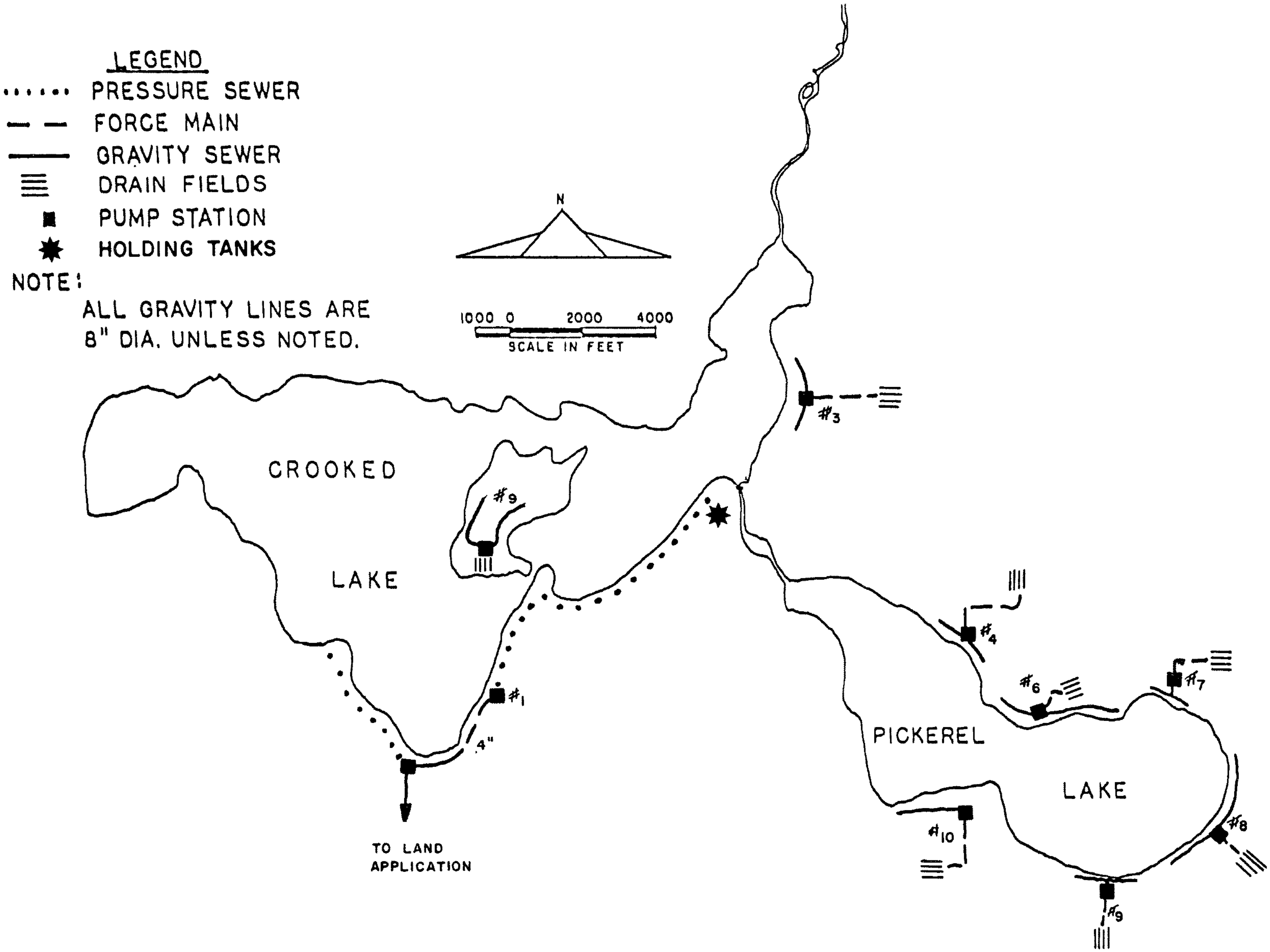


FIGURE IV-8 EIS ALTERNATIVE 5

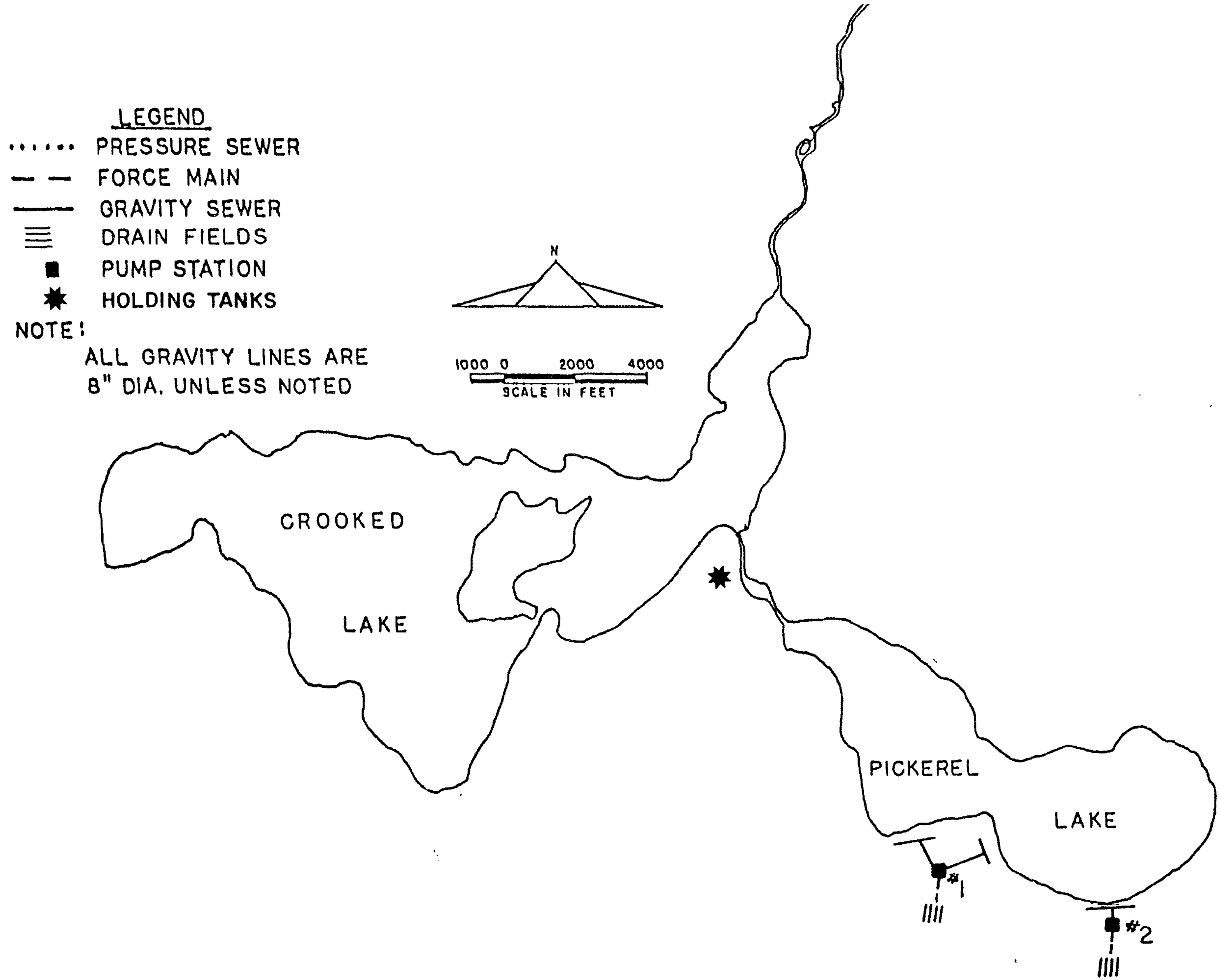


FIGURE IV- 9 EIS ALTERNATIVE 6

Future Systems	Percent	Number of Homes
Conventional Septic Tank and Drainfield	66	102
Mound System	20	30
Cluster System	14	21

Design and costing assumptions used in developing EIS Alternative 6 are presented in Appendix H-2.

C. FLEXIBILITY OF ALTERNATIVES

1. NO ACTION

The No Action Alternative maintains the existing conditions and places no additional planning and design restrictions upon the treatment of wastewater. Because no action is taken at present, the flexibility for future planning is high compared to an alternative recommending an extensive commitment of resources.

2. FACILITY PLAN PROPOSED ACTION

Centralized treatment of all wastewater flows within the Proposed Service Area would reduce the flexibility for future wastewater planning and design changes. This alternative would commit the entire Proposed Service Area to one treatment scheme and involve an extensive dedication of resources. Thus, with the entire Proposed Service Area served, flexibility is reduced.

3. EIS ALTERNATIVE 1

Since the majority of the Service Area would be treated by localized cluster systems, the immediate commitment of resources is less than for the Proposed Action in the Facility Plan. The decentralized nature of this alternative allows for future expansion and changes in local planning. The proposed cluster systems have some capacity for expansion because drainfields would be oversized by 100% to incorporate capacity for projected growth. Using holding tanks or other decentralized approaches for the dwellings in Segment 7 provides flexibility for future planning.

4. EIS ALTERNATIVE 2

This alternative, more decentralized than the Facility Plan Proposed Action, has better flexibility for future growth. However, since this still proposes sewering a significant portion of the Proposed Service Area and constructing two sites for the land application of wastewater, a significant resources commitment would result. This decreases the flexibility for future planning.

5. EIS ALTERNATIVE 3

EIS Alternative 3 combines conventional and land treatment with on-site disposal using holding tanks for Segment 7 dwellings. This alternative provides some flexibility for future expansion because of the many modes of treatment used. Also, the decentralized nature of the alternative permits flexibility for basing future decisions concerning land use development upon local conditions. The flexibility for future expansion of the Petoskey sewage treatment plant will depend mainly upon the design of the facility and the availability of land.

6. EIS ALTERNATIVE 4

This alternative is similar to the Proposed Action in the Facility Plan, except that wastewater would be treated by land application rather than at the Petoskey plant. The same discussion of flexibility applies to both alternatives. Expansion of a land application site retains the flexibility for future planning as long as sufficient land that is conveniently close to the existing facility can be obtained.

7. EIS ALTERNATIVE 5

EIS Alternative 5 is similar to EIS Alternative 3, but flows from the sewered segments around Crooked Lake would be treated at a land application site. This alternative provides some flexibility for future expansion because of the many modes of treatment used. Also, the decentralized nature of the alternative permits flexibility for basing future decisions concerning land use development upon local conditions. Expansion of a land application site retains flexibility for future planning as long as sufficient land that is available near the existing facility.

8. EIS ALTERNATIVE 6

In this alternative, existing on-septic systems would be repaired and upgraded, and cluster systems or other collection techniques would be employed. This alternative would meet environmental requirements, while still providing flexibility for future planning and design changes within the unsewered sections of the Study Area. Cluster systems, similar to those designed and costed for EIS Alternative 1, could be added according to the identified needs of the area. Should such needs arise, the necessary additional clusters could be the object of a phase II grant application.

D. COSTS OF ALTERNATIVES

Project costs were categorized into capital expenses, operating and maintenance expenses, and salvage values of the equipment for each alternative. A contingency fund amounting to approximately 25% of capital and salvage value was included to provide for such expenses as engineering and legal fees, acquisition of rights-of-way, and administration. Appendix H-1 describes the methodology and assumptions used in the analyses as well as detailed costs for each alternative.

Table IV-4 summarizes present and future project costs for each of the alternatives. The analyses of total present worth and annual equivalent costs of each alternative are also presented there. (Debt service on financing the local share is not included.) Section V.E.2 includes a discussion of Federal/State cost sharing and remaining local costs.

Table IV-4

COST-EFFECTIVE ANALYSIS OF ALTERNATIVES

	FACILITY PLAN PROPOSED ACTION (OLD POPULATION)	FACILITY PLAN PROPOSED ACTION (NEW POPULATION)	EIS 1	EIS 2	EIS 3	EIS 4	EIS 5	EIS 6
Present Project Capital Cost (x $1000)	3,938.98	3,776.75	1,791.94	2,632.15	2,662.64	2,866.39	1,955.68	858.50
Future Project Construction Cost (x $1000/year)	26.90	10.81	66.10	36.41	52.22	26.50	54.38	33.53
Total Present Worth (x $1000)	3,896.55	3,558.03	2,514.74	3,126.61	3,197.16	3,175.49	2,597.58	1,184.23
Average Annual Equivalent Cost (x $1000/year)	357.31	326.27	230.60	286.71	293.18	291.19	238.20	108.59

CHAPTER V

IMPACTS

A. WATER QUALITY IMPACTS

1. PRIMARY IMPACT

a. Eutrophication Potential Analysis

This section discusses the effects of phosphorus loading associated with the wastewater management alternatives and their impact on the trophic status of open waters of Crooked Lake and Pickerel Lake. Phosphorus is considered the limiting nutrient for plant growth in both lakes because soluble and total phosphorus concentrations are very low relative to nitrogen (Gannon and Mazur 1979).

Section II.B identified the major sources of phosphorus to Crooked Lake and Pickerel Lake as:

- tributaries (including immediate drainage area),
- septic tanks, and
- precipitation.

Other sources known to contribute to nutrient loading such as detritus, waterfowl and release from sediments are less significant over the time scales being considered.

Future Load Scenario. Table V-1 shows the estimated phosphorus loads for each alternative, as well as for the existing conditions. The loading estimates indicate that none of the alternatives is anticipated to have a significant impact on the water quality of the open water. Although complete sewering (EIS Alternative 4 or Facility Plan Proposed Action) around Crooked Lake and Pickerel Lake would eliminate septic leachate discharges, this would reduce the total nutrient load by only about 2-3%, compared to the No Action Alternative.

Continued reliance on septic tanks for existing and projected population throughout the planning period would increase phosphorus loads by only 4% as compared to existing conditions and much of this increase would be from non-point sources. The small contribution by septic tanks can be explained by the fact that non-point sources and tributaries account for 77% and 87% of the total nutrient load for Crooked Lake and Pickerel Lake, respectively. A few examples illustrate the difference between the alternatives. EIS Alternative for an additional $1.3 million removes an additional 1.7 KG/yr of phosphorus from Crooked Lake and 9.8 KG/yr more from Pickerel Lake than EIS Alternative 6. The most effective alternatives (EIS Alternative 4 and the Facility Plan Proposed Action) remove 37.8 KG/yr of phosphorus from Crooked Lake and 49.6 KG/yr from Pickerel Lake. In the case of Crooked Lake, this is equal to the increase in phosphorus that will occur from non-point sources. Elimination of the Oden Fish Hatchery discharge would result in phosphorus reductions 2.5 to 3 times those of any sewer alternative.

The watershed of Crooked Lake and Pickerel Lake is very large relative to the size of the lakes and high nutrients loadings are discharged to the lake and tributaries by runoff. The small increases in nutrient loads that could result from continued reliance on septic tanks will have no effect on the trophic status of Crooked Lake or Pickerel Lake. Similarly complete sewering is not likely to improve the trophic status. Predicted trophic status with the various alternatives is shown in Figure V-1.

The following assumptions were made in determining future phosphorus loadings:

- Phosphorus loadings from septic tanks were assumed to be 0.25 lb/cap/yr based on EPA estimates used in the National Eutrophication Survey.

