A Nonpoint Source Control Plan for the Oconomowoc River Priority Watershed Project

This plan was prepared under the provisions of the Wisconsin Nonpoint Source Water Pollution Abatement Program by the **Wisconsin Department of Natural Resources** and the **Waukesha, Washington,** and **Jefferson County Land Conservation Departments.**

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A NONPOINT SOURCE CONTROL PLAN FOR THE OCONOMOWOC RIVER PRIORITY WATERSHED PROJECT

The Wisconsin Nonpoint Source Water Pollution Abatement Program
1986

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In Cooperation With:
Waukesha County Land Conservation Department
Washington County Land Conservation Department
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Publication WR-194-86

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March 26, 1986

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I am pleased to be able to approve the Nonpoint Source Control Plan for the Oconomowoc River Priority Watershed. As you know, the watershed encompasses portions of Washington, Jefferson, and Waukesha Counties, including the City of Oconomowoc. Each of you is to be congratulated for your efforts in assisting in development of the Plan and preparing for its implementation. I am especially impressed by the high degree of cooperation among the counties and the City of Oconomowoc to reach the common goal of protecting and improving the water resources of the area.

The Plan estimates total needs in the watershed to be $4,181,000 for installation of nonpoint source management practices, and 17 person years of effort to provide administration and technical assistance. Over the eight year project, actual cost and personnel needs will, of course, depend on participation rates during the three year sign-up period. The Department's Nonpoint Source Program will make funds available for additional County or City staff that may be needed to complete the project, and cost sharing funds will be made available for the installation of management practices.

Judging by the high level of interest shown by people living in the watershed, there is a great opportunity to achieve the water quality goals laid out in the Plan. Enhancement and protection of the many lakes in the watershed, as well as the Oconomowoc River and some regionally important trout streams, are very worthwhile goals.

The Plan for Control of Nonpoint Source Pollution in the Oconomowoc River Watershed has been reviewed by Department staff and meets the intent and conditions of s. 144.25, Statutes, and

NR 120, Wisconsin Administrative Code. It is consistent with, and will serve to implement, the areawide water quality plan (Section 208, PL92-500) for southeastern Wisconsin and is, therefore, approved as an element part of that plan.

Sincerely,

C. D. Besadny
Secretary

C

RESOLUTION NO. 272 - 3/86

APPROVAL OF OCONOMOWOC RIVER WATERSHED PLAN

WHEREAS, Waukesha County requested that the Oconomowoc River Watershed be approved as a priority watershed project to acquire state funding to address water quality problems within the watershed.

WHEREAS, the Waukesha County Board has approved participation in the Oconomowoc River Watershed program.

WHEREAS, the Waukesha County Land Conservation Committee and Plan Development and Advisory Committee have reviewed the initial draft of the Oconomowoc River Watershed Plan and a public hearing has been held concerning the plan.

WHEREAS, the Waukesha County Land Conservation Committee will be lead agency to administer the plan.

WHEREAS, the Plan requires grant assistance agreements with participating landowners and municipalities for the involved conservation practices.

NOW, THEREFORE, BE IT HEREBY RESOLVED the Waukesha County Board does hereby approve the Oconomowoc River Watershed Plan and authorizes the County Board Chairman, Land Conservation Committee Chairman and County Conservationist to sign the necessary agreements on behalf of Waukesha County. This plan does not further obligate the county financially, other than already approved expenditures.

BE IT FURTHER RESOLVED, that a copy of the Oconomowoc River Watershed Plan be on file in the County Clerk's office and Land Conservation Department.

PRESENTED BY:	APPROVED BY:
Lloyd G. Owens, Chairman	Frank E. Narlock, Chairman
Joe C. Marchese	Lawrence A. Bartell
Roland L. Merz	Thomas Schwaab
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AGRICULTURE & RESOURCE COMMITTEE	[illegible] COMMITTEE

D

RESOLUTION NO. 272 - 3/86

APPROVAL OF OCONOMOWOC RIVER WATERSHED PLAN

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Corporation Counsel

3 / 12 / 86 1986
Date

Audrey A. Carlson, County Clerk

1986
Date

A NONPOINT SOURCE CONTROL PLAN FOR THE OCONOMOWOC RIVER PRIORITY WATERSHED PROJECT

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THE OCONOMOWOC RIVER PRIORITY WATERSHED PROJECT

SUMMARY

General Watershed Information

The Oconomowoc River Watershed, shown in Map I-1, is a surface water drainage basin approximately 128 square miles in size which is located in southeastern Wisconsin. The Oconomowoc River, the principal stream that drains the watershed, originates as a network of drainage ditches in the Town of Richfield, Washington County. From its source, it flows 39.5 miles before entering the Rock River in the Town of Ixonia, Jefferson County. Major water resources in the watershed include the Oconomowoc River, six lakes through which the Oconomowoc River flows (Friess, North, Okauchee, Oconomowoc, Fowler, and LaBelle lakes), six streams tributary to the Oconomowoc River and its chain of lakes (Coney River, Flynn Creek, Mason Creek, Little Oconomowoc River, Rosenow Creek, and Battle Creek) and five outlying lakes (Keesus, Moose, Pine, Beaver, and Silver lakes).

In 1980, land use in the watershed was distributed as follows:

- Agricultural	46,120 acres (56%)
- Woodland, wetland	18,530 acres (23%)
- Urban	11,220 acres (14%)
- Surface waters	5,990 acres (7%)

The most densely developed urban areas are located in Waukesha County, adjacent to Okauchee, Fowler, and LaBelle Lakes. Publicly owned recreation lands total about 1,100 acres, and include three large, county owned parks adjacent to Friess Lake, Okauchee Lake, and near the Monches Millpond on the Oconomowoc River. Other recreational facilities include boat launching or other public access sites on North, Pine, LaBelle, Okauchee, Fowler, Keesus, and Beaver lakes.