- Phosphorus loadings from non-point source runoff were estimated by using Omernik's regression model. This model, detailed in Appendix B-5 approximates the total phosphorus (and nitrogen) concentration in surface water based upon the influence of agricultural, forested and residential land in the watershed. Conversion of forested land to residential or agricultural uses increases the non-point source load. Although future land use in the Study Area is uncertain, it was assumed that land for residential use would double over the planning period. This seemed to be a reasonable approximation considering population trends for the townships of Springvale, Littlefield and Bear Creek (Vilican-Leman & Associates, Inc. 1971).

b. Lakeshore Eutrophication

Growth of Cladophora along lake shores requires high nutrient loads not generally available in oligotrophic or mesotrophic waters. Because of the need for localized nutrient sources, it is suspected that the colonization of Cladophora along the Crooked Lake and Pickerel Lake results from nutrient influx from human activity.

Under existing conditions Cladophora growth is found along certain shore areas where there is a high density of septic leachate plumes. Continued total reliance on septic tanks (No Action) may result in increased Cladophora growth as the lakeshore becomes more developed. In particular, Cladophora growth may be a problem in the Ellsworth Point and Botsford Landing areas, which already experience heavy growth. It is suspected that poor soil conditions, aided by the closeness of the drainfields to the shoreline, may result in groundwater transport of nutrients from septic tanks to surface water in areas where there is suitable solid substrate to sustain Cladophora growth. Upgrading the septic tanks or converting to mound systems may effectively reduce nutrient loadings from some lakeshore areas.

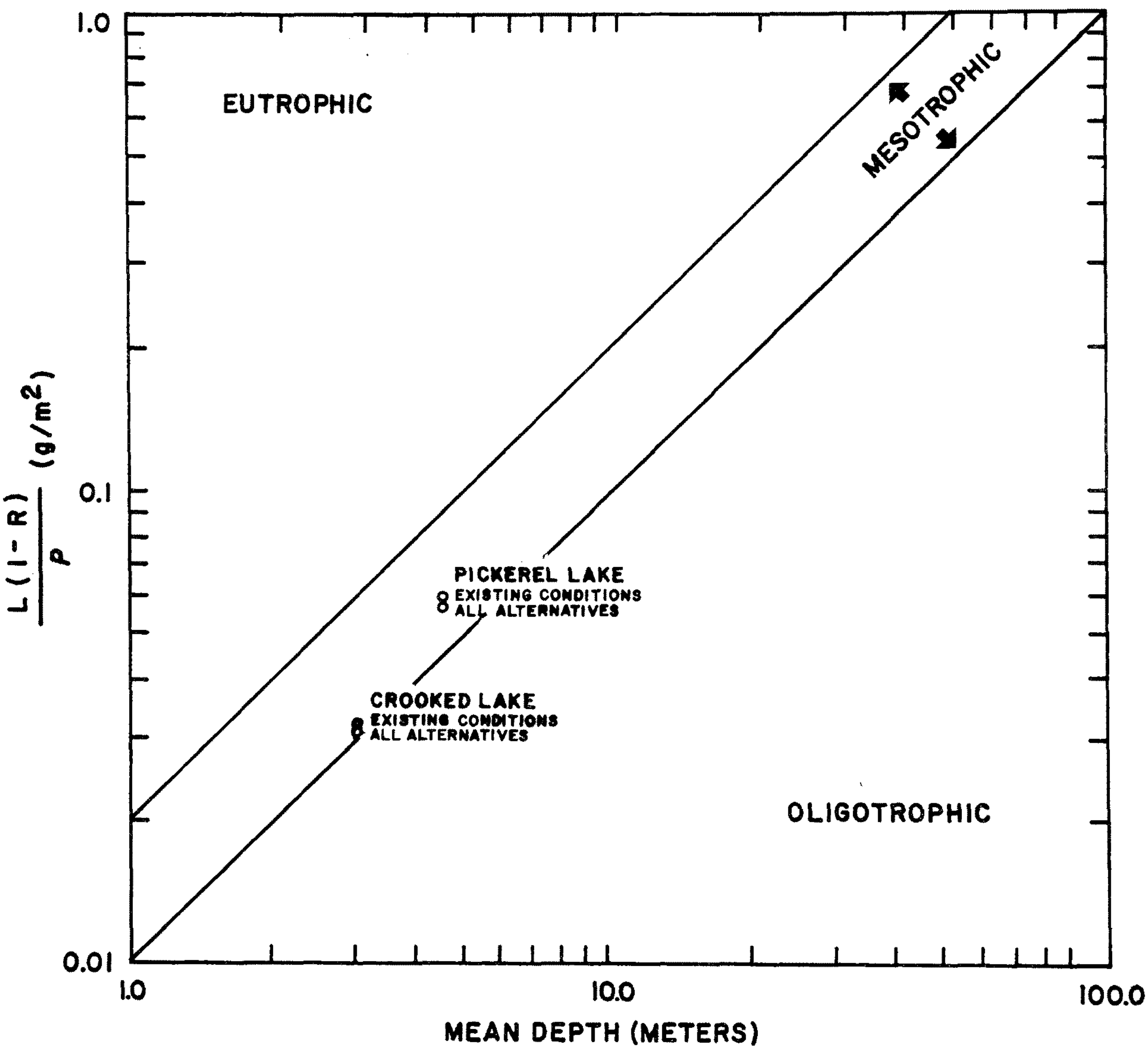
However, along much of the shoreline area depth to groundwater is so shallow that mounds cannot overcome the site limitations and off-site or centralized systems may be needed to reduce nutrient loading to

Table V-1

PHOSPHORUS INPUTS (KG/YR) TO CROOKED LAKE
AND PICKEREL LAKE BY ALTERNATIVE

	Crooked Lake	Pickerel Lake
1977 Conditions		
Non-Point Sources (Tributaries)	1,135.3	1,228.7
Precipitation	321.7	143.2
Fish Hatchery	101.3	---
Septic Tanks	20.6	22.2
Total	1,579.3	1,394.1
No Action and Alternative #6		
Non-Point Sources	1,178.9	1,247.2
Precipitation	321.7	143.2
Fish Hatchery	101.3	---
Septic Tanks	37.8	49.7
Total	1,639.7	1,440.1
EIS Alternative #4*		
Non-Point Sources	1,178.9	1,247.2
Precipitation	321.7	143.2
Fish Hatchery	101.3	---
Septic Tanks	---	---
Total	1,601.9	1,390.4
EIS Alternative #1		
Non-Point Sources	1,178.9	1,247.2
Precipitation	321.7	143.2
Fish Hatchery	101.3	---
Septic Tanks	35.5	39.9
Total	1,637.4	1,430.3
EIS Alternative #2		
Non-Point Sources	1,178.9	1,247.2
Precipitation	321.7	143.2
Fish Hatchery	101.3	---
Septic Tanks	35.5	39.9
Total	1,637.4	1,430.3
EIS Alternatives #3 and #5		
Non-Point Sources	1,178.9	1,247.2
Precipitation	321.7	143.2
Fish Hatchery	101.3	---
Septic Tanks	---	---
Total	1,601.9	1,390.4

*Phosphorus input is the same as for Facility Plan Proposed Action



L= AREAL PHOSPHORUS INPUT ($g/m^2/yr$)
R= PHOSPHORUS RETENTION COEFFICIENT
P= HYDRAULIC FLUSHING RATE (yr^{-1})

FIGURE V-1 TROPHIC STATUS OF CROOKED LAKE AND PICKEREL LAKE BASED ON 1974-1975 DATA surface water. The centralized alternatives (EIS Alternative 4 and Facility Plan Proposed Action) have the greatest potential for reducing *Cladophora* growth. Every alternative except No Action has the potential for substantial *Cladophora* reduction in the present problem areas of Ellsworth Point and Botsford Landing.

c. Bacterial Contamination

There is no evidence that the existing on-site systems are contributing significant bacterial loads to either Crooked Lake or Pickerel Lake, and this situation is not anticipated to change regardless of the alternative selected. Available data suggests that bacteria are being effectively removed by the soils even though these soils are generally poorly permeable and shallow. However, continued reliance on undersized and/or improperly installed systems (No Action Alternate) could result in localized contamination of groundwater or surface wter.

d. Non-Point Source Nutrient Loads

The primary impacts on surface water quality are related to construction and the replacement of ST/SAS. Such activities are likely to result in increased soil erosion. Similarly, installation of sewers, especially those that pass under the many small drainage ways leading to the lakes, will increase erosion. Increased nutrient loading will continue until the soils are stabilized by new vegetation.

Compliance with State and local soil erosion control requirements could substantially mitigate the erosion problems and the subsequent impact on water quality.

2. SECONDARY IMPACTS

As indicated previously (Section II.B.3.a), the Crooked Lake and Pickerel Lake watershed encompasses a very large area. The watershed(s) and the land use patterns within the watershed govern the flow and nutrient concentration in non-point source runoff. Because the drainage area is so large, nutrient loads from non-point sources very are high, accounting for about 80% of the total nutrient load to Crooked Lake and Pickerel Lake. Most of the land within the watershed is forested. Conversion of forested land to residential or agricultural uses generally increases both the volume of runoff and the concentration of nutrients and sediment. However, using Omernik's model to estimate increases in non-point source runoff, it is not apparent that non-point source runoff will increase significantly over the planning period. The acreage of land in residential use will still be very small compared to the amount of forested land.

However, the topography of the watershed suggests that certain areas may be particularly vulnerable to increased non-point source runoff. The lake shoreline is particularly sensitive because it acts as a buffer, trapping nutrients from upland areas and retarding erosion. Upland areas that drain into creeks feeding into Crooked/Pickerel Lakes are also sensitive especially where slopes are steep.

Continued housing development along lake shores may increase nutrient and sediment loads into the lake as a result of:

- increased runoff from construction of impervious surfaces such as rooftops and parking areas;
- lawn and garden fertilization creating unnaturally high nutrient levels in the runoff; and
- soil disruption by human activities (e.g., housing construction, leveling of forested area).

3. MITIGATIVE MEASURES

The impact analysis has indicated that non-point source runoff contributes a large percentage of the total nutrient load to both Crooked Lake and Pickerel Lake. To reduce these loads, it is recommended that the Crooked/Pickerel Lakes maintain their high priority 208 "plan of study area" status. This area should undergo a watershed and floodplain management study to determine the spatial occurrence of non-point source pollution.

This study should include the definition of the 100 year floodplain for participation in the Department of Housing and Urban Development National Flood Insurance Program. In many instances first order or headwater stream areas are not subject to the extensive flooding that downstream second or third order stream experience. As a result they often are not included in the floodplain districts. It is recommended that the 100 year floodplain and a 100 foot buffer strip on each bank of streams outside floodplain areas be included in the County or Township zoning districts as an open space area. The 50 foot set back from a lakeshore might also be included in this district. These areas should be left in a naturally vegetated state to provide: shade to maintain natural water temperatures, a vegetative means of controlling erosion and sedimentation, and a system to help prevent surge flows during storm events, thus reducing flood potential downstream.

The Michigan Erosion and Sedimentation Control Act goes far toward controlling non-point source problems in the construction phase of wastewater collection and treatment facilities as well as in the development of housing units. However, erosion and sediment control measures are concerned only with construction processes. As impervious surface cover is developed, hydrologic head in runoff increases, creating flows capable of eroding and carrying considerably more sediment. Structural storm drains tend to increase flow velocities which carry more sediment and create additional flood problems at the point of discharge. In order to address these closely related problems, an overall runoff control program should be implemented. As part of a watershed and floodplain management program consideration should be given to the feasibility of enacting a package of environmental performance standards that would control stormwater, erosion, and sedimentation. This approach would require that the amount of runoff from any specific development not exceed the carrying capacity of the natural drainage system. This would require runoff from development not to exceed that which occurs prior to construction.

Consideration should be made of formulating a County Stormwater Management design manual to detain a 50 to 100 year storm runoff on site. Such a design manual might include recommendation of an artificial wetland as a non-point source treatment system. Incorporation of an artificial wetland into stormwater detention/retention basin design could provide many benefits. Such marshes would serve the following important functions:

- Filtration of settleable solids and uptake, adsorption and slow release of nutrients,
- a vegetated landscape amenity instead of the eyesore in which many detention basins result, and
- increase in wildlife habitat diversity.

Additional Design Measures. These should include vegetative drainage swales along contours instead of stormwater conduits. Where flows are anticipated to be more excessive than can be accommodated by swales, gravel bedding as well as vegetation can be used.

Although septic tanks have been shown to be a minor source of nutrients, several mitigative measures could minimize the nutrient load from this source. *Cladophora* growth along the Crooked/Pickerel Lakes shoreline has been attributed to localized nutrient sources. Several measures are available which may minimize *Cladophora* growth. These include upgrading the existing on-site systems, use of off-site systems or alternative toilets and minimizing the use of phosphorus-containing fertilizers.

These improvements in septic tanks are intended to reduce nutrients for algal growth along the shoreline. There is no guarantee that *Cladophora* growth would be eliminated by these mitigative measures, except along the problem areas of Ellsworth Point and Botsford Landing. As a last resort remaining *Cladophora* growth which does occur may be controlled by adding copper sulfate locally. Used in properly low concentrations, this chemical will interact with polypeptides secreted by the algae. This will kill the algae but make the copper unavailable for uptake (and toxicity) to other organisms.

B. GROUNDWATER

1. GROUNDWATER QUANTITY IMPACTS

The conversion from sewage disposal practices based on individual soil absorption systems to central collection and treatment systems without land application of effluent can result in a loss of groundwater recharge. The significance of this loss depends upon its relationship to the recharge from all other sources, including downward infiltration percolation from percipitation and surface water bodies as well as inflow from adjacent aquifers. The precise quantification of this significance requires an accurate delineation of the aquifer(s) plus knowledge of its hydrology (precipitation, runoff, evapotranspiration, discharge, etc.) and hydrualic characteristics (transmissivity*, storage coefficients*, etc.). There are not enough data to attempt such quantification for Crooked/Pickerel Lakes. However, it is not anticipated that any wastewater management alternative will impact groundwater quantity.

2. GROUNDWATER QUALITY IMPACTS

Human wastewater disposal can impact the quality of groundwater through three main types of pollutants. The first type includes suspended solids, bacteria and other forms of oganic matter which are normally removed by downward movement through approximately 5 feet of soil above the water table of aquifers. These contaminants are very unlikely to present problems in the Study Area as soil types and the impermeable confining layer provide more than adequate barriers to their entry into the confined aquifer. Also depth to this aquifer is generally more than 20 feet, except in those localized areas where thin layers of soil are underlain by clays. Water levels in the surficial groundwater aquifer are generally near the land surface.

The second type of pollutant requiring consideration is phosphorus or phosphate. It is of interest not because of its significance in groundwater per se, but because phosphorus-containing groundwaters are potential contributors to the fertilization of lakes.

Jones et al. (1977), in a comprehensive review of studies on this subject for the Environmental Protection Agency, concluded:

> "...it is very unlikely that under most circumstances, sufficient available phosphate would be transported from septic tank wastewater disposal systems to significantly contribute to the excessive aquatic plant growth problems in water courses recharged by these waters."

Field studies, they pointed out, have shown that most soils, even medium sandy soils, typically remove more than 95% of phosphates in relatively short distances from effluent sources. Their review indicated that there are two primary factors in the removal of phosphates applied to the land. The first is the tendency of phosphorus to collect or cling onto small amounts of clay minerals, iron oxide and aluminum oxide in soil and aquifer materials. The second is that the calcium carbonate in hard waters precipitates phosphate as hydroxyapatite.

In the same review, Jones et al. (1977) noted several studies in areas similar to the Study Area in which loamy, clayey soils overlie glacial moraine and outwash deposits and where the soil has removed essentially all of the phosphorus present in septic tank effluents. They also stated that in areas of hard water, the likelihood of significant phosphate transport from septic tank effluent to the surface waters is greatly reduced because of the calcium carbonate present in the soil and subsoil systems. While the Study Area has documented incidences of phosphorus transport to surface waters, the number of plumes does not reflect the severe limitation rating SCS has given the soils. Conservative estimates contained in this EIS indicate that continued use of on-site systems would result in only a 4% increase of phosphorus leaching into the lake from septic tanks.

The soluble nitrates constitue the third type of pollutant. High concentrations of nitrates in groundwaters cause methemoglobinemia* in infants who consume foods prepared with such waters. A limit of 10 mg/l of nitrates expressed as nitrogen (NO_3-N) has been set in the National Interim Primary Drinking Water Regulations (40 CFR 141) in accordance with the Safe Drinking Water Act (P.L. 93-523).

Under the favorable conditions of moisture, temperature and oxygen that exist in the well drained soils of sub-surface disposal sites, the nitrogen compounds in human wastes are rapidly oxidized at or near land surface to soluble nitrates. Nitrates are not removed by passage through soils down to groundwaters. On entry into groundwaters, nitrates are transported in the direction of flow; their concentration is reduced as a result of dilution.

In the Study Area, the impermeable confining layer above the buried outwash aquifer should also serve as an effective barrier against the entry of nitrates into the aquifer by infiltration. No impacts on groundwater quality are therefore expected from any of the alternatives under consideration. The only potential exception to this would be individual homes with unusually shallow or poorly constructed wells which might allow nitrate leakage from overlying soil layers.

3. MITIGATIVE MEASURES

Groundwater quality should be carefully monitoried for all alternatives involving the use of ST/SAS's, cluster systems and land application systems to check that water quality is not being significantly degraded and to signal the existence of malfunctions, inadequate treatment or the need for corrective action.

C. POPULATION AND LAND USE IMPACTS

The population and land use impacts associated with the various wastewater management alternatives evaluated in this EIS are related to three major factors:

- System Configuration: The physical design and layout of the proposed wastewater management system including the area to be served and the routes of major collector and interceptor lines.
- Site-Dependency: The type of wastewater management system proposed whether it consists of septic tanks (site-dependent), centralized collection and treatment (site-independent), cluster systems (non-centralized, site-independent), or a combination of these systems.

- System Capacity: The capability of the proposed wastewater management system in terms of the number of people it is designed to serve, or (for the No Action or Limited Action Alternatives) the natural assimilative capacity of the land.

These three system-related factors in conjunction with existing development pressures, market trends, and existing natural development constraints such as soil suitability for on-site systems largely determine the magnitude and types of primary and secondary impacts associated with each proposed alternative.

The nine wastewater management plans evaluated in this EIS have been grouped into four categories for population and land use impact analysis purposes:

- No Action Alternative: continued reliance upon on-site (septic tank) systems.
- Facility Plan Proposed Action and EIS Alternative 4: completely centralized collection and treatment systems.
- EIS Alternatives 2, 3, and 5: combined use of centralized and cluster treatment systems.
- EIS Alternatives 1 and 6: completely decentralized (cluster) treatment systems.

Based on these four groups of alternatives and the system-related and local factors discussed previously, the population and land use impacts associated with the various alternatives will be evaluated in this section and summarized in an impact matrix in Section V.F.

1. IMPACTS ON POPULATION

The population impacts associated with the various wastewater management alternatives will be evaluated in regard to the baseline population projections presented in Chapter II. These baseline projections represent probable future conditions without regard to the availability of sewage treatment capacity or to existing natural constraints to development. As a result, the baseline population projections represent a middle ground between the No Action and other alternatives.

The provision of centralized and/or decentralized wastewater management facilities would induce population growth in the Crooked/Pickerel Lakes Service Area beyond the baseline population (1,263) projected for the year 2000. The magnitude of this induced population growth could potentially be as high as 100% over the baseline projections, based on the Facility Plan Proposed Action designed for the higher population level of 2,080 people.

EIS Alternative 4, which also consists of a completely centralized system, could potentially induce population growth as high as 65% over the baseline projections. The lower induced growth projected for EIS Alternative 4 is a result of this proposed system not serving the northern half of Oden Island (Segment 17) or the easternmost segment of Crooked Lake (Segment 18). Both the Facility Plan Proposed Action and EIS Alternative 4 would in effect neutralize the natural development constraints imposed by poor drainage and poor soil characteristics, effectively increasing the inventory of developable acreage as well as the capacity of existing developable acreage.

EIS Alternatives 2, 3 and 5, combining centralized and cluster systems, could also induce population growth but at a substantially lower level than the centralized alternatives. EIS Alternatives 3 and 5 (which differ only in their proposed servicing of Oden Island) have the potential for induced population growth of approximately 2.5% to 5.0% while EIS Alternative 2, which provides centralized service to all segments except 7, 8, 9, 17, and 18, could induce population growth of approximately 10% to 15% over the baseline projections. The major difference between these combined centralized/cluster system alternatives and the totally centralized alternatives lies in the proposed servicing of Segments 7, 8, and 9. The centralized alternatives provide full service to these segments while the combined systems provide holding tanks for Segment 7, a cluster system for Segment 8, and no wastewater treatment for Segments 9.

The No Action Alternative and EIS Alternative 6 (Limited Action) are likely to hold population growth in the Proposed Service Area 10% to 25% respectively below the baseline level while EIS Alternative 1 would be expected to allow population growth nearly equal to the baseline figure. The fact that EIS Alternative 6 and the No Action Alternative would open up virtually no new land for development accounts for the lower population growth under these alternatives.

Under the Facility Plan Proposed Action and EIS Alternatives 2, 3, 4, and 5, it is likely that total system capacity will be exhausted before the year 2000. The exact timing of system exhaustion will depend on the development pressures in the service area and the rate of population growth during the planning period. Currently, the development pressures in the Service Area do not indicate an induced population growth of 100% during the planning period. However, the trend toward greater demand for permanent residences in the Service Area and the introduction of a wastewater management system in the Service Area could substantially increase the rate of growth.

Areas of Springvale and Littlefield Townships lying outside of the Proposed Service Area should not be significantly influenced by the type of wastewater management system implemented in the Service Area. Currently, residential demand in these outlying segments is relatively low except for the more urbanized areas such as Alanson. For the most part, residential demand in the Crooked/Pickerel Lakes area is influenced by visual and physical access to the lakes. Consequently, the demand for residential development in non-lakeshore areas is not likely to be significantly different with or without the provision of centralized treatment facilities.

2. IMPACTS ON LAND USE

The land use impacts associated with the various wastewater management alternatives are primarily related to the induced population increases and the resultant demand for residential land. While the potential for commercial or industrial land uses typically exists when extensive wastewater management systems are introduced into an area, there does not appear to be any likelihood of significant non-residential development in the Proposed Service Area.

a. Land Use Conversion

The primary and secondary development pressures generated by the provision of centralized and/or decentralized wastewater management facilities in the Proposed Service Area could increase developed acreage by as much as 130 acres over the existing figure by the year 2000. This would occur under the Proposed Action and would result in total residential area of nearly 245 acres. In comparison, the No Action Alternative would result in an increase in developed acreage of only 25 acres for a total figure of approximately 140 acres. The intermediate alternatives are projected to result in land use increases of 77 acres for EIS Alternative 1; 93 acres for EIS Alternative 2; 80 acres for EIS Alternative 3; 97 acres for EIS Alternative 4; 79 acres for EIS Alternative 5; and 38 acres for EIS Alternative 6. On a per capita or per dwelling unit basis, the less centralized alternatives are more land consumptive since permitted residential densities are only two units per acre for areas not serviced by a centralized system whereas centralized service permits densities of approximately four units per acre.

b. Land Use Pattern and Intensity Changes

The pattern of land use development in the Proposed Service Area is not expected to be significantly influenced by the type of wastewater management facilities proposed. The major change will result from centralized and/or cluster systems which open existing forest, agricultural, and other lands to development. However, the resulting land use pattern will be a continuation of the existing residential development at somewhat higher densities. The No Action and Limited Action (EIS Alternative 6) Alternatives will have limited effects on the existing land use pattern while the remaining alternatives will have a very similar effects which will only vary in magnitude.

Land use intensity will change significantly under the various alternatives as a result of the different residential densities permitted with or without centralized treatment. It is projected that residential densities could go as high as 3 dwelling units per acre under the Proposed Action compared to an existing density of 1.85 dwelling units per acre. EIS Alternative 4 is also projected to have a comparatively higher density of 2.85 dwelling units per acre while the remaining alternatives are all anticipated to have residential densities under 1.95 dwelling units per acre. The two centralized alternatives and their associated higher densities are likely to jeopardize the area's rural character, while the other alternatives will result in lower density development which should maintain this rural character.

Segments of the Service Area which are likely to undergo major intensity changes under various alternatives include the northern half of Oden Island (Segment 17) and Segment 18 under the Proposed Action; Segments 7 and 9 under EIS Alternative 4 and the Proposed Action; and the southern half of Oden Island (Segment 5) under EIS Alternatives 3 and 4 and the Proposed Action. Other segments proposed for centralized treatment service are also likely to incur density increases, but not if the same magnitude as Segments 5, 7, 9, 17, and 18.

3. MITIGATIVE MEASURES

With the exception of New Alternatives 1 and 6 and the No Action Alternative, the introduction of wastewater management systems in the Crooked/ Pickerel Lakes Proposed Service Area will induce population growth and associated land conversion beyond that projected in the baseline forecasts for the year 2000. The extent of this induced population growth varies from 2.5% to nearly 100% over the baseline projections. The associated land use conversion results in respective increases of from 25 to 129 acres of additional residential land. The maximum extremes of these ranges would likely result in a change in the rural character of the area and could result in environmental degradation of sensitive areas.

Measures available to the local governments of the service area to mitigate these effects revolve primarily around the development and effective implementation of land use control and environmental protection ordinances. Of particular importance is the need to strengthen the Springvale Township Zoning Ordinance in order to more closely regulate the permitted densities in the Lakeshore Zoning District (within 1,000 feet of the lake). No density restrictions currently exist in the District, theoretically allowing residential densities of over ten dwelling units per acre (condominiums or other multi-family units). The Emmet County and Preliminary Littlefield Township Zoning Ordinances permit residential densities of approximately one and one-half to four dwelling units per acre depending upon whether centralized sewer service is available and which zoning district the land lies in. The north shore of Pickerel Lake is designated as a Scenic Resource District, designed to preserve the natural resources vital to the recreation and aesthetic qualities of the area. This type of land use control in the Springvale Township portions of the service area would likely maintain the character of the area without denying necessary growth and development.

Currently, the Michigan Inland Lakes and Streams Act and Michigan's Soil Erosion and Sedimentation Control Act represent the only mechanisms for environmental protection in the Service Area. These acts are designed to regulate development in submerged lands and to monitor tree cutting, cut and fill operations, and vegetation removal along the shore of a lake, stream, or river. However, more stringent local controls dealing with wetlands development, soil suitability, and protection of scenic and environmental resources may be needed to fully control residential development. In addition, it may be necessary for the local governments in conjunction with State or Federal agencies to acquire particularly valuable aesthetic or environmental resources for public use and/or preservation. Such efforts have already been made to protect the Crooked-Pickerel Lakes Channel and similar efforts may be required for the northern half of Oden Island and other portions of the shoreline.

As a final means of mitigation, the local governments must prepare for the potential influx of population associated with the provision of wastewater management systems. Needed efforts in this direction included the programming and budgeting of infrastructure improvements and additions which will be required by larger service area population. A capital improvement program designating the types of improvements needed (roads, utility systems, schools), when they will be needed, and potential funding sources should be initiated concurrently with the decision to provide a wastewater management system to the area.

D. ENCROACHMENT ON ENVIRONMENTALLY SENSITIVE AREAS

Construction activities related to the various wastewater treatment alternatives and secondary impacts from induced growth may be felt in certain environmentally sensitive areas. The Emmet County Future Land Use Plan recognizes development constraints imposed by poorly drained soils throughout the Crooked/Pickerel Lakes area, and the Plan also recognizes serious water pollution hazards generated by overintensive or inappropriate land development patterns. Numerous sensitive areas, identified in Chapter II, could be affected to different degrees by the alternatives reviewed in this EIS.

1. WETLANDS

a. Primary Impacts

Much of the shoreline of Crooked/Pickerel Lakes is low-lying, poorly drained, and vegetated with mixed hardwood - conifer forest growing in a thin organic soil on top of saturated sand. The entire area between the two lakes consist of wet woodland habitat (see Figure II-11). Table V-2 indicates the Service Area segments that contain wetland areas and the alternatives that would have impact on these segments. The wetland areas may be subject to sedimentation during construction of a sewer collection system. Water circulation patterns may be modified by these activities.

The Facility Plan Proposed Action and EIS Alternative 4 have the greatest potential to disturb wetland areas. Much of this can be attributed to construction activity which will be necessary in segments 7 and 8. These areas contain numerous wetlands. The most favorable alternative would be EIS Alternative 6 due to its minimal disturbance to wetland areas due to lack of construction of centralized sewers.

b. Secondary Impacts

Secondary impacts to wetland areas would occur as a result of development induced by the availability of additional sewerage service. This new development could impact the wetlands of the Study Area in various ways including:

Table V-2

ENVIRONMENTALLY SENSITIVE AREAS
AND IMPACTS BY ALTERNATIVE

SERVICE AREA SEGMENT #	201 ACTION	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
1	2	2	2	2	2	2	0
2	2	2	2	2	2	2	0
3	1	1	1	1	1	1	1
4	0	0	0	0	0	0	0
5	2	2	2	2	2	2	0
6	2	2	2	2	2	2	2
7 South	1,2	0	0	0	1,2	0	0
7 North	1,2,3,4	0	0	0	1,2,3,4	0	0
8	1,2,4	1,2,4	1,2,4	1,2,4	1,2,4	1,2,4	0
9	2,4	0	0	0	2,4	0	0
10	0	0	0	0	0	0	0
11	1	1	1	1	1	1	0
12	1,2	1,2	1,2	1,2	1,2	1,2	1,2
13	1	1	1	1	1	1	1
14	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0
17	0	0	0	0	0	1	1
18	1	0	0	0	0	0	0
Total Number of Environmentally Sensitive Segments Impacted by Alternative	12	9	9	9	11	10	5

KEY: 0 = No Environmentally Sensitive Areas Impacted
1 = Wetlands Impacted
2 = Prime Agricultural Land Impacted
3 = Bald Eagle Nesting Site Impacted
4 = Archaeological Site Impacted

- Causing sedimentation and fluctuation of groundwater levels during construction, and

- Promoting development contiguous to these areas thus increasing sedimentation and runoff into the wetlands.

The differences in magnitude of impacts lie in the degree of centralization of sewers and the concomitant service areas associated with the alternatives. Table V-3 indicates the amount of additional land that is projected to be developed as a result of the various sewerage alternatives.