The Oconomowoc River Watershed was divided into 19 subwatersheds for purposes of this planning effort, as shown in Map I-1. The delineation of subwatersheds is important, since evaluation of nonpoint pollution source impacts and projections of water quality improvements requires working with relatively small drainage areas. This is particularly true in this watershed, where each lake acts as a pollutant trap that must be accounted for in assessing the impacts of pollutant sources on downstream water quality. Geographic boundaries of the civil divisions in the watershed are also shown in Map I-1. These boundaries are important, since the local units of government will be instrumental in implementing this priority watershed project. Table S-1 lists the civil divisions in the watershed, which subwatersheds each one contains, and information concerning the proportion of each civil division within the watershed.

Water Resources Assessment

Table S-2 summarizes the existing conditions for each of the major water resources in the Oconomowoc River Watershed, and the water resources

Table S-1. Local Units of Government In The Oconomowoc River Watershed.

County or Civil Division	Subwatersheds (See Map)	Square Miles Within Watershed	% of Watershed	% of County or Civil Division
Waukesha County	4-19	67.2	52.5	11.6
City of Delafield	12	0.2	0.1	1.9
City of Oconomowoc	13-17,19	5.5	4.3	100.0
Village of Chenequa	8,9,10	4.6	3.6	97.9
Village of Lac LaBelle	17	0.5	0.4	100.0
Village of Merton	7,8	0.1	0.1	4.3
Village of Nashotah	10,12	0.4	0.3	25.0
Village of Oconomowoc Lake	13	3.1	2.4	100.0
Town of Merton	4-12	22.9	17.9	79.5
Town of Oconomowoc	12,15-17,19	18.0	14.1	53.9
Town of Summit	12-15,18,19	11.2	8.7	36.8
Town of Lisbon	7	0.7	0.6	2.1
Washington County	1-7	47.6	37.2	10.9
Village of Slinger	1	0.5	0.4	25.0
Town of Erin	1,3-6	23.7	18.5	65.8
Town of Hartford	1	0.9	0.7	2.6
Town of Polk	1	7.4	5.8	21.6
Town of Richfield	1-4,7	15.1	11.8	41.6
Jefferson County	17-19	12.4	9.7	2.1
Town of Concord	18-19	11.2	8.8	31.0
Town of Ixonia	17-19	1.2	0.9	3.2
Dodge County	6	0.7	0.6	0.1
Town of Ashippun	6	0.7	0.6	1.9
TOTAL WATERSHED	1-19	127.9	100.0	*

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objectives of the Oconomowoc River Priority Watershed Project. The water resources objectives in this table reflect the magnitude of the existing water resource problems, the role played by nonpoint pollution sources in causing those problems, and the capability of this program to address the nonpoint pollution sources. In some cases, a better objective might be attained, but would require pollution controls brought about through other programs. Although not shown in Table S-2, the watershed plan states where such conditions occur.

Nonpoint Source Pollutant Control Strategy

Table S-3 summarizes the pollutant load reduction that can be brought about through installation of urban and rural land management practices in this watershed, and the types of controls that will be needed to achieve this reduction. The pollution control strategy summarized in this table applies to pollution sources inventoried during the planning process. The inventories of upland erosion, critical areas for winterspreading manure, and urban areas outside the City of Oconomowoc were limited to a corridor one-eighth mile along either side of streams and lakes in the watershed. This is considered to be the "Priority Management Area," or PMA, for these sources. Only critical sources located within this PMA are eligible for cost sharing. The inventory of urban areas within the City of Oconomowoc was based on the storm sewer drainage network, and all contributing areas are included in the PMA. In some cases, areas within the one-eighth mile corridor are excluded because they are not connected to the surface channel network; in other cases, the storm sewer system extends past the corridor. The inventory covered about 8,800 urban acres, or 80 percent of the urban area in the watershed, and about 33,000 rural acres, or 50 percent of the rural land use.

All barnyards in the watershed were inventoried. Eligibility for barnyards is based on many factors that affect barnyard pollution potential, including, but not limited to, their distances from surface waters.

In each subwatershed, management categories were assigned to each pollution source. Sources in Management Category I are the most severe, and landowners are eligible to receive cost share and technical assistance to control them. A landowner must agree to control all Management Category I sources on his or her land as part of any financial and technical assistance package entered into through this priority watershed project. Sources in Management Category II are less severe, but their control through the Nonpoint Source Control Program is still desirable. Landowners are eligible to receive cost share and technical assistance to control sources in Management Category II, however, a landowner need not agree to include such sources in the pollution control agreement in order to be eligible for cost sharing on other sources. Sources in Management Category III are not eligible for cost sharing.

Although the nonpoint source inventory conducted as part of the planning process for the Oconomowoc River watershed project establishes a firm basis on which to begin a pollution control effort, the inventory may need updating by local project staff as the project is implemented. Revision of management categories, and in some cases redefinition of the PMA boundary to include newly discovered pollution sources, may be expected as a result of this review.

Table S-2. Existing Water Resource Conditions in the Oconomowoc River Watershed, and Objectives of the Oconomowoc River Priority Watershed Project.