Table V-3
ADDITIONAL LAND DEVELOPED AS A RESULT
OF ALTERNATIVE SEWERAGE CONFIGURATIONS

Alternative	Additional Acreage Developed in Study Area
Facility Plan Proposed Alternative (without modification)	130 ac.
Facility Plan Proposed Alternative (with flow reduction)	97 ac.
EIS Alternative 1	77 ac.
EIS Alternative 2	93 ac.
EIS Alternative 3	80 ac.
EIS Alternative 4	97 ac.
EIS Alternative 5	79 ac.
EIS Alternative 6	38 ac.
No Action	25 ac.

The Facility Plan Proposed Action (with and without flow reduction) would have the greatest potential for secondary impacts followed closely by EIS Alternative 4. EIS Alternative 6 and the No Action Alternative would have the least potential for disruption to wetlands.

c. Mitigating Measures

Emmet County has conducted an inventory of wetlands within its boundaries. However, this information was not available for use in this report. Examination should be made to determine the need for a 100 foot buffer zone to protect these valuable resource areas from upland erosion and sedimentation. All wetlands should be mapped for inclusion in open space zoning and also within the Great Lakes Submerged Lands Act.

Executive Order 11990 (1977) requires that Federal agencies should take all possible actions to minimize disturbance of Federally sponsored actions to wetlands (see Appendix I). Specifically, the order states that each agency shall provide leadership and shall take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agencies responsibilities for (1) providing Federally undertaken, financed, or assisted construction and improvements; and (2) conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities.

The Michigan Inland Lakes and Streams Act requires issuance of a permit for development activity in submerged lands (areas lying below the ordinary high water mark). Any dredge and fill operations are therefore subject to a public review process. Administrative action to issue or deny a permit which meets general guidelines provided in the Act must explicitly consider site-specific environmental constraints in reaching a final decision.

The Soil Erosion and Sedimentation Control Act governs construction activity occurring within 500 feet of the shore of lake, river, or stream. Limitations are imposed upon tree cutting, removal of vegetative cover, and cut and fill operations. Mitigating measures must be adopted to control runoff from construction sites.

Local zoning regulations for Littlefield and Springvale Townships should be revised to provide total protection for wetland areas. Ideally, these areas should be zoned for open space. Development projected to occur near wetland areas should provide an adequate buffer zone.

If sewer lines are constructed along the southeast shoreline of Crooked Lake and connected to the interlake stream and southwest shoreline of Pickerel Lake, they should be constructed in such a way as to prevent the wet woodland from being broken into several "islands", separated by corridors which may prevent some species of wildlife from using the woodland as breeding habitat. The adverse effects of construction on wildlife would be minimized if the interceptor line were to be built along roadways, where possible, or at the back of existing lakeshore lots in those areas where dead end roads lead to the lake. Furthermore, the potential impacts of construction can be reduced if such activities were limited to the period of 15 August through 1 April or better still, to 1 October through 1 March. Wintertime construction, although difficult, will reduce the potential impact on seasonally nesting birds, such as wood ducks and other waterfowl, green herons, many kinds of warblers and sparrows, colonially-nesting blackbirds, plus many shore and wading birds. In addition, although the seasonal activities of the wetlands mammals are not as obvious or pronounced, summer is also the time when these animals require relatively disturbance-free conditions. Consequently, the detrimental effects of construction would be minimized if the wetlands were ditched and filled during the six cold months of the year.

2. PRIME AGRICULTURAL LANDS

a. Primary Impacts

Class II soils, identified by the US Soil Conservation Service (SCS), are located throughout the Study Area and are shown in Figure II-6. Class I and II soils are rated by the SCS as being "prime" for agricultural usage.

Table V-2 indicates the Service Area segments that contain significant acreages of prime agricultural lands and the alternatives that would be likely to impact these segments. The direct loss of these soils due to construction of sewerage facilities and establishment of rights-of-way from any of the alternatives would be minor. However, on a comparative basis, the 201 Facility Plan Proposed Action and EIS Alternative 4 would have the greatest impacts in this regard while EIS Alternative 6 would have the least impact.

b. Secondary Impacts

Some prime agricultural land is likely to be developed regardless of the wastewater management option chosen. However, the Facility Plan Proposed Action, EIS Alternative 2 and EIS Alternative 4 would have a greater potential to consume prime agricultural areas contiguous to Crooked/ Pickerel Lakes. EIS Alternative 6 would have the least potential for this type of impact.

c. Mitigating Measures

Prime agricultural lands should be afforded the greatest protection from development by guiding and containing growth to protect these areas. The State of Michigan has adopted measures to help preserve prime agricultural lands, open space, and areas utilized for environmental protection. The program provides for restrictive agreements to limit use of lands for a period of ten years. It provides for reduced taxes during this period and is instituted as a local option. Emmet County has adopted the State measure but at this time no one in the Study Area has applied for participation in the program.

3. THREATENED OR ENDANGERED SPECIES

a. Primary Impacts

The bald eagle is the only species on the Federal list of Endangered or Threatened Species whose habitat range is known to include the Study Area. A nesting site is located in the northeast side of the Crooked/Pickerel channel (segment 7). The 201 Facilities Plan Proposed Action and EIS Alternative 4 could have serious impacts on this site because of short term construction activities. Other alternatives were rated as having no impact on the nesting site.

b. Secondary Impacts

In addition to the site mentioned above, an additional nesting site exists 1.5 miles south of Pickerel Lake. With the advent of development, these nesting sites may be impacted to some degree. However, the exact degrees of the impact and the relative magnitude of impacts imposed by the various alternatives is difficult to ascertain.

4. ARCHAEOLOGICAL SITES

a. Primary Impacts

One potentially important archaeological site is located in segments 7, 8, and 9 on the north shore of Pickerel Lake. All the alternatives, with the exception of EIS Alternative 6, could have impacts on this large archaeological site. The exact degree of the impact imposed by the alternatives is difficult to ascertain without more precise locational information about the archaeological site.

b. Secondary Impacts

With the advent of additional residential development projected to occur in the Study Area in the future, this archaeological site may be impacted to some degree. EIS Alternative 6 has the least potential to create this type of impact.

c. Mitigating Measures

According to the Michigan State Historic Preservation Officer (SHPO), the potentially important sites must be investigated for archaeological artifacts prior to construction of any facilities.

E. ECONOMIC IMPACTS

1. INTRODUCTION

The economic impacts of the proposed wastewater system alternatives proposed for the Crooked/Pickerel Lakes area are evaluated in this section. These impacts include: financial burden on system users; financial pressure causing residents to move away from the Study Area (displacement pressure); and financial pressure to convert seasonal residences to full-year residences (conversion pressure).

2. USER CHARGES

User charges are the costs periodically billed to customers of the wastewater system. User charges consist of three parts: debt service (repayment of principal and interest), operation and maintenance costs, and a reserve fund allocation assumed to equal 20% of the debt service amount. The reserve fund is a portion of current revenues invested to accumulate adequate funds to finance future needed capital improvements. Estimated user charges for each alternative are presented in Table IV-4.

Table V-4

ANNUAL USER CHARGES

ALTERNATIVE	USER CHARGES
Facility Plan Proposed Action (Old Population)	$650
Facility Plan Proposed Action (New Population)	$660
EIS Alternative #1	$200
EIS Alternative #2	$600
EIS Alternative #3	$330
EIS Alternative #4	$610
EIS Alternative #5	$340
EIS Alternative #6 (Limited Action)	$ 90

a. Eligibility

Eligibility refers to that portion of wastewater facilities costs determined by EPA to be eligible for a Federal wastewater facilities construction grant. Capital costs of wastewater facilities are funded under Section 201 of the 1972 Federal Water Pollution Control Act Amendments and the Clean Water Act of 1977. The 1972 and 1977 Acts enable EPA to fund 75% of total eligible capital costs of conventional systems and 85% of the eligible capital costs of innovative and alternative systems. Innovative and alternative systems considered in the EIS include land treatment, pressure sewers, cluster systems, and septic tank rehabilitation and replacement. The State of Michigan funds 5% the capital costs of both conventional and innovative/alternative wastewater facilities. The funding formula in Michigan thus requires localities to pay 20% of the capital costs of conventional systems and 10% of the capital costs of innovative/alternative systems. Operation and maintenance costs are not funded by the Federal government and must be paid by the users of the facilities.

The percentage of capital costs eligible for Federal and State funding greatly affects the cost that local users must bear. Treatment capital costs were assumed to be fully eligible for grant funding while collection system capital costs were subject to the terms of Program Requirements Memorandum (PRM) 78-9. This PRM establishes three main conditions that must be satisfied before collector sewer costs may be declared eligible:

- Systems in use for disposal of wastes from the existing population are creating a public health problem, contaminating groundwater or violating point source discharge requirements.
- Two-thirds of the design population (year 2000) served by a sewer must have been in residence on 18 October 1972.
- Sewers must be shown to be cost-effective when compared to decentralized or on-site alternatives.

The Michigan Department of Natural Resources evaluated the eligibility of the sewers proposed in the Facility Plan and the EIS. The eligibility evaluation concluded that all innovative/alternative systems and sewers in segments 5, 6, 8, and 16 are eligible for Federal funding. All other collection capital costs are ineligible for Federal funding. The local costs presented in Table IV-5 are based upon the EPA determination of eligibility.

A final determination of grant eligibility will be prepared by the Michigan Department of Natural Resources (MDNR). MDNR's determination will be based upon Step 2 plans and specifications for the alternative selected to be funded. The MDNR determination may differ from the EPA determination in two respects:

- EPA did not have detailed plans and specifications for all alternatives upon which to base its computation. Consequently a detailed sewer-by-sewer determination was impossible.

Table V-5

LOCAL SHARE OF COSTS

ALTERNATIVE	LOCAL SHARE
Facility Plan Proposed Action (Old Population)	1,282,200
Facility Plan Proposed Action (New Population)	1,269,800
EIS Alternative #1	163,400
EIS Alternative #2	960,000
EIS Alternative #3	423,700
EIS Alternative #4	994,000
EIS Alternative #5	431,500
EIS Alternative #6	45,900

- In estimating collector sewer eligibilities, EPA did not compare the alternatives to one another in regard to cost-effectiveness or to their probable success in satisfying documented public health, groundwater or point source problems. Each alternative was considered on its own merits and on its ability to meet the "two-thirds" rule. Enforcement of the "need" criteria would further increase the eligibility of the centralized alternatives.

b. Calculation of User Charges

The user charges developed for the Crooked/Pickerel Lakes alternative systems consist of local capital costs, operation and maintenance costs, and a reserve fund charge. The calculation of debt service was based on local costs being paid through the use of a 30-year bond at 6 7/8% interest. The user charges in Table IV-4 are presented on an annual charge per household basis.

The centralized alternatives (Facility Plan Proposed Action, both old and new population, EIS Alternative 2, and EIS Alternative 4) are the most costly to users in the Crooked/Pickerel Lakes area. The annual user charges for the centralized alternatives range from $600 to $650 per household. The relatively high costs of the centralized alternatives are attributable to the ineligibility of certain collector sewer segments. Costs for these ineligible sewers must be met entirely at the local level without Federal and State assistance.

The decentralized alternatives (EIS Alternatives 1, 3, 5, and 6) are less expensive than the centralized alternatives and range from $90 to $340. EIS Alternative 6 (Limited Action) is the least expensive of all the alternatives. Operation and Maintenance costs are a more significant part of the annual user charges for the decentralized alternatives than the centralized alternatives. Overall, the decentralized alternatives involve the least amount of sewering and have the lowest amount of ineligible costs.

In addition to user charges, households connected to a gravity sewer would have to pay the capital costs (approximately $1,000) of the sewer connection. Pressure sewer connections, especially for cluster systems, are eligible for Federal funding and do not represent a private cost to homeowners. Seasonal homeowners also may have to pay the full price for the replacement or rehabilitation of their on-site systems (septic tanks and soil absorption systems) if these systems are not ceded to the local wastewater management agency, or the agency given access by easement for repairs and upgrading. These private costs would vary from household to household due to differences in in the distance to the gravity collector sewer and the condition of on-site systems.

3. LOCAL COST BURDEN

a. Significant Financial Burden

High-cost wastewater facilities may place an excessive financial burden on users of the system. Such burdens may cause families to alter their spending patterns substantially. The Federal government has developed criteria to identify high-cost wastewater projects (The White House Rural Development Initiatives 1978). A project is identified as high-cost when the annual user charges are:

- 1.5% of median household incomes less than $6,000
- 2.0% of median household incomes between $6,000 and $10,000
- 2.5% of median household incomes greater than $10,000.

The 1978 median household income for the service area has been estimated to be $16,000 for permanent residents. (No data are available for seasonal resident income characteristics.) According to the Federal criteria, annual user charges should not exceed 2.5% ($400) of the $16,000 median household income figure. Any alternative having annual user charges exceeding $400 is identified as a high-cost alternative and is likely to place a financial burden on users of the system. Each of the centralized alternatives would be classified as high-cost according to the Federal criteria. None of these decentralized alternatives would be classified as high-cost.

Significant financial burden is determined by comparing annual user charges with the distribution of household incomes. Families not facing a significant financial burden would be the only families able to afford the annual wastewater user charges. Table IV-6 shows the percentage of households estimated to face a significant financial burden under each of the alternatives. The centralized alternatives imply annual user charges that would place a significant financial burden on 60-80% of the households in the Crooked/Pickerel Lakes area. Approximately 20-40% of the households in the area would be able to afford the annual user charges under the centralized alternatives. Significant financial burden under the decentralized alternatives ranges from 5 to 45% of the households. The number of households able to afford the decentralized alternatives ranges from 55 to 95%. The Limited Action Alternative (EIS Alternative 6) would place the least financial burden (5-10%) on households.

b. Displacement Pressure

Displacement pressure is the stress placed upon families to move away from the service area as a result of costly user charges. Displacement pressure is measured by determining the percentage of households having annual user charges exceeding 5% of their annual income. The displacement pressure induced by each of the alternatives is listed in Table IV-6.

Displacement pressure is highest under the centralized alternatives and ranges from 20 to 45% of the total number of households. Displacement pressure is less under the decentralized alternatives, ranging from 1 to 10%. The Limited Action Alternative (EIS Alternative 6) would place the least amount of displacement pressure 1 to 5%, on households.

Table V-6

FINANCIAL BURDEN AND DISPLACEMENT PRESSURE

ALTERNATIVE	DISPLACEMENT PRESSURE	FINANCIAL BURDEN	CAN AFFORD
Facility Plan Proposed Action (Old Population)	35-45%	60-80%	20-40%
Facility Plan Proposed Action (New Population)	35-45%	60-80%	20-40%
EIS Alternative #1	5-10%	10-20%	80-90%
EIS Alternative #2	20-35%	60-80%	20-40%
EIS Alternative #3	5-10%	35-45%	55-65%
EIS Alternative #4	20-35%	60-80%	20-40%
EIS Alternative #5	5-10%	35-45%	55-65%
EIS Alternative #6	1-5%	5-10%	90-95%

c. Conversion Pressure

In a seasonal home area, the conversion of seasonal to permanent units can be expected to result from: (1) retirement age households permanently relocating to their seasonal residence; (2) local households converting a seasonal residence to a permanent home; and (3) previously seasonal households converting their second home to a permanent residence in an effort to move away from metropolitan areas while retaining access to employment opportunities and other urban amenities. In the Crooked/Pickerel Lakes Proposed Service Area, the introduction of centralized and/or decentralized wastewater management systems is likely to accelerate an already substantial conversion rate of approximately 1.0% per year by further encouraging the first two of these three factors.