WATERS	EXISTING WATER RESOURCE CONDITIONS	WATER RESOURCE OBJECTIVES
Coney R./Ocon. R.(1)	Water Quality: fair-good; limited oxygen, nutrient, bacteria problems. Aquatic Life: degraded forage fish community, spawning sport fish.	Improve forage fish community, protect spawning sport fish; reduce loading of sediment, nutrients, and bacteria to Friess L.
Flynn C.	Aquatic Life: degraded forage fish, potential for trout in lower reach.	Improve forage fish community, improve trout potential; reduce loading of sediment and nutrients to North L.
Little Ocon. R.	Water Quality: excellent in middle segment, silty and weed choked in upper and lower segments; high levels of nutrients and bacteria. Aquatic Life: degraded forage fish community throughout stream.	Improve forage fish community; reduce loading of nutrients, sediment, and bacteria to North L.
Mason C.	Water Quality: Headwaters- excellent to poor(temp., silt, turbidity problems); Mainstem- good, but silt problems & high nutrient levels. Aquatic Life: trout; slender madtom(endangered); degraded forage fish .	Protect and improve forage fish community, protect slender madtom population, protect trout and extend range; reduce sediment, nutrient, and bacteria loading to North L.
Rosenow C.	Water Quality: fair to good; high bacteria levels; streambed silty, stream channel widened, lacks bank cover. Aquatic Life: degraded trout population, carp dominate lower reaches.	Improve potential of stream to support trout; reduce loading of sediment and nutrients to Lac LaBelle.
Upper Ocon. R.(2)	Water Quality: good; high bacteria, nutrients; millponds silted. Aquatic Life: degraded forage fish community; slender madtom (endangered)	Protect recreational uses; improve degraded forage fish community, protect slender madtom; reduce sediment, nutrient, bacteria load to North L.
Lower Ocon. R.(3)	Water Quality: Upper- excellent habitat, gradient, and flow; Lower- silt problems, high nutrients. Aquatic Life: Upper- good forage fish community, sl. madtom; Lower- carp.	Protect forage fish community in upper portion, improve forage fish and recreation potential of lower reaches.
Battle C.	Aquatic Life: forage fish community, condition unknown.	Improve forage fish potential.
Friess L.	Water Quality: fair to good, but high in nutrients; limited siltation. Aquatic Life: healthy warmwater sportfish population.	Protect or improve recreational uses; reduce nutrient load to North L.
North L.	Water Quality: fair to good, but high in nutrients; limited siltation. Aquatic Life: healthy warmwater sportfish population; coldwater cisco .	Protect or improve recreational and aquatic life potential; reduce nutrient load to Okauchee L.
Okauchee L.	Water Quality: deep waters, good; shallows have algae & weed problems; navigation channel siltation. Aquatic Life: healthy warmwater sportfish population.	Protect recreation, aquatic life potential; improve channel navigation; reduce nutrient load to Oconomowoc L.
Oconomowoc L.	Water Quality: good to very good, but high in nutrients. Aquatic Life: healthy warmwater fish population; coldwater cisco.	Protect recreation and aquatic life potential; reduce nutrient load to Fowler L.
Fowler L.	Water Quality: excellent, but weed growths heavy. Aquatic Life: healthy warmwater fish population.	Protect recreation and aquatic life potential; reduce nutrient load to Lac LaBelle.

Table S-2 (Continued)

WATERS	EXISTING WATER RESOURCE CONDITIONS	WATER RESOURCE OBJECTIVES
LaBelle L.	Water Quality: fair to good, but locally poor water clarity, high nutr. Aquatic Life: Unhealthy warmwater sport fish population, carp abundant.	Protect overall recreational use potential, improve recreation and aquatic life potential in localized areas.
Pine L.	Water Quality: Very good. Aquatic Life: wmwater sportfish ; coldwater cisco; chubsucker(watch sp).	Protect recreation and aquatic life potential.
Beaver L.	Water Quality: Very good. Aquatic Life: wmwater sportfish ; coldwater cisco; chubsucker(watch sp).	Protect recreation and aquatic life potential.
Silver L.	Water Quality: good. Aquatic Life: warmwater sportfish.	Protect recreation and aquatic life potential.
Keesus L.	Water Quality: good, but high in nutrients.	Protect recreation and aquatic life potential.
Moose L.	Water Quality: very good. Aquatic Life: warmwater sportfish.	Protect recreation and aquatic life potential.

(1) Includes portion of Oconomowoc River above Friess L.
(2) Includes portion of the Oconomowoc River between Friess L. and North L.
(3) Includes portion of the Oconomowoc River below the Lac LaBelle Dam.

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Implementing the Priority Watershed Plan

The success of the Oconomowoc River Priority Watershed Project will depend on the voluntary cooperation of landowners and operators in controlling the nonpoint pollution sources identified in this plan. Although the Department of Natural Resources has overall administrative and financial responsibility for the Nonpoint Source Control Program, the statutory responsibility to implement this priority watershed project rests with the cities, counties, and villages within the watershed that are designated as management agencies. Table S-4 summarizes the roles of the key participants in this watershed project. These roles are briefly discussed below.

Landowners

The local management agencies will contact owners of critical lands within their respective jurisdictions, explain the cost share program, and work with the landowners to develop cost share agreements. The cost share agreement is between the landowner and the specific local management agency. The cost share agreement will specify what control practices the landowner will install, an installation schedule, a maintenance period during which the landowner is responsible to keep the practice in working condition, and a cost share rate at which the landowner will be reimbursed upon installing each practice. The eligible practices and cost share rates are specified in these watershed plans.

Upon installation of the practice, the landowner will request that the local management agency certify the practice correctly installed. After certification, the landowner will submit installation bills to the local management agency who will pay the state cost share from the project account, using procedures specified in this plan.

The period during which cost share agreements can be signed starts when the watershed plan is approved, and lasts for three years. All management practices in an agreement must be installed within a five year period.

Local Management Agencies

Generally, local management agencies carry out a number of activities in a priority watershed project, including:

1. preparing annual workplans for completion of watershed-related work,
2. conducting the watershed's information and education program,
3. contacting eligible landowners within their respective jurisdictions,
4. entering into cost share agreements with landowners,
5. providing technical assistance to landowners,
6. providing project and fiscal management, and

7. reporting to the Department of Natural Resources on progress and any additional support needed to complete the project.

The local management agencies in the Oconomowoc River Priority Watershed Project will emphasize the following tasks:

1. Waukesha, Washington, Jefferson counties:

   a. conduct project and financial management,

   b. conduct information and education programs,

   c. make landowner contacts,

   d. develop conservation plans and cost share agreements,

   e. enter into cost share agreements with landowners,

   f. offer technical assistance to landowners and to municipalities where appropriate, and

   g. assist municipalities in the review of stormwater management and construction erosion control ordinances.

2. City of Oconomowoc:

   a. identify detention basin sites for areas of future development;

   b. investigate in greater detail the feasibility of urban practices recommended in this plan,

   c. make landowner contacts,

   d. install practices recommended in this plan to the extent feasible, and

   e. review construction erosion control and stormwater management ordinance.

3. Villages of Slinger, Chenequa, Lac LaBelle, Merton, Nashotah, and Oconomowoc Lake:

   a. review construction erosion control and stormwater management ordinances.

Lead Management Agency

Waukesha County will serve as the lead management agency for the Oconomowoc River Priority Watershed Project.

Department of Natural Resources

The Department of Natural Resources (DNR) will enter into local assistance grant agreements with selected local management agencies, including the City

Table S-3. Pollution Control Strategy For The Oconomowoc River Priority Watershed.

WATERS	POLLUTANT LOAD REDUCTION(1.)				POLLUTANT CONTROL STRATEGY									
	Phos-phorus	Urban Toxics	Sedi-ment	Bac-teria	Upland Erosion (Acres)	Upland Erosion (Farms)	Barnyard Runoff (Farms)	Manure Runoff (Acres)	Manure Runoff (Farms)	Bank Erosion (Feet)	Bank Erosion (Sites)	Urban Stormwater Runoff (Acres Infiltrated)	Urban Stormwater Runoff (Acres Detained)	(Other)
Coney R.(2.)	M	L	M	H	580	39	11	230	23	(5.)				(6.)(7.)
Flynn C.	L	L	M	L	320	21	3	20	4	(5.)				(6.)(7.)
Little Ocon. R.	M	L	H	M	540	30	4	50	6	(5.)				(6.)(7.)
Mason C.	M	L	M	M	190	12	3	30	10	7,000	5			(6.)(7.)
Rosenow C.	L	L	M	L	270	11	1	20	4	10,000	6			(6.)(7.)
Upper Ocon. R.(3.)	L	L	M	L	220	15	2			(5.)				(6.)(7.)
Lower Ocon. R.(4.)	L	80%	H	M	1,020	56	9	50	13	(5.)		30	500	(6.)(7.)
Battle C.	L	L	M	L	260	17		4	3	(5.)				(6.)(7.)
Friess L.	40%	L	M	H	600	41	14	230	23	(5.)				(6.)(7.)
North L.	30%	L	M	H	1,300	80	13	100	21					(6.)(7.)
Okauchee L.	20%	L	M	L	130	8	1			700	1			(6.)(7.)
Oconomowoc L.	15%	L	M	L	160	4								(6.)(7.)
Fowler L.	20%	70%	M	L	180	4				100	1	60	300	(6.)(7.)
LaBelle L.	30%	50%	M	L	1,040	34	1	40	6	100	1	15	110	(6.)(7.)
Pine L.	L	L	H	L	20	2								(6.)(7.)
Beaver L.	L	L	M	L	20	4				(5.)				(6.)(7.)
Silver L.	L	L	H	L	40	2	1			(5.)				(6.)(7.)
Keesus L.	M	L	H	L	180	11	1	10	1					(6.)(7.)
Moose L.	L	L	L	L	0	0	0	0	0	(5.)				(6.)(7.)

(1.) = 0-25%, Medium= 25-50%, High=50-100%. Figures based on 100% landowner participation.
(2.) Portion of the Oconomowoc River above Friess Lake.
(3.) Portion of the Oconomowoc River Between Friess and North Lakes.
(4.) Portion of Oconomowoc River below dam at Lac LaBelle.
(5.) A detailed inventory was not completed for these waterbodies.
(6.) Information & education programs will stress what homeowners can do to reduce their impact on water resources.
(7.) Existing codes and ordinances will be reviewed to determine if modifications are needed to protect water resource from urban runoff and construction erosion.

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of Oconomowoc, and Washington, Waukesha, and Jefferson counties. These agreements will identify workloads to be handled by each local management agency, and the level of state support to help the local agency provide the additional staff needed to complete the workload. These grant agreements will be reviewed annually and adjusted as needed.

The Department of Natural Resources will enter into a nonpoint source grant agreement with Waukesha County, the lead management agency for this project, to make cost share funds available to eligible landowners throughout the watershed for installing approved land management practices. Waukesha County will administer the account at the local level, and will be reimbursed by the DNR for monies expended.

Project Costs

Figure S-1 shows the cost of installing 75 percent of the urban and rural management practices recommended in this priority watershed plan. A total of $3,136,000 will be required. Seventy percent, or $2,129,000, will be provided as cost share monies through the Nonpoint Source Control Program. The remaining 30 percent, a total of $1,007,000, will be provided by cost share recipients in the watershed.

Figure S-1 shows that 57 percent of the total cost will occur in the urban areas, and 43 percent will occur in the rural areas.

Project Staffing Needs

Figure S-2 shows the estimated staffing needed to carry out the local implementation activities over the eight year project period, assuming a landowner participation rate of 75 percent. A total of 30,000 staff hours would be required. The Department of Natural Resources would support an estimated 24,000 hours, or about 80 percent of this workload, through local assistance grants.

In Washington County, the estimated total workload for the eight year project period is 11,600 hours. During the first three project years, the period for entering into cost share agreements, the estimated annual workload is about 1,000 hours, plus the workload associated with design and installation activities. The Department of Natural Resources will provide support for additional staff hired by the county to perform this workload, with the exception of hours worked to manage the project and maintain financial records. These project and financial management hours are estimated to be 250 hours annually.

In Waukesha County, the estimated total workload for the eight year project period is 13,800 hours. During the first three project years, the period for entering into cost share agreements, the estimated annual workload is about 1,200 hours, plus the workload associated with design and installation activities. The Department of Natural Resources will provide support for additional staff hired by the county to perform this workload, with the exception of hours worked to manage the project and maintain financial records. These project and financial management hours are estimated to be 350 hours annually.