Alternatives providing any form of centralized wastewater management service to the existing seasonal units will make the conversion of such homes by retirement age and local households more attractive by eliminating the problems associated with on-lot systems. However, since a significant number of conversions are already occurring and are projected to continue to occur during the planning period, it would appear that the provision of wastewater management service would only increase the conversion rate by an additional .25% to .50% per year. This would nearly double the number of existing seasonal units converted during the planning period from 23 to 44.

Continued use of septic tank systems may result in the highest increase in the conversion rate. Since there is only a limited amount of developable land available without the provision of centralized or decentralized wastewater management facilities, the demand for permanent units by local households will have to be met largely by existing seasonal units. As the development pressures for new permanent units continue to increase and the existing environmental constraints continue to limit the amount of new residential development, many second home owners may take advantage of the opportunity to profit from the sale of their relatively costly (in terms of amount of use) seasonal residences. This stronger conversion pressure could potentially increase the conversion rate by an additional 1.0% over the baseline rate, adding 25 to 30 seasonal units which would be converted during the planning period.

4. MITIGATIVE MEASURES

The significant financial burden and displacement pressure may be mitigated by selection of a lower cost decentralized alternative or the local wastewater management authority may seek to obtain a loan or grant from the Farmers Home Administration. Such a loan would decrease annual user charges by spreading out the payment of the local share over a longer period of time with a lower interest rate. The impacts of the high costs to seasonal users may be mitigated by not charging for operation and maintenance during the months that seasonal residences are vacant.

F. IMPACT MATRIX

IMPACT CATEGORY	RESOURCE	IMPACT TYPE & DEGREE	IMPACT DESCRIPTION
Surface Water Quality	Nutrient Loading	Primary; Long-Term	All Alternatives: None of the alternatives will have a significant impact on nutrient loadings to the lakes. Less than 2% of the phosphorus loads to the lakes come from septic tanks in contrast to the significant loads from non-point sources (80%).
	Eutrophication Potential	Primary; Long-Term	All Alternatives: No alternative is anticipated to have a significant impact on open water quality. Continued reliance on ST/SAS would increase phosphorus loads by only 4%.
	Shoreline Eutrophication *Cladophora* Growth	Primary; Long-Term	Alternatives 1, 2, 3, 4, 5 and Facility Plan: These alternatives would have the greatest potential for eliminating localized lakeshore eutrophication by eliminating ST/SAS as a source of nutrients for *Cladphora* growth. Alternative 6 and No Action: Alternative 6 would mitigate the two major *Cladophora* problems areas however localized blooms would continue.
Groundwater	Groundwater quantity	Primary; Long-Term	All Alternatives: Failure to return wastewater flows to groundwater systems will result in negligible loss of groundwater recharge.
		Secondary; Long-Term	All Alternatives: Loss of aquifer recharge area as a result of possible development of impervious surface coverage will be minimal.
	Groundwater quality	Primary; Long-Term	No Action: Septic tank phosphorus would continue to leach into the groundwater. Alternative 6: A combination of renovation and clustering for on-site systems around the lakeshore areas will reduce phosphorus levels leaching into groundwater systems. Phosphorus would be eliminated within the two existing Cladophora problem areas. Alternatives 1, 2, 3, 4, 5, and Facility Plan: Sewering and clustering the entire lakeshore area eliminates any possibility of septic systems as a source of groundwater phosphorus for localized algae growth.
Environmentally Sensitive Areas	Wetlands	Primary; Short-Term	Alternative 4 and Facility Plan: Construction impacts will be unavoidable. Extent of impact will be directly related to extent of sewerage. Duration of impact will relate to the timing of construction and the swiftness of restoration.
		Primary; Short Term	Alternatives 1, 2, 3, 5, and 6: Except for minimal effects during construction, impacts will be negligible.
		Secondary; Long-Term	Alternative 4 and Facility Plan: The highest rate of induced growth would occur with these alternatives resulting in significant development impacts on wetland areas. Alternatives 1, 2, 3, and 5: These alternatives would have comparably moderate rates of induced growth. The greater the degree of centralized service, the greater the degree of impact on wetland areas. Alternative 6 and No Action: This alternative would have minimal impact on wetland areas.

IMPACT CATEGORY	RESOURCE	IMPACT TYPE & DEGREE	IMPACT DESCRIPTION
	Prime Agricultural Land	Primary; Short-Term	All Alternatives: Direct impacts from construction of wastewater management alternatives will be minimal.
		Secondary; Long-Term	Alternatives 2, 4, and Facility Plan: These alternatives will result in the greatest amount of conversion of prime agricultural land for residential use.
			Alternatives 1, 3, and 5: Some Prime Agricultural Land will be developed in shoreline areas. As well, acreage will be consumed by cluster system absorption areas.
			Alternative 6 and No Action: This alternative will have minimal impact on Prime Agricultural Lands.
	Endangered Species	Primary: Short-Term	Alternative 4 and Facility Plan: Construction activities could have a significant impact on the Bald Eagle nesting site.
			Alternatives 1, 2, 3, 5, and No Action: No impact.
	Archaeological Sites	Primary Short-Term	Alternatives 1, 2, 3, 4, 5, and Facility Plan: Potential impacts exist under these alternatives.
			Alternative 6 and No Action: No impact.
		Secondary; Long-Term	Alternatives 1, 2, 3, 4, 5, and Facility Plan: Growth pressures that would occur with these alternatives could impact this resource.
			Alternative 6 and No Action: No impact.
Population	Rate of Growth	Secondary; Long-Term	Alternatives 4 and Facility Plan: These alternatives would result in significnat induced growth, 65% to 100% above the baseline projected.
			Alternatives 2, 3, and 5: These alternatives would induce a moderately high rate of growth, 2.5% to 10.0%, above the baseline.
			Alternative 1: Alternative 1 would accommodate the rate of growth projected.
			Alternative 6 and No Action: This alternative would hold population growth to 10% to 25% below that projected.
Land Use	Developable Acreage: Growth Patterns	Secondary; Long-Term	Proposed Action: Residential acreage would increase up to 130 additional acres. Higher density development close to the shoreline would result.
			Alternatives 1, 2, 3, 4, and 5: Residential acreage would increase between 77 and 97 additional acres with proportionally high densities.
			Alternative 6: Acreage is anticipated to increase by 38 acres with scattered low density development.
			No Action: Acreage would only increase by 25.
Local Economy	Local Cost Burden	Primary; Long-Term	Facility Plan: Average annual user charge would be $662 for the Facility Plan design flow and $653 for the EIS design flow.

IMPACT CATEGORY	RESOURCE	IMPACT TYPE & DEGREE	IMPACT DESCRIPTION
			Alternatives 2 and 4:
			Annual user cost would be $604 and $609, respectively.
			Alternatives 3 and 5:
			Annual user cost would be $332 and $339, respectively.
			Alternatives 1 and 6:
			Annual user cost would be $201 and $90, respectively.
Economy	Conversion Pressure	Primary; Long-Term	All Alternatives: Recent trends indicate that regardless of the alternative conversion from seasonal to permanent units will continue to occur. The highest rate will occur with Alternative 6 since there will be the least number of housing opportunities. Under any of the other alternatives, conversion pressure will be least with the more centralized forms of wastewater collection and treatment.
	Displacement Pressure	Primary; Long-Term	Alternatives 2, 4, and Facility Plan: Displacement pressure would be highest under these alternatives, from 20% to 45%.
			Alternatives 1, 3, 5, and 6:
			These alternatives would result in low displacement pressure ranging from 1% to 10%.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

A. INTRODUCTION

As discussed in Section I.D.1, EPA has several possible courses of action with respect to the Facility Plan Proposed Action. The Agency may:

- Approve the grant application, possibly with recommendations for design changes and/or measures to mitigate impacts of the Facility Plan Proposed Action;
- With the applicant's and the State's concurrence, approve Step II funding for an alternative to the Facility Plan Proposed Action.
- Return the application with recommendations for additional Step 1 analysis; or
- Reject the grant application.

The choice of one of the above options depends upon how the EIS alternatives compare to the Facility Plan Proposed Action.

B. SUMMARY OF EVALUATION

Four primary criteria were used in selecting the EIS recommendation; costs, impact, reliability, and flexibility. Within each category several factors were compared. Cost factors for example, included present worth, user charges and total 1980 private costs. Impacts which EPA considers to be decisive in selection of an alternative are identified and considered. The reliability of alternatives is measured against centralized collection and treatment as the standard.

A matrix offers a simple way to visualize the relationship between alternatives and the criteria used to evaluate them. By tabulating the factors that influence the range of choice for each alternative, one can quickly compare the effect of each upon that factor. A matrix relating alternatives to environmental impacts is presented in Section V.F. Table VI-1 presents a matrix summarizing the relationship between the alternatives and their costs, environmental impacts, reliability, and flexibility.

Table VI-1 also ranks the alternatives according to their total present worth. This ranking has two purposes:

- Costs are easily quantifiable, perhaps the least subjective measure of value.

Table VI-1

ALTERNATIVE SELECTION MATRIX

	COSTS			ENVIRONMENTAL IMPACTS					SOCIOECONOMIC IMPACTS			
	Present Worth (x$1000)	User Charge ($)	Total 1980 Private Costs (x$1000)	Wastewater Quality Impacts	Groundwater Quality Impacts	Environmentally Sensitive Areas	Population Impacts	Land Use	Financial Burden %	Displacement Burden %	Flexibility	Reliability
EIS Alternative 4	3,175.49	610	75.07	Nutrient loads from septic tank drainfields are eliminated Non-point sources continue to be a major source of nutrients Estimated nutrient load decreases only 2-3%	Eliminates septic systems as a possible source of groundwater pollution	Construction impacts are unavoidable Significant impacts will result from induced growth	Population will increase 65% over baseline projected	Residential acreage would increase 97 acres High density development would occur	60-30%	20-35%	Reduced flexibility with a fixed collection system size. Land Application systems retains flexibility limited only by available land	With proper design, operation, and maintenance land application systems provide a good level of reliability
EIS Alterna-sive 2	3,126.61	600	104.82	Nutrient loads from septic tank drainfields are eliminated Non-point sources continue to be a major source of nutrients	Eliminates septic systems as a possible source of groundwater pollution	Minimal impacts during construction Moderate rate of induced growth results in impacts on wetlands and prime agriculture lands	Population will increase 10-15% above baseline	Residential acreage would increase 93 acres Moderately high density development would occur	35-45%	5-10%	Land application systems retains flexibility limited only by available land Provides for flexibility for future expansion because of different treatment modes used	Properly designed and maintained cluster systems will provide satisfactory service. With proper design, operation, and maintenance land application systems provide a good level of reliability
EIS Alternative 5	2,597.58	340	24.72	Nutrient loads from septic tank drainfields are eliminated Non-point sources continue to be a major source of nutrients	Eliminates septic systems as a possible source of groundwater pollution	Minimum impacts	Population will increase 5-10% above baseline	Residential acreage would increase 79 acres Medium density development would occur	35-45%	5-10%	Land application systems retains flexibility limited only by available land Provides for flexibility for future expansion because of different treatment modes used	Properly designed and maintained cluster systems will provide satisfactory service With proper design, operation, and maintenance land application systems provide a good level of reliability

Table VI-1 - Cont'd.

	COSTS			ENVIRONMENTAL IMPACTS					SOCIOECONOMIC IMPACTS			
	Present Worth (x$1000)	User Charge ($)	Total 1980 Private Costs (x$1000)	Wastewater Quality Impacts	Groundwater Quality Impacts	Environmentally Sensitive Areas	Population Impacts	Land Use	Financial Burden %	Displacement Burden %	Flexibility	Reliability
Facility Plan Proposed Action (Old Design Flow)	3,896.55	650	250.24	Nutrient loads from septic tank drain-fields are eliminated Non-point sources continue to be a major source of nutrients Estimated nutrient load decreases only 2-3%	Eliminates septic systems as a possible source of groundwater pollution	Construction impacts are unavoidable Significant impacts will result from induced growth	Population will increase 100% above baseline population projected by this EIS	Residential acreage would increase up to 130 additional acrea High density development would occur	60-80%	35-45%	Reduced flexibility in terms of design changes and future planning	High, centralized collection and treatment has been tested and proven Pumps may be subject to periodic failure
Facility Plan Proposed Action (EIS Design Flow)	3,558.03	660	199.10	Nutrient loads from septic tank drain-fields are eliminated Non-point sources continue to be a major source of nutrients Estimated nutrient load decreases only 2-3%	Eliminates septic systems as a possible source of groundwater pollution	Construction impacts are unavoidable Significant impacts will result from induced growth	Population will increase 100% above baseline population projected by this EIS	Residential acreage would increase 97 acres	60-80%	35-45%	Reduced flexibility in terms of design changes and future planning	High, centralized collection and treatment has been tested and proven
EIS Alternative 3	3,197.15	330	10.88	Nutrient loads from septic tank drain-fields are eliminated Non-point sources continue to be a major source of nutrients Estimated nutrient load decreases only 2-3%	Eliminated septic systems as a possible source of groundwater pollution	Minimal impacts during construction Moderate rate of induced growth impacts wetlands and prime agricultural lands	Population will increase 2.5 to 5% above baseline projected	Residential acreage would increase 80 acres Medium density development would occur	35-45%	5-10%	Provides for flexibility for future expansion because of different treatment modes used	Properly designed and maintained cluster systems will provide satisfactory service. Pumps may be subject to failure. Centralized collection and treatment same as Proposed Action.

Table VI-1 - Cont'd.

	COSTS			ENVIRONMENTAL IMPACTS					SOCIOECONOMIC IMPACTS			
	Present Worth (x$1000)	User Charge ($)	Total 1980 Private costs (x$1000)	Wastewater Quality Impacts	Groundwater Quality Impacts	Environmentally Sensitive Areas	Population Impacts	Land Use	Financial Burden %	Displacement Burden %	Flexibility	Reliability
EIS Alternative 1	2,514.74	200		Nutrient loads from septic tanks drainfields are eliminated Non-point sources continue to be a major source of nutrients	Eliminated septic systems as a possible source of groundwater pollution	Minimum impact	Baseline population would be accommodated	Residential acreage would increase 77 acres	10-20%	5-10%	High flexibility to accommodate future growth	Properly designed and maintained cluster systems provide satisfactory service
EIS Alternative 6	1,184.23	90		Phosphorus load to lake increases by 4%. No impact on open water. Near shore cladaphora growth may occur	Amount of nutrients reaching groundwater reduced	No impact	Population growth would be 10% below baseline projected	Residential acreage would increase 38 acres in low density pattern	5-10%	1-5%	High flexibility for future design and planning changes	On-site ST/SAS and cluster systems provide satisfactory service
No Action				Nutrient loads from septic tank drainfields continue to leach into the lakes	Leachate continues to pose groundwater pollution problems	No impact	Population growth would be 25% below baseline projected	Scattered low density development would increase only 25 acres			High flexibility for future design and planning	On-site systems would continue to malfunction

- EPA Construction Grants regulations require selection of the most cost-effective alternative, that is, the alternative meeting project goals with the least total present worth with acceptable environmental and socioeconomic impacts.

Selection of the cost-effective alternative requires identification of trade-offs between costs and other criteria. The evaluation factors included with total present worth in Table VI-1 are those EPA has determined to be most important in identifying trade-offs for this project.

C. CONCLUSIONS

In regard to the existing on-site systems around Crooked/Pickerel Lakes, information gathered during the preparation of this EIS has indicated the following: 1) Approximately 51 effluent plumes were found entering Crooked/Pickerel Lakes. 2) Eight septic system surface malfunctions* were confirmed by field verification of aerial photography. 3) Sanitary surveys have revealed that periodic sewage backups in some households have occurred. 4) Effluent plumes from septic systems do not contribute significant quantities of nutrients to Crooked/Pickerel Lakes however they do support localized Cladophora growth. While detailed site-by-site analysis may reveal more problems, field studies conducted so far indicate that approximately 36% of the systems arround the lakeshore are causing problems of one type or another.

Most of the on-site systems presently in use within the EIS Service Area are poorly maintained and many are inadequately designed. Routine maintenance for all on-site systems and upgrading of inadequately designed systems will substantially reduce the number of problems caused by them.

Where problems cannot be solved by routine maintenance or upgrading alone, alternatives to the conventional septic tank -- subsurface adsorption systems are feasible in the Study Area which will minimize or eliminate the problems.

Future growth in Crooked/Pickerel Lakes Service Area depends on how many new lots can be developed and the allowable density. Wastewater disposal alternatives relying on continued use of on-site systems as compared to extensive sewering around the lakes would restrict both the number of new lots as well as their density. An effect of these limitations would be to preserve the present character of the community.

Total present worth for the more centralized alternatives (Facility Plan Proposed Action, EIS Alternatives 2, 3 and 4) are higher than for the decentralized alternatives (EIS Alternatives 1, 5, and 6). As calculated in this EIS, the Facility Plan Proposed Action is 1.5 times more expensive than EIS Alternative 1 and 3.3 times more expensive than EIS Alternative 6. Differences in water quality impacts of the alternatives are not proportionate to these large differences in costs. Because of the high costs and limited benefits to water quality with the more centralized alternatives (Facility Plan Proposed Action and EIS Alternative 2, 3, and 4), they are not cost-effective and are not recommended.

The No Action alternative is not recommended because it would fail to address identified water quality and public health problems. The No Action alternative would also fail to improve the monitoring and management of existing systems. Improved surveillance and regulation of on-site systems in the Crooked/Pickerel Lakes Service Area would ensure the maintenance of the unique scenic and recreational values of the area.

The remaining alternatives, EIS Alternatives 1, 5, and 6, include the use of alternative on-site and small scale off-site systems around Crooked/ Pickerel Lakes. Each alternative incorporates a different mix of technology: EIS Alternative 6 emphasizes continued use of on-site systems, EIS Alternative 1 emphasizes off-site treatment using cluster systems, and EIS Alternative 5 examines land application for part of the Proposed Service Area. Comparison of the costs and impacts for these three alternatives has led to the following conclusions:

- Continued use of on-site systems, where environmentally acceptable, is the cost effective approach to wastewater management

- At low housing densities where on-site systems cannot be used, pressure sewer collection and cluster system disposal of wastewater will likely be the cost-effective approach.

- When housing density exceeds approximately 50 houses per mile of sewer (assuming all houses require off-site treatment) gravity collection for cluster systems becomes more cost effective than pressure sewers.

- Land application (surface) of wastewater becomes more practicable as the number of residences and the design flow increases. The cost comparison between surface application and subsurface disposal (cluster systems) is complicated by the factors of site suitability, site availability and the local availability of adequately trained operations personnel.

- Reliance on on-site systems, as in EIS Alternative 6 will restrict development opportunities compared to alternatives using off-site treatment. This impact can be mitigated by selective use of cluster or land application systems serving areas that are environmentally suitable for development.

- Where groundwater flow rates or soil conditions are conducive to nutrient transport, and substrate* is suitable for Cladophora growth, on-site systems may stimulate local growth of aquatic plants. Off-site treatment may reduce the occurrence of these local growths.

The final selection of appropriate technologies to meet the treatment needs of the Crooked/Pickerel Lakes Service Area will be dependant on the development of the site specific environmental and engineering data base outlined in Section III.E.2.b. This data base will determine which existing systems could be upgraded on-site. Where on-site upgrading is not feasible, such a data base would provide the necessary information to choose the next cost-effective collection and treatment method. This analysis would depend upon housing density, transmission distances, and the suitability of soils for cluster systems or land application.

D. DRAFT EIS RECOMMENDATION

On a preliminary basis, this EIS recommends formation of a small waste flows district and construction of EIS Alternative 6 at a minimum. There are four major reasons for this: 1) water quality impact of the alternatives varies significantly only for shoreline algae concentrations; EIS Alternative 6 provides off-site treatment for the two major algal problem areas; 2) EIS Alternative 6 is clearly cost effective by a margin of at least 2 to 1 compared to the other alternatives; 3) EIS Alternative 6 possesses ample flexibility for expansion or improvement; should groups of individual property owners wish to develop land in one of the EIS Alternative 1 cluster areas, they could do so by special assessment for construction of a cluster system; should unforeseen on-site water quality problems arise, they could be the object of a new construction grant application for a cluster system, blackwater/greywater separation or other appropriate approach; 4) It is unlikely that the State of Michigan or EPA Region V would certify Federal or State funding for a more elaborate alternative in the absence of a more clearly defined water quality problem.

Please note that EIS Alternative 6 may vary from the design outlined in Chapter IV. This is because the detailed site by site design work needed to decide the level of on-site upgrading for each house (see section III.E.2.b) may indicate that particular dwellings have problems requiring different technologies than those incorporated in EIS Alternative 6. When upgrading of existing conventional septic tank-soil absorption systems is found to be impractical, alternative on-site measures should be evaluated. These include composting or other alternative toilets, flow reduction as well as holding tanks and separate greywater/blackwater disposal.

Cluster systems in addition to those in EIS Alternative 6 may be eligible for Construction Grants funding where site data, evaluation of conventional and alternative on-site systems, and cost-effective analyses demostrate the practicality of off-site treatment and disposal. It is possible that one or more cluster system could be required due to localized site conditions, notably in the area of Channel Road or Oden Island. Addition of both of these, if needed, could increase total present worth costs of Alternative 6 by as much as 30 percent, to perhaps $1.6 million.

One major feature of small waste flow district management should be a continuing monitoring program to detect lake and groundwater quality problems. Purchase of instruments for this monitoring effort is grant eligible.

One decision the small waste flows district will have to make is whether to operate its own pumping truck ("honey wagons") for septage from the few holding tanks, or to contract with local haulers. Should the district wish to operate its own trucks, purchase of them would be grant elibible at 85% funding.

E. IMPLEMENTATION

1. Completion of Step I (Facility Planning) Requirements for the Small Waste Flows District

Assuming that the applicant, the local municipalities and the State concur in the Recommended Action, Construction Grants regulations for individual systems ("Privately owned alternative wastewater treatment works...serving one or more principal residences...) require the applicant to take the following action prior to award of a Step II grant. (40 CFR 35.918):

- Certify that the project be constructed and an operation maintenance program be established to meet local, State and Federal requirements. This would involve development of variance procedures for upgrading and continued use of nonconforming on-site systems.

- Obtain assurance of unlimited access to each individual system at all reasonable times for such purposes as inspections, monitoring, construction, maintenance, operations, rehabilitation and replacement.

- Plan for an overall program for management of individual system including inspection and maintenance.

Completion of these steps would allow immediate processing of the application and prompt disbursal of Step II funds.

2. Scope of Step II for the Small Waste Flows District

A five step program for wastewater management in small waste flow districts was suggested in Section III.E.2. Three of these steps would begin immediately after receiving Step II funds. These are:

- Develop a site-specific environmental and engineering data base.

- Design the Management Organization, and

- Agency start-up.

EPA will assist the applicant in defining specific objectives and tasks for Step II work.

3. Compliance with State and Local Standards in the Small Waste Flows District

As discussed in Section II.C. many existing on-site systems do not conform to current design standards for site, design or distance from wells or surface waters. For some systems, such as those with undersized septic tanks, non-conformance can be remedied relatively easily and inexpensively. In other cases the remedy may be disruptive and expensive. It is evident that renovation or replacement of on-site systems should be undertaken only where the need is clearly identified. Data on the effects of existing systems indicate that many non-conforming systems still may operate satisfactorily. In instances where compliance with design standards is either 1) not feasible, or excessively expensive to attain or 2) site monitoring of ground and surface waters shows that acceptable impacts are or can be attained, then a variance procedure to allow renovation and continued use is recommended. Decisions to grant variances should be based on site-specific data or on a substantial history of similar sites in the area.

Local and state decisions to develop variance procedures would likely be influenced by the degree of authority vested in the small waste flows district. If the district has sufficient financial backing to correct errors, and appropriately trained personnel to minimize errors in granting variances, variance procedures may be more liberal than if fiscal and professional resources are limited. Higher local costs, caused by unnecessary repairs or abandonment of systems is expected to result from very conservative variance guidelines, or none at all. Conversely, ill-conceived or improperly implemented variance procedures could effect frequent water quality problems and demands for more expensive off-site technologies.

4. Ownership of On-Site Systems Serving Seasonal Residences

Construction Grants regulations allow Federal funding for renovation and replacement of publicly owned on-site systems serving principal or seasonally occupied residences and of privately owned on-site systems serving principal residences. Privately owned systems serving seasonally occupied residences are not eligible for Federally funded renovation and replacement.

Depending on the extent and costs of renovation and replacement necessary for seasonal residences, the municipalities or a small waste flows district may elect to accept ownership of the on-site systems. Rehabilitation of these systems would then be eligible for Federal assistance. Ownership of seasonally used systems may create responsibilities that the agency does not want or may not leagally be capable of fulfilling. Under PRM79-8 however receipt of a binding easement allowing district access to a site for repair, replacement, maintenance or upgrading at all reasonable times is considered tantamount to public ownership.

CHAPTER VII

ENVIRONMENTAL CONSEQUENCES OF THE RECOMMENDED ACTION

A. UNAVOIDABLE ADVERSE IMPACTS

The implementation of the Recommended Action is not expected to create any significant adverse impacts. By upgrading on-site systems or implementing small scale off-site treatment, the Recommended Action would reduce the occurrence of inadequately treated wastewater reaching surface waters or creating public health problems. The Recommended Action would thus be an improvement on the existing situation which has not created significant adverse impacts.

B. CONFLICTS WITH FEDERAL, STATE, AND LOCAL OBJECTIVES

The Recommended Action would have some effect on the number of existing ST/SAS's which currently do not comply with the provisions of State and local codes pertaining to minimum lot sizes, setback distances from wells, surface water bodies, etc., and the sizes of some soil absorption fields. The special studies undertaken for this EIS have indicated that the noncompliance with these provisions has not resulted in significant adverse impacts. The monitoring and maintenance programs proposed under the Recommended Action should, under these circumstances, prove to be the cost-effective solution to the existing noncompliance with State and local codes.

C. RELATIONSHIP BETWEEN SHORT-TERM USE AND LONG-TERM PRODUCTIVITY

1. SHORT-TERM USE OF THE STUDY AREA

The Crooked/Pickerel Lakes Study Area has been and will continue to be used as a residential and recreational area. The site was initially disturbed when construction of houses first began. Disturbance of the Study Area by routine residential/recreational activities will continue. Implementation of the Recommended Action is not expected to alter these disturbances.

2. IMPACTS ON LONG-TERM PRODUCTIVITY

a. Commitment of Non-Renewable Resources

Implementation of the Recommended Action would result in a minimal loss of terrestrial habitat. Most future development is expected in lakeshore areas where a sufficiency of land (excluding terrestrial habitats) exists. Unlike the Facility Plan Proposed Action, there is little potential for induced growth.

Non-renewable resources associated with the Recommended Action would include concrete for construction. Unlike the Facility Plan Proposed Action, comparatively little electric power would be required for pumps. Some increase of manpower above existing levels would be required for the construction, operation, and management of the on-site systems as well as the water quality monitoring program.

b. Limitations on Beneficial Use of the Environment

The Recommended Action would not have any significant effect on the beneficial use of the environment. The level of public enjoyment of the lakes, parks and other scenic features of the Study Area would be maintained. This alternative, unlike the Facility Plan Proposed Action, does not have a potential for inducing growth that would overcrowd the lakes.

D. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The resources that would be committed during implementation of the Recommended Action include those associated with construction and maintenance of wastewater systems. These were discussed in Section VII.C.2.a.

In addition, growth expected in the Study Area would require a commitment of resources to the construction of new dwellings and commercial establishments, construction or improvement of roads and facilities associated with water sports. Besides construction materials, such as lumber, steel, concrete and glass, electricity and manpower would also be committed to new development.

Human resources would include construction personnel and, perhaps additional personnel to service added community needs for services (schools, hospitals, roads, etc.).

GLOSSARY

GLOSSARY

ACTIVATED SLUDGE PROCESS. A method of secondary wastewater treatment in which a suspended microbiological culture is maintained inside an aerated treatment basin. The microbial organisms oxidize the complex organic matter in the wastewater to simpler materials, and energy.

ADVANCED WASTE TREATMENT. Wastewater treatment beyond the secondary or biological stage which includes removal of nutrients such as phosphorus and nitrogen and a high percentage of suspended solids. Advanced waste treatment, also known as tertiary treatment, is the "polishing stage" of wastewater treatment and produces a high quality of effluent.

AEROBIC. Refers to life or processes that occur only in the presence of oxygen.

ALGAL BLOOM. A proliferation of algae on the surface of lakes, streams or ponds. Algal blooms are stimulated by phosphate enrichment.

ALKALINE. Having the qualities of a base, with a pH of more than 7.

ALLUVIAL. Pertaining to material that has been carried by a stream.

ALTERNATIVE TECHNOLOGY. Alternative waste treatment processes and techniques are proven methods which provide for the reclaiming and reuse of water, productively recycle waste water constituents or otherwise eliminate the discharge of pollutants, or recover energy. Alternative technologies may not be variants of conventional biological or physical/ chemical treatment.

AMBIENT AIR. The unconfined portion of the atmosphere; the outside air.

ANAEROBIC. Refers to life or processes that occur in the absence of oxygen.

AQUATIC PLANTS. Plants that grow in water, either floating on the surface, or rooted emergent or submergent.

AQUIFER. A geologic stratum or unit that contains water and will allow it to pass through. The water may reside in and travel through innumerable spaces between rock grains in a sand or gravel aquifer, small or cavernous openings formed by solution in a limestone aquifer, or fissures, cracks, and rubble in such harder rocks as shale.

ARTESIAN AQUIFER. A water-filled layer that is sufficiently compressed between less permeable layers to cause the water to rise above the top of the aquifer. If the water pressure is great, water will flow freely from artesian wells.

ARTESIAN WELL. A well in which flow is sustained by the hydrostatic pressure of the aquifer. See Artesian Aquifer.

BACTERIA. Any of a large group of microscopic plants living in soil, water or organic matter, important to man because of their chemical effects as in nitrogen fixation, putrefaction or fermentation, or as pathogens.

BAR SCREEN. In wastewater treatment, a screen that removes large floating and suspended solids.