Table S-4. Relationships Between Cost Share Recipients, Local Management Agencies, and the Department of Natural Resources In The Oconomowoc River Priority Watershed Project

Role	Entity	Receive Cost Share and Technical Asst. For Installing Management Practices	Enter Into Cost Share Agreements With Landowners To Provide Tech. & Fin. Support For Installing Mgt. Practices	Enter Into Local Assistance Agreements With DNR For Support Of Additional Local Staff	Enter Into Nonpoint Source Grant Agreement With DNR To Make Cost Share Monies Available To Landowners Throughout Project Area
Local Management Agency					
	Cities		X	X	
	Counties		X	X	X (Waukesha)
	Villages		X	X	
Cost Share Recipient					
	Individual	X			
	Corporation	X			
	Partnership	X			
	Town	X			
	Town Sanitary Dist.	X			
	Inland Lake Dist.	X			
	City	X			
	Village	X			
	County	X			
	State Agency	X			

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In Jefferson County, the estimated total workload for the eight year project period is 4,600 hours. During the first three project years, the period for entering into cost share agreements, the estimated annual workload is about 400 hours, plus the workload associated with design and installation activities. The Department of Natural Resources will provide support for additional staff hired by the county to perform this workload, with the exception of hours worked to manage the project and maintain financial records. These project and financial management hours are estimated to be 150 hours annually.

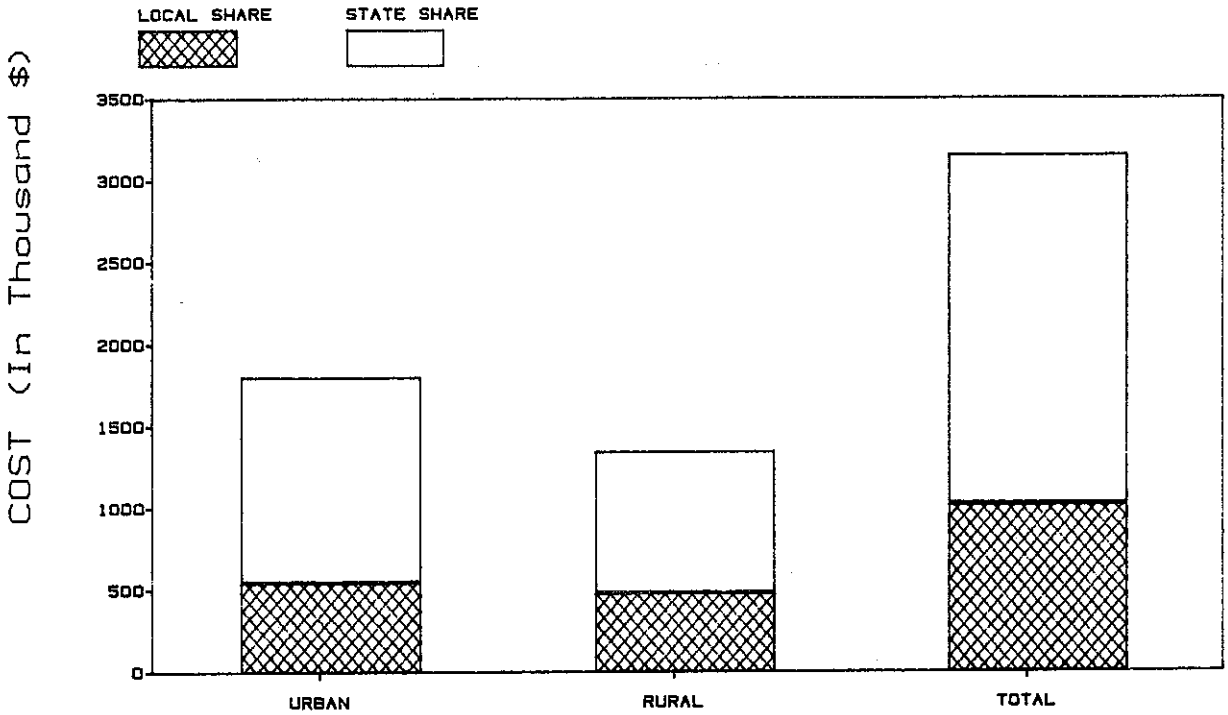
Work activities for the City of Oconomowoc have been identified, but a workload estimate has yet to be made. State support for the hiring of city staff or the contracting out for professional services as needed to complete watershed activities will also be made available to the city.

There will also be a need for financial resources to support an extensive information and education program in the Oconomowoc River Watershed. The eight year educational effort is estimated to require about $25,000 in out-of-pocket costs, in addition to local staff time. These out-of-pocket costs will be paid for by the Department of Natural Resources. The local staffing effort needed to complete these educational activities is estimated to be 4,000 hours over the eight year project period. These hours will be distributed as follows: 900 hours in Washington County, 2400 hours in Waukesha County, and 700 hours in Jefferson County. These hours have been included in the estimates presented in Figure S-2, which was previously discussed.

Project Evaluation

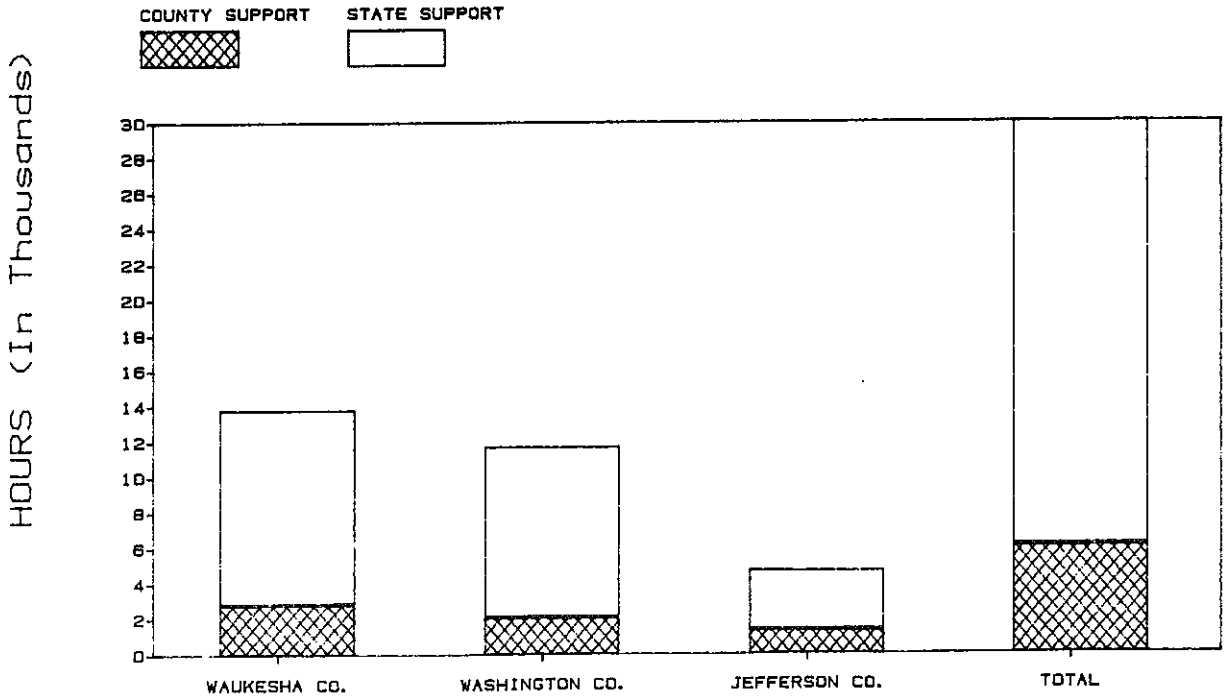
The progress and success of the Oconomowoc River Priority Watershed Project will be evaluated by two different approaches. One approach to be used will be an assessment of the changes in land use practices and reductions in pollutant loads as a result of the project. The other approach will involve measuring changes in water quality, habitat and water resource characteristics.

FIG. S-1 ESTIMATED COST OF MANAGEMENT PRACTICES NEEDED IN THE OCONOMOWOC RIVER PRIORITY WATERSHED



Costs are based on a 75% landowner participation rate.

FIG. S-2 ESTIMATED STAFFING NEEDED TO IMPLEMENT THE OCONOMOWOC RIVER PRIORITY WATERSHED PROJECT



Hours will be worked over an 8 year period.
Workload represents 75% of the total need.
Cy of Oconomowo: staffing yet to be determined.

THE OCONOMOWOC RIVER PRIORITY WATERSHED PROJECT

PREFACE

The Wisconsin Nonpoint Source Program

Most citizens of Wisconsin are familiar with point sources of pollutants, such as industrial and municipal wastewater treatment plants, and the fine record of point source pollutant control achieved in Wisconsin through the efforts of industry, municipalities, regional planning commissions, and state and federal agencies. Fewer people, however, are aware of nonpoint sources of pollutants, their impacts on our water resources, and a unique state program which is bringing these sources under control in selected watersheds in Wisconsin.

There are many sources of nonpoint pollutants in both urban and rural areas. They include such sites as poorly managed barnyards; eroding croplands, streambanks and construction sites; and paved surfaces in urban areas including streets, sidewalks, and parking lots. Pollutants in runoff waters carried from these sites into surface and groundwaters impair our use of water resources for recreation, fishing, and aesthetic purposes. The water resource impacts caused by pollutants from nonpoint sources often take many years, even decades, to develop. The control of these sources is often necessary in order to fully realize the benefits of our point source pollution control efforts.

In 1978, the Wisconsin Legislature created the Wisconsin Nonpoint Source Water Pollution Abatement Program, also known as the Nonpoint Source Control Program, as a means to improve and protect water resources threatened by nonpoint source pollution in critical areas throughout the state. The Nonpoint Source Control Program has four characteristics:

1. It is a water quality program, with the installation of land management practices restricted to critical nonpoint pollution sources.

2. The program is implemented on a watershed basis, focusing the financial, technical and educational resources needed to achieve an adequate level of pollution control. To date, nonpoint source pollution control activities are underway in 29 priority watershed projects statewide, including the Oconomowoc River Priority Watershed Project.

3. The mechanism for achieving control of critical nonpoint pollution sources is the voluntary installation of land management practices by landowners or operators, including municipalities. State cost share funds are available to eligible landowners and operators to help pay for installing approved pollution control practices. Cost share rates generally vary from 50 percent to 70 percent of the total practice cost.

4. Counties, cities, and villages within each priority watershed project actively participate in the projects, providing project administration, technical assistance, and educational services. The state provides financial support needed by these local management agencies to carry out their responsibilities.

How The Oconomowoc River Priority Watershed Project Was Selected

The Oconomowoc River Priority Watershed Project was selected through a three-step process. The Southeastern Wisconsin Regional Planning Commission (SEWRPC), with advice from its seven member counties, recommended to the State Nonpoint Source Advisory Committee that the watershed be selected for planning and funding under the Nonpoint Source Control Program. The committee, in turn, passed this recommendation on to the Department of Natural Resources. The Department, acting on these recommendations, selected the Oconomowoc as a priority watershed project.

Key reasons for selection included: the high density of regionally significant water resources, including 11 major lakes and two trout streams; a manageable number of nonpoint pollution sources; extensive support by local units of government and citizens' groups, including a local citizens task force; existing efforts by Washington and Waukesha counties to control problem septic systems; and existing procedures in Washington County, Waukesha County, and the City of Oconomowoc to control construction site erosion.

In the fall of 1983, the Department of Natural Resources offered the project to the Board of Supervisors for Waukesha, Washington, and Jefferson counties, and to the Common Council of the City of Oconomowoc. These governments accepted the project, initiating the project's planning phase.

Role and Development of The Oconomowoc River Priority Watershed Plan

This priority watershed plan was prepared as a condition for the release of state cost share and local assistance funds to local units of government within the Oconomowoc River watershed project. The purpose of this plan is to identify critical nonpoint pollution sources eligible for funding, the water resources benefits that will occur as a result of controlling these sources, and a strategy that local units of government will follow in carrying out their nonpoint pollution control activities.