BASE FLOW. The rate of movement of water in a stream channel which occurs typically during rainless periods when stream flow is maintained largely or entirely by discharges of groundwater.

BASIC USAGE. Those functions that small waste flow districts would be required to perform in order to comply with EPA Construction Grants regulations governing individual on-site wastewater systems.

BEDROCK. The solid rock beneath the soil and subsoil.

BIOCHEMICAL OXYGEN DEMAND (BOD). A measure of the amount of oxygen consumed in the biological processes that decompose organic matter in water. Large amounts of organic waste use up large amounts of dissolved oxygen; thus, the greater the degree of pollution, the greater the BOD.

BIOMASS. The weight of living matter in a specified unit of environment. Or, an expression of the total mass or weight of a given population of plants or animals.

BIOTA. The plants and animals of an area.

BOD_5. See "Biochemical Oxygen Demand." Standard measurement is made for 5 days at 20°C.

BOG. Wet, spongy land; usually poorly drained, and rich in plant residue, ultimately producing highly acid peat.

CAPITAL COSTS. All costs associated with installation (as opposed to operation) of a project.

CAPITAL EXPENDITURES. See Capital Costs.

CHLORINATION. The application of chlorine to drinking water, sewage or industrial waste for disinfection or oxidation of undesirable compounds.

COARSE FISH. See Rough Fish.

COLIFORM BACTERIA. Members of a large group of bacteria that flourish in the feces and/or intestines of warm-blooded animals, including man. Fecal coliform bacteria, particularly _Escherichia coli_ (_E. coli_), enter water mostly in fecal matter, such as sewage or feed-lot runoff. Coliform bacteria apparently do not cause serious human diseases, but these organisms are abundant in polluted waters and they are fairly easy to detect. The abundance of coliform bacteria in water, therefore, is used as an index to the probability of the occurrence of such diease-producing bodies (pathogens) as Salmonella, Shigella, and enteric viruses. These pathogens are relatively difficult to detect.

COLIFORM ORGANISM. Any of a number of organisms common to the intestinal tract of man and animals whose presence in wastewater is an indicator of pollution and of potentially dangerous bacterial contamination.

COMMINUTOR. A machine that breaks up wastewater solids.

CONNECTION FEE. Fee charged by municipality to hook up house connection to lateral sewer.

CUBIC FEET PER SECOND (cfs). A measure of the amount of water passing a given point.

CULTURAL EUTROPHICATION. Acceleration by man of the natural aging process of bodies of water.

DECIDUOUS. The term describing a plant that periodically loses all of its leaves, usually in the autumn. Most broadleaf trees in North America and a few conifers, such as larch and cypress, are deciduous.

DECOMPOSITION. Reduction of the net energy level and change in chemical composition of organic matter by action of aerobic or anaerobic microorganisms. The breakdown of complex material into simpler substances by chemical or biological means.

DETENTION TIME. Average time required for water to flow through a basin. Also called retention time. Or, the time required for natural processes to replace the entire volume of a lake's water, assuming complete mixing.

DETRITUS. (1) The heavier mineral debris moved by natural watercourses (or in wastewater) usually in bed-load form. (2) The sand, grit, and other coarse material removed by differential sedimentation in a relatively short period of detention. (3) Debris from the decomposition of plants and animals.

DISINFECTION. Effective killing by chemical or physical processes of all organisms capable of causing infectious disease. Chlorination is the disinfection method commonly employed in sewage treatment processes.

DISSOLVED OXYGEN (DO). The oxygen gas (O_2) dissolved in water or sewage. Adequate oxygen is necessary for maintenance of fish and other aquatic organisms. Low dissolved oxygen concentrations sometimes are due to presence, in inadequately treated wastewater, of high levels of organic compounds.

DRAINAGE BASIN. (1) An area from which surface runoff is carried away by a single drainage system. Also called catchment area, watershed, drainage area. (2) The largest natural drainage area subdivision of a continent. The United States has been divided at one time or another, for various administrative purposes, into some 12 to 18 drainage basins.

DRAINAGEWAYS. Man-made passageways, usually lined with grass or rock, that carry runoff of surface water.

DRYWELL. A device for small installations, comprising one or more pits extending into porous strata and lined with open-jointed stone, concrete block, precast concrete or similar walls, capped, and provided with a means of access, such as a manhole cover. It serves to introduce into the ground, by seepage, the partly treated effluent of a water-carriage wastewater disposal system.

EFFLUENT. Wastewater or other liquid, partially or completely treated, or in its natural state, flowing out of a reservoir, basin, treatment plant, or industrial plant, or part thereof.

EFFLUENT LIMITED. Any stream segment for which it is known that water quality will meet applicable water quality standards after comliance with effluent discharge standards.

ELEVATED MOUND. A mound, generally constructed of sand, to which settled wastewater is applied. Usually used in areas where conventional on-site treatment is inadequate.

ENDANGERED SPECIES (FEDERAL CLASSIFICATION). Any species of animal or plant declared to be in known danger of extinction throughout all or a significant part of its range. Protected under Public Law 93-205 as amended.

ENDANGERED SPECIES (STATE CLASSIFICATION). Michigan's list includes those species on the Federal list that are resident for any part of their life cycle in Michigan. Also includes indigenous species the State believes are uncommon and in need of study.

ENDECO. Type 2100 Septic Leachate Detector. See "Septic Snooper".

ENVIRONMENT. The conditions external to a particular object, but generally limited to those conditions which have a direct and measurable effect on the object. Usually considered to be the conditions which surround and influence a particular living organism, population, or community. The physical environment includes light, heat, moisture, and other principally abiotic components. The components of the biotic environment are other living organisms and their products.

ENVIRONMENTAL IMPACT STATEMENT. A document required by the National Environmental Policy Act (PL 91-190, 1969) when a Federal action would significantly affect the quality of the human environment. Used in the decision-making process to evaluate the anticipated effects (impacts) of the proposed action on the human, biological and physical environment.

EPILIMINION. The upper layer of generally warm, circulating water in lakes.

EROSION. The process by which an object is eroded, or worn away, by the action of wind, water, glacial ice, or combinations of these agents. Sometimes used to refer to results of chemical actions or temperature changes. Erosion may be accelerated by human activities.

EUTROPHIC. Waters with a high concentration of nutrients and hence a large production of vegetation and frequent die-offs of plants and animals.

EUTROPHIC LAKES. Shallow lakes, weed-choked at the edges and very rich in nutrients. The water is characterized by large quantities of algae, low water transparency, low dissolved oxygen and high BOD.

EUTROPHICATION. The normally slow aging process by which a lake evolves into a bog or marsh, ultimately assumes a completely terrestrial state and disappears. During eutrophication the lake becomes so rich in nutritive compounds, especially nitrogen and phosphorus, that algae and plant life become superabundant, thereby "choking" the lake and causing it eventually to dry up. Eutrophication may be accelerated by human activities. In the process, a once oligotrophic lake becomes mesotrophic and then eutrophic.

EVAPOTRANSPIRATION. A process by which water is evaporated and/or transpired from water, soil, and plant surfaces.

FECAL COLIFORM BACTERIA. See Coliform Bacteria.

FLOE. A sheet of floating ice.

FORCE MAIN. Pipe designed to carry wastewater under pressure.

GLACIAL DEPOSIT. A landform of rock, soil, and earth material deposited by a melting glacier. Such material was originally picked up by the glacier and carried along its path; it usually varies in texture from very fine rock flour to large boulders. Named according to their location and shape.

GLACIAL DRIFT. Material which has been deposited by a glacier or in connection with glacial processes. It consists of rock flour, sand, pebbles, cobbles, and boulders. It may occur in a heterogeneous mass or be more or less well-sorted, according to its manner of deposition.

GRAVITY SYSTEM. A system of conduits (open or closed) in which no liquid pumping is required.

GROUNDWATER. Water that is below the water table.

GROUNDWATER RUNOFF. Groundwater that is discharged into a stream channel as spring or seepage water.

HABITAT. The specific place or the general kind of site in which a plant or animal normally lives during all or part of its life cycle. An area in which the requirements of a specific plant or animal are met.

HOLDING TANK. Enclosed tank, usually of fiberglass or concrete, for the storage of wastewater prior to removal or disposal at another location.

HYDROPONIC. Refers to growth of plants in a nutrient solution, perhaps with the mechanical support of an inert medium such as sand.

HYPOLIMNION. Deep, cold and relatively undisturbed water separated from the surface layer in the lakes of temperate and arctic regions.

IGNEOUS. Rock formed by the solidification of magma (hot molten material).

INFILTRATION. The flow of a fluid into a substance through pores or small openings. Commonly used in hydrology to denote the flow of water into soil material.

INFILTRATION/INFLOW. Total quantity of water entering a sewer system. Infiltration means entry through such sources as defective pipes, pipe joints, connections, or manhole walls. Inflow signifies discharge into the sewer system through service connections from such sources as area or foundation drainage, springs and swamps, storm waters, street wash waters, or sewers.

INNOVATIVE TECHNOLOGIES. Technologies whose use has not been widely documented by experience. They may not be variants of conventional biological or physical/chemical treatment but offer promise as methods for conservation of energy or wastewater constituents, or contribute to the elimination of discharge of pollutants.

INTERCEPTOR SEWERS. Sewers used to collect the flows from main and trunk sewers and carry them to a central point for treatment and discharge. In a combined sewer system, where street runoff from rains is allowed to enter the system along with the sewage, interceptor sewers allow some of the sewage to flow untreated directly into the receiving stream to prevent the treatment plant from being overloaded.

LAGOON. In wastewater treatment, a shallow pond, usually man-made, in which sunlight, algal and bacterial action and oxygen interact to restore the wastewater to a reasonable state of purity.

LAND TREATMENT. A method of treatment in which soil, air, vegetation, bacteria, and/or fungi are employed to remove pollutants from wastewater. In its simplest form, the method includes three steps: (1) pretreatment to screen out large solids; (2) secondary treatment and chlorination; and (3) application to cropland, pasture, or natural vegetation to allow plants and soil microorganisms to remove additional pollutants. Some of the applied wastewater evaporates, and the remainder may be allowed to percolate to the water table, discharged through drain tiles, or reclaimed by wells.

LEACHATE. Solution formed when water percolates through solid wastes, soil or other materials and extracts soluble or suspendable substances from the material.

LIMITING FACTOR. A factor whose absence, or excessive concentration, exerts some restraining influence upon a population of plants, animals or humans.

LOAM. The textural class name for soil having a moderate amount of sand, silt, and clay. Loam soils contain 7 to 27% of clay, 28 to 50% of silt, and less than 52% of sand.

LOESS. Soil of wind-blown origin, predominantly silt and fine sand.

MACROPHYTE. A large (not microscopic) plant, usually in an aquatic habitat.

MELT WATER. Water which is formed from the melting of snow, rime, or ice.

MESOTROPHIC. Waters with a moderate supply of nutrients and, compared to eutrophic waters, having less production of organic matter.

MESOTROPHIC LAKE. Lakes of characteristics intermediate between oligotrophic and eutrophic, with a moderate supply of nutrients and plant life.

METHEMOGLOBINEMIA. The presence of methemoglobin in the blood. Methemoglobin is the oxidized form of hemoglobin and it is unable to combine reversibly with oxygen.

MICROSTRAINER. A device for screening suspended solids that are not removed by sedimentation.

MILLIGRAM PER LITER (mg/l). A concentration of 1/1000 gram of a substance in 1 liter of water. Because 1 liter of pure water weighs 1,000 grams, the concentration also can be stated as 1 ppm (part per million, by weight). Used to measure and report the concentrations of most substances that commonly occur in natural and polluted waters.

MORPHOLOGICAL. Pertaining to Morphology.

MORPHOLOGY. The form or structure of a plant or animal, or of a feature of the earth, such as a stream, a lake, or the land in general. Also, the science that is concerned with the study of form and structure of living organisms. Geomorphology deals with the form and structure of the earth.

NON-POINT SOURCE. A general source of pollution. Surface water runoff is an example as it does not originate from a single source and is not easily controlled.

NUTRIENT BUDGET. The amount of nutrients entering and leaving a body of water on an annual basis.

NUTRIENTS. Elements or compounds essential as raw materials for the growth and development of organisms, especially carbon, oxygen, nitrogen and phosphorus.

OLIGOTROPHIC. Surface waters with good water quality, relatively low concentrations of nutrients, and modest production of vegetation.

OLIGOTROPHIC LAKES. Lakes with highly transparent water of good quality, high DO levels, and modest production of aquatic vegetation.

ORDINANCE. A municipal or county regulation.

OUTWASH. Drift carried by melt water from a glacier and deposited beyond the marginal moraine.

OUTWASH PLAIN. A plain formed by material deposited by melt water from a glacier flowing over a more or less flat surface of large area. Deposits of this origin are usually distinguishable from ordinary river deposits by the fact that they often grade into moraines and their constituents bear evidence of glacial origin. Also called frontal apron.

PARAMETER. Any of a set of physical properties whose values determine characteristics or behavior.

PERCOLATION. The downward movement of water through pore spaces or larger voids in soil or rock.

PERMEABILITY. The property or capacity of porous rock, sediment, or soil to transmit a fluid, usually water, or air; it is a measure of the relative ease of flow under unequal pressures. Terms used to describe the permeability of soil are: slow, less than 0.2 inch per hour; moderately slow, 0.2 to 0.63 inch; moderate, 0.63 to 2.0 inches; moderately rapid. 2.0 to 6.3 inches; and rapid, more than 6.3 inches per hour. A very slow class and a very rapid class also may be recognized.

PETROGLYPH. An ancient or prehistoric carving or inscription on a rock.

PHOSPHORUS LIMITED. Of all the primary nutrients necessary to support algal growth, phosphorus is in the shortest supply. Phosphorus can limit additional algal growth, or if abundant, can stimulate growth of algae.

PHYTOPLANKTON. Floating plants, microsopic in size, that supply small animals with food and give polluted water its green color and bad taste.

POINT SOURCE. A stationary source of a large individual emission. This is a general definition; point source is legally and precisely defined in Federal regulations.

POVERTY LEVEL. An index providing a range of poverty income cutoffs adjusted by such factors as family size, sex of family head, number of children under 18 years of age, and farm or non-farm residence.

PREHISTORIC. A term which describes the period of human development that occurred before the advent of written records. More generally, any period in geologic time before written history.

PRESENT WORTH. The sum of money that must be set aside at the beginning of the planning period in order to amortize the costs of a project over the planning period.

PRESSURE SEWER SYSTEM. A wastewater collection system in which household wastes are collected in the building drain and conveyed therein to the pretreatment and/or pressurization facility. The system consists of two major elements, the on-site or pressurization facility, and the primary conductor pressurized sewer main.

PRIMARY PRODUCTION. Growth of green plants resulting from solar energy being fixed as sugar during photosynthesis.

PRIMARY TREATMENT. The first stage in wastewater treatment in which nearly all floating or settleable solids are mechanically removed by screening and sedimentation.

RAPID INFILTRATION. A form of land treatment where wastewater is placed into spreading basins and applied to the land to percolate into the soil.

RAPID INFILTRATION BASIN. Unlined wastewater lagoons designed so that all or part of the wastewater percolates into the underlying soil.

RARE SPECIES. A species not Endangered or Threatened but uncommon and deserving of further study and monitoring. Peripheral species, not listed as threatened, may be included in this category along with those species that were once "threatened" or "endangered" but now have increasing or protected, stable populations. Used as official classification by some states.