It must be recognized that control of nonpoint pollution sources is only one part of a comprehensive water quality management effort for the watershed. Many important activities outside the scope of the Nonpoint Source Control Program need to be carried out in order to fully achieve the potential of lakes and streams in the watershed. Examples include:

1. municipal and industrial wastewater control,
2. control of municipal and industrial sludges,
3. control of septic systems and septage spreading,
4. inlake rehabilitation,
5. instream fish habitat improvements,
6. public access development, and
7. implementation of land use plans, including needed land use regulations.

Coordination of these activities within the Oconomowoc River watershed project will be required to fully achieve and maintain the public uses of the watershed's lakes and streams. The document A Regional Water Quality Management Plan For Southeastern Wisconsin; Volume III, Recommendations, prepared in 1979 by the Southeastern Wisconsin Regional Planning Commission (SEWRPC), is the principal guide for state agencies and local units of government who are responsible for carrying out water resource management activities. The areawide plan includes specific land use, point source, nonpoint source, sludge management, and lake management recommendations for the Oconomowoc River Watershed. This priority watershed plan, as a refinement of the areawide plan, will guide nonpoint source pollution control activities. The Department of Natural Resources will continue to control industrial and municipal wastewaters and sludges, and septage pumped from septic systems, under the Wisconsin Pollutant Discharge Elimination Program. In addition, the DNR will continue fish management activities within the watershed. The areawide plan remains the principal guide to local and special purpose units of government in conducting the septic system management, land use planning and regulation, and inlake rehabilitation activities that are also needed in this watershed.

The Oconomowoc River Priority Watershed Plan was developed cooperatively by several agencies and local governments. Principal cooperators included the Department of Natural Resources, land conservation committees for Washington, Waukesha, and Jefferson counties, the City of Oconomowoc, the United States Department of Agriculture (Soil Conservation Service and Agriculture Stabilization and Conservation Service), University of Wisconsin-Extension, and the Southeastern Wisconsin Regional Planning Commission. A watershed advisory committee, the Oconomowoc River Plan Development Advisory Committee, was formed in the fall of 1983 to assist in plan development. It is made up of representatives of local units of government in the Oconomowoc River Watershed, and met periodically to review portions of this plan.

This watershed plan will be reviewed annually by the Department of Natural Resources and the local management agencies, and adjustments will be made as needed. Minor revisions will be made by agreement of the DNR and the local management agencies; major changes will be made consistent with state administrative rules governing amendments to areawide water quality management plans.

THE OCONOMOWOC RIVER PRIORITY WATERSHED PROJECT

INTRODUCTION TO THE WATERSHED PLAN

CHAPTER I

PLAN PURPOSE AND LEGAL STATUS

The Oconomowoc River Watershed, located in southeastern Wisconsin, includes 128 square miles of agricultural and urban lands that drain into the Rock River via the Oconomowoc River. Within the watershed (Map I-1), the river flows through six lakes and receives water from six tributary streams. There are five additional lakes in the watershed.

Existing Aquatic Resources and Project Objectives

Existing water quality in the lakes along the Oconomowoc River is generally good, although nutrient concentrations are high. Most lakes support healthy warm water fish communities and exhibit localized algae and weed problems. Several lakes support cold water cisco populations. Water resources objectives for these lakes are to protect their potential to support high quality recreational and aquatic life uses. Limited improvement may occur in the lakes further up the chain.

Existing water quality in the Oconomowoc River is generally good as well. In several areas, nutrient and bacterial levels are high, and sediment and turbidity problems have resulted in degraded fish communities. The slender madtom, an endangered species, is found in the Oconomowoc River above North Lake. Water resources objectives for the Oconomowoc River include improving the forage fish community, protecting the slender madtom, and improving the recreational use potential of the river.

Streams that are tributary to the Oconomowoc River and its chain of lakes are very few in number. Most are small, with limited flows, and support forage fish communities. Some of these may support trout if nonpoint sources are controlled. Two streams currently support trout populations. Water resources objectives for these tributaries include improvement of their potential to support either higher quality forage fish communities, or, in some limited stream reaches, trout communities. In streams where trout currently exist, the objectives are the protection and improvement of trout populations.

Watershed Plan Preparation

This plan analyzes the water resources of the Oconomowoc River Watershed and describes the nonpoint source controls needed to protect and improve these water resources.

The plan was prepared jointly by the Department of Natural Resources - Nonpoint Source and Land Management Section; the Land Conservation Committees for Washington, Waukesha and Jefferson counties; the City of Oconomowoc, the U.S. Department of Agriculture (Soil Conservation Service and Agriculture Stabilization and Conservation Service); University of Wisconsin-Extension; and the Southeastern Wisconsin Regional Planning Commission.

Guidance was provided throughout the planning process by a plan development advisory committee. This advisory committee consisted of representatives of local units of government within the project area and was staffed by the Southeastern Wisconsin Regional Planning Commission.

Principal individual participants in the planning process are identified on the inside of the front cover of this plan.

Purpose of the Watershed Plan

This plan has been prepared to guide the implementation of a priority watershed project for the Oconomowoc River Watershed in Washington, Waukesha and Jefferson counties as part of the Wisconsin Nonpoint Source Water Pollution Abatement Program. The plan is divided into three major sections:

1. a watershed assessment;

2. a detailed program for implementation; and

3. a project evaluation.

The purposes of the Watershed Assessment portion of the plan are to:

1. identify the water quality and water resources problems in the Oconomowoc River Watershed;

2. identify the water quality and water resources objectives for the Oconomowoc River Watershed that can be achieved through a nonpoint source control project;

3. identify the levels of pollutant control needed to achieve the objectives;

4. identify and rank the significant nonpoint sources;

5. identify Priority Management Areas for the watershed project; and

6. identify and discuss the Best Management Practices that will achieve the targeted pollutant control.

The purpose of the Detailed Program for Implementation portion of the plan is to outline a strategy to assist landowners and land operators in installing Best Management Practices to control the nonpoint sources of pollutants. This strategy must include:

1. a cost share budget based on the estimated cost of the Best Management Practices and expected participation rates;

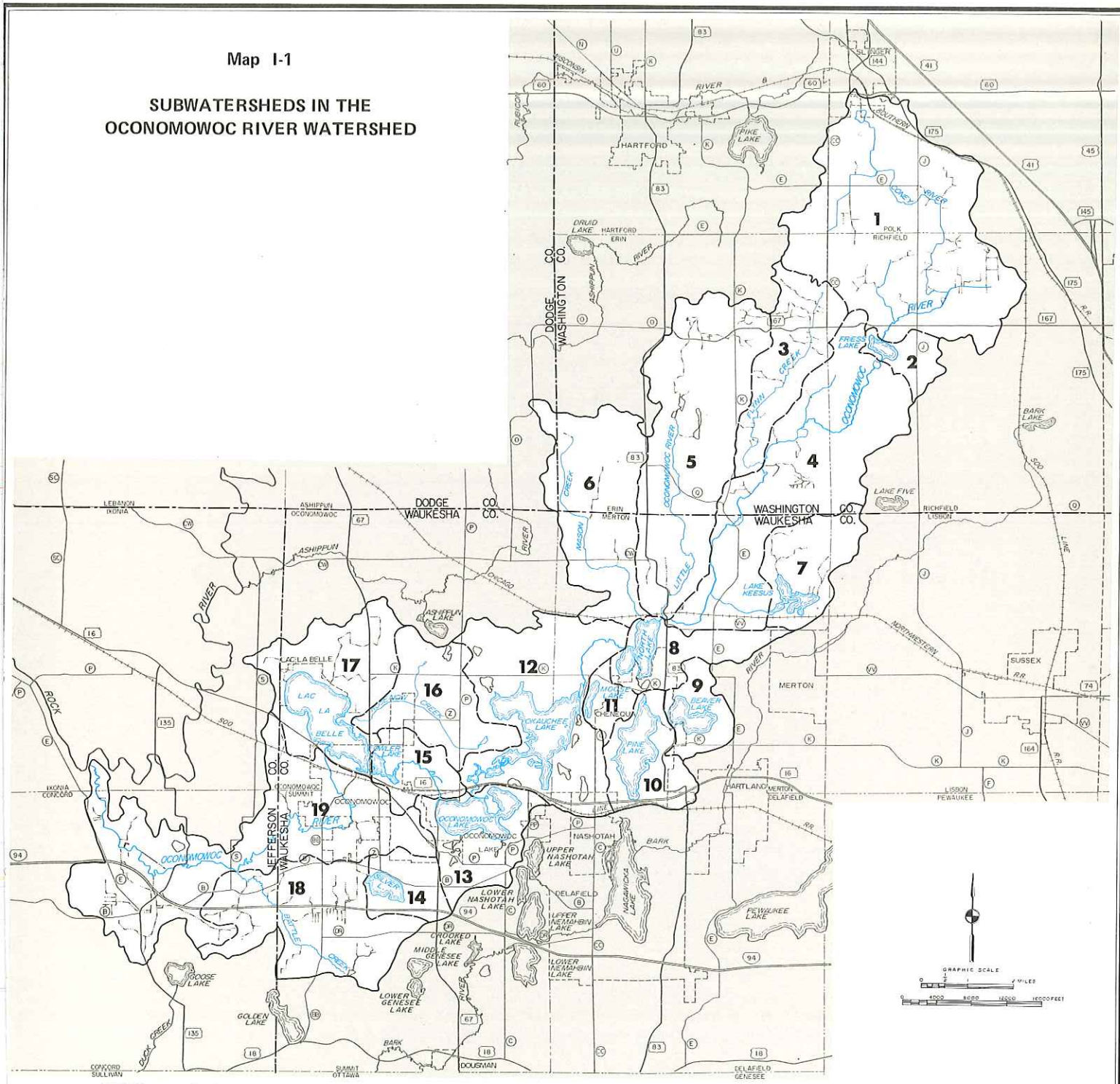
2. a schedule for implementation activities;

3. a description of information and education activities;

4. a summary of fiscal management procedures; and

Map I-1

SUBWATERSHEDS IN THE OCONOMOWOC RIVER WATERSHED



NUMBER	SUBWATERSHED NAME	GENERAL LOCATION*
1	Coney River	Towns of Polk, Richfield
2	Friess Lake	Town of Richfield
3	Flynn Creek	Town of Erin
4	Upper Oconomowoc River	Towns of Richfield, Erin, and Merton
5	Little Oconomowoc River	Towns of Erin, Merton
6	Mason Creek	Towns of Erin, Merton
7	Lake Keesus	Town of Merton
8	North Lake	Town of Merton Village of Chenequa
9	Beaver Lake	Town of Merton Village of Chenequa
10	Pine Lake	Village of Chenequa
11	Moose Lake	Town of Merton
12	Okauchee Lake	Towns of Merton, Oconomowoc
13	Oconomowoc Lake	Village of Oconomowoc Lake
14	Silver Lake	Town of Summit
15	Fowler Lake	Town of Oconomowoc City of Oconomowoc
16	Rosenow Creek	Town of Oconomowoc City of Oconomowoc
17	Lac La Belle	Village of Lac La Belle City and Town of Oconomowoc
18	Battle Creek	Towns of Summit, Concord
19	Lower Oconomowoc River	City of Oconomowoc, Towns of Summit, Concord, and Ixonia

*Governmental units containing the major streams and lakes.

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

OCONOMOWOC RIVER WATERSHED

BASE MAP DESIGN: L.H. FREBLIN	
DRAWN BY: B.J. KLEHMER	DATE: FEB 15, 1984
CHECKED BY: L.H. FREBLIN	DATE: FEB 21, 1984
APPROVED BY: [illegible]	DATE: FEB 28, 1984
REVISED BY: R.H. HEINEN	DATE: AUG 8, 1994

5. an estimate of technical assistance needs