RECHARGE. The process by which water is added to an aquifer. Used also to indicate the water that is added. Natural recharge occurs when water from rainfall or a stream enters the ground and percolates to the water table. Artificial recharge by spreading water on absorptive ground over an aquifer or by injecting water through wells is used to store water and to protect groundwater against the intrusion of sea water.

RETENTION TIME. See Detention Time.

ROTATING BIOLOGICAL CONTACTOR (RBC). A device, consisting of plastic disks that rotate alternately through wastewater and air, used for secondary treatment of wastewater.

ROUGH FISH. Those fish species considered to be of low sport value when taken on tackle, or of poor eating quality; e.g. gar, suckers. Rough fish are more tolerant of widely changing environmental conditions than are game fish. Also called coarse fish.

RUNOFF. Surface runoff is the water from rainfall, melted snow or irrigation water that flows over the surface of the land. Groundwater runoff, or seepage flow from groundwater, is the water that enters the ground and reappears as surface water. Hydraulic runoff is groundwater runoff plus the surface runoff that flows to stream channels, and represents that part of the precipitation on a drainage basin that is discharged from the basin as streamflow. Runoff can pick up pollutants from the air or the land and carry them to the receiving waters.

SANITARY SEWERS. Sewers that transport only domestic or commercial sewage. Storm water runoff is carried in a separate system. See sewer.

SANITARY SURVEY. (1) A study of conditions related to the collection, treatment, and disposal of liquid, solid, or airborne wastes to determine the potential hazards contributed from these sources to the environment. (2) A study of the effect of wastewater discharges on sources of water supply, on bathing or other recreational waters, on shellfish culture, and other related environments.

SCENIC EASEMENT. A partial transfer of land rights to preserve the aesthetic attractiveness of the land by restricting activities such as the removal of trees, placement of billboards, or development incompatible with the scenic qualities of the land. Just compensation is given to owners for rights lost. The right of legal trespass is generally not included as part of this easement.

SECCHI DISK. A round plate, 30 cm (1 foot) in diameter, that is used to measure the transparency of water. The disk is lowered into the water until it no longer can be seen from the surface. The depth at which the disk becomes invisible is a measure of transparency.

SECONDARY TREATMENT. The second stage in the treatment of wastewater in which bacteria are utilized to decompose the organic matter in sewage. This step is accomplished by using such processes as a trickling filter or activated slugde. Effective secondary treatment processes remove virtually all floating solids and settleable solids as well as 90% of BOD and suspended solids. Disinfection of the effluent by chlorination customarily is the last step in this process.

SEPTIC SNOOPER. Trademark for the ENDECO (Environmental Devices Corporation) Type 2100 Septic Leachate Detector. This instrument consists of an underwater probe, a water intake system, an analyzer control unit and a graphic recorder. Water drawn through the instrument is continuously analyzed for specific fluorescence and conductivity. When calibrated against typical effluents, the instrument can detect and profile effluent-like substances and thereby locate septic tank leachate or other sources of domestic sewage entering lakes and streams.

SEPTIC TANK. An underground tank used for the collection of domestic wastes. Bacteria in the wastes decompose the organic matter, and the sludge settles to the bottom. The effluent flows through drains into the ground. Sludge is pumped out at regular intervals.

SEPTIC TANK EFFLUENT PUMP (STEP). Pump designed to transfer settled wastewater from a septic tank to a sewer.

SEPTIC TANK SOIL ABSORPTION SYSTEM (ST/SAS). A system of wastewater disposal in which large solids are retained in a tank; fine solids and liquids are dispersed into the surrounding soil by a system of pipes.

SEWER, COMBINED. A sewer, or system of sewers, that collects and conducts both sanitary sewage and storm-water runoff. During rainless periods, most or all of the flow in a combined sewer is composed of sanitary sewage. During a storm, runoff increases the rate of flow and may overload the sewage treatment plant to which the sewer connects. At such times, it is common to divert some of the flow, without treatment, into the receiving water.

SEWER, INTERCEPTOR. See Interceptor Sewer.

SEWER, LATERAL. A sewer designed and installed to collect sewage from a limited number of individual properties and conduct it to a trunk sewer. Also known as a street sewer or collecting sewer.

SEWER, SANITARY. See Sanitary Sewer.

SEWER, STORM. A conduit that collects and transports storm-water runoff. In many sewerage systems, storm sewers are separate from those carrying sanitary or industrial wastewater.

SEWER, TRUNK. A sewer designed and installed to collect sewage from a number of lateral sewers and conduct it to an interceptor sewer or, in some cases, to a sewage treatment plant.

SHOALING. The bottom effect that influences the height of waves moving from deep to shallow water.

SINKING FUND. A fund established by periodic installments to provide for the retirement of the principal of term bonds.

SLOPE. The incline of the surface of the land. It is usually expressed as a percent (%) of slope that equals the number of feet of fall per 100 feet in horizontal distance.

SOIL ASSOCIATION. General term used to describe a pattern of occurrence of soil types in a geographic area.

SOIL TEXTURAL CLASS. The classification of soil material according to the proportions of sand, silt, and clay. The principal textural classes in soil, in increasing order of the amount of silt and clay, are as follows: sand, loamy sand, sandy loam, loam, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. These class names are modified to indicate the size of the sand fraction or the presence of gravel, sandy loam, gravelly loam, stony clay, and cobbly loam, and are used on detailed soil maps. These terms apply only to individual soil horizons or to the surface layer of a soil type.

STATE EQUALIZED VALUATION (SEV). A measure employed within a State to adjust assessed valuation upward to approximate true market value. In this way it is possible to relate debt burden to the full value of taxable property in each community within that State.

STRATIFICATION. The condition of a lake, ocean, or other body of water when the water column is divided into a relatively cold bottom layer and a relatively warm surface layer, with a thin boundary layer (thermocline) between them. Stratification generally occurs during the summer and during periods of ice cover in the winter. Overturns, or periods of mixing, occur in the spring and autumn. Stratification is most common in middle latitudes and is related to weather conditions, basin morphology, and altitude.

STUB FEE. See Connection Fee.

SUBSTRATE. (1) The surface on which organisms may live; generally the soil, the bottom of the ocean, of a lake, a stream, or other body of water, or the face of a rock, piling, or other natural or man-made structure. (2) The substances used by organisms in liquid suspension. (3) The liquor in which activated sludge or other matter is kept in suspension.

SUCCESSION. A gradual sequence of changes or phases in vegetation (or animals) over a period of time, even if the climate remains unaltered; hence plant succession. This will proceed until some situation of equilibrium is attained, and a climax community is established.

SUPPLEMENTAL USAGE. Those functions that small waste flow districts are not required to perform in order to comply with EPA Construction Grants regulations governing individual, on-site wastewater systems. These functions may, however, be necessary to achieve administrative or environmental objectives.

SUSPENDED SOLIDS (SS). Undissolved particles that are suspended in water, wastewater or other liquid, and that contribute to turbidity. The examination of suspended solids plus the BOD test constitute the two main determinations for water quality performed at wastewater treatment facilities.

TERTIARY TREATMENT. See Advanced Waste Treatment.

THREATENED SPECIES (FEDERAL CLASSIFICATION). Any species of animal or plant that is likely to become an Endangered species within the foreseeable future throughout all or a significant part of its range. Protected under Public Law 93-205, as amended.

TILL. Deposits of glacial drift laid down in place as the glacier melts. These deposits are neither sorted nor stratified and consist of a heterogeneous mass of rock flow, sand, pebbles, cobbles, and boulders.

TOPOGRAPHY. The configuration of a surface area including its relief, or relative evaluations, and the position of its natural and man-made features.

TRICKLING FILTER PROCESS. A method of secondary wastewater treatment in which biological growth is attached to a fixed medium, such as a bed of rocks, over which wastewater is sprayed. The filter organisms biochemically oxidize the complex organic matter in the wastewater to simpler materials and energy.

TROPHIC LEVEL. Any of the feeding levels through which the passage of energy through an ecosystem proceeds. In simplest form, trophic levels are: primary producers (green plants) herbivores, omnivores, predators, scavengers, and decomposers.

TURBIDITY. (1) A condition in water or wastewater caused by the presence of suspended matter, resulting in the scattering and absorption of light rays. (2) A measure of fine suspended matter in liquids. (3) An analytical quantity usually reported in arbitrary turbidity units determined by measurements of light diffraction.

WATER QUALITY. The relative condition of a body of water as judged by a comparison between contemporary values and certain more or less objective standard values for biological, chemical, and/or physical parameters. The standard values usually are based on a specific series of intended uses, and may vary as the intended uses vary.

WATER TABLE. The upper level of groundwater that is not confined by an upper impermeable layer and is under atmospheric pressure. The upper surface of the substrate that is wholly saturated with groundwater. This level varies seasonally with the amount of percolation. Where it intersects the ground surface, springs, seepages, marshes or lakes may occur. Also known as the groundwater level.

WATERSHED. The land area drained by a stream, or by an entire river system.

WELL LOG. A chronological record of the soil and rock formations encountered in the operation of sinking a well, with either their thickness or the elevation of the top and bottom of each formation given. It also usually includes statements about the lithologic composition and water-bearing characteristics of each formation, static and pumping water levels, and well yield.

ZONING. The regulation by governmental action (invested by the State to cities, townships, or counties) of the use of the land, the height of buildings, and/or the proportion of the land surface that can be covered by structures.

BIBLIOGRAPHY

BIBLIOGRAPHY

Arthur Beard Engineers, Inc. 1979. Correspondence

Bailey, J.R, R.J. Benoit, J.L. Dodson, J.M. Robb, and H. Wallman, 1969. A Study of Flow Reduction and Treatment of Wastewater from Households. Cincinnati, Ohio; U.S. Government Printing Office.

Cooper, I.A., and J.W. Rezek. 1977. Septage treatment and disposal. For EPA, Technology Transfer.

Dearth, K.H., 1977. Current costs of conventional approaches. Data presented at US-EPA National Conference on Less Costly Wastewater Treatment Systems for Small Communities, Reston, Virginia.

Dillon, P.J. 1975. The application of the phosphorus loading concept to eutrophication research. National Research Council of Canada, Burlington, Ontario.

Emmet County. 1969. Emmet County Sanitary Code.

Environmental Prottection Agency. October 1977. Process design manual for land treatment of municipal wastewater. EPA 625/1-77-008.

EPA. Construction Grants Program Requirements Memorandum 78-9. 3 March 1978.

EPA. Grants for Construction of Treatment Works - Clean Water Act (40 CFR 35 Part E): Rules and Regulations. 43 FR 44022-44099, 27 September 1978.

EPIC. 1978. Aerial Photographic Survey of Crooked and Pickerel Lakes.

Gannon, John. December 13, 1978. Water Quality Data and Nutrient Budgets: Crooked/Pickerel Lakes Report.

Gannon, John E., and Daniel J. Munzar, 1979. Part I: Water Quality and Nutrient Budget. Pellston, MI.

Gold, Arthur, and John E. Gannon. 1978. The suitability of soils for on-site wastewater disposal, Pickerel and Crooked Lakes, Emmet County, Michigan. A report to WAPORA, Inc. (Mimeo). Biological Station, University of Michigan, Pellston MI.

Gold, Arthur and John E. Gannon. 1979. Limnological Features of Crooked and Pickerel Lakes. Emmet County, Michigan. Biological Station, University of Michigan, Pellston, MI. Technical Report #8.

Great Lakes Upper Mississippi River Board of State Sanitary Engineers. 1978. Recommended standards for sewage works. Albany, NY.

Illinois Environmental Protection Agency Memorandum, "Issuance of Final 'Illinois Guidelines for the Preparation of Facilities Plans for Unsewered Communities'", September 16, 1977.

Jones, R.A., and G.F. Lee. Septic Tank Disposal Systems as Phosphorus Sources for Surface Waters. Robert S. Kerr Environmental Research Lab. EPA-600/3-77-129.

Kerfoot, W. 1978. Investigation of Septic Leachate Discharges into Crooked and Pickerel Lake, Michigan, November 1978. K-V Associates, Inc., Falmouth, Massachusetts.

Leverett, Frank. 1907. Flowing wells and municipal water supplies in the middle and notrhern portions of the southern peninsula of Michigan. Water-Supply and Irrigation Paper No. 183. US Geological Survey, Washington DC.

McLaughlin, E.R., 1968. A recycle system for conservation of water in residences. Water and sewage works 115:4, pp. 175-176.

Michigan Cleaning Agents and Water Conditioners Act (Act 226, Public Acts of 1971; Effective July 1, 1972).

Michigan Department of Commerce, Travel Bureau. 1975. Tourist Industry Growth Study.

Michigan Department of Natural Resources (DNR). Air Quality Division. 1975. Air quality report, State of Michigan. Lansing MI.

Michigan DNR, Air Quality Division. 1976. Air quality report, State of Michigan. Lansing MI.

Michigan DNR, Department of Public Health. 1976, 1977. 186 water well records, 1969-1973, Emmet County. Lansing MI.

Michigan Department of Natural Resources. Variously dated. Lake fish collections and aquatic vegetation analysis records. Unpublished.

National Oceanic and Atmospheric Administration (NOAA). 1975. Climatological data: Michigan Annual Summaries. 90(13). USDC, NCC, Ashville NC.

NOAA. 1976. Climatological data: Michigan Annual Summaries. 91(13). USDC, NCC, Asheville NC.

Northwest Michigan Regional Planning and Development Commission. 1972. Northwest Michigan Regional Clean Water Program Vol. I Working Papers 1-14. Traverse city, MI Variously Paged.

Otis, R.J., and D.E. Steward, 1976. "Alternative Wastewater Facilities for Small Unsewered Communities in Rural America," Annual Report to the Upper Great Lakes Region Commission.

Siegrist, R., M. Witt, and W.C. Boyle, 1976. Characteristics of Rural Household Wastewater. Journal of the Environmental Engineering Division, ASCE, No. EES, Proc. Paper 12200, pp. 533-548.

Troyan, J.J., and D.P. Norris, March 1977. Cost-Effectiveness Analysis of Alternatives for Small Wastewater Treatment Systems. Paper prepared for the Environmental Protection Agency Technology Transfer Municipal Design Seminar on Small Wastewater Treatment Systems, Seattle WA.

University of Michigan. 1978. Sanitary Systems of Crooked and Pickerel Lakes, Emmet County, Michigan: An On-site Survey. For EPA Region V, Water Division.

US Bureau of the Census. 1970. Summary data. Department of Commerce, Census of Population and Housing, Washington, DC.

USDA Soil Conservation Service, in cooperation with Michigan Argicultural Experiment Station. 1973. Soil survey of Emmet County, Michigan. Prepared by Stanley D. Alfred, Adam G. Hyde, and Richard L. Larson. US Government Printing Office, Washington DC.

US Geological Survey. 1957, 1958. Topographic maps, 7.5 minute series.

Vilican-Leman and Associates, Inc. April, 1971. Future Land Use Plan: Emmet County. Prepared for Emmet County Planning Commission. Southfield MI.

Williams and Works. 1976. Little Traverse Bay area facility plan, Springvale-Bear Creek area segment, for wastewater collection and treatment. Grand Rapids MI.

✩ U.S. GOVERNMENT PRINTING OFFICE: 1979 652-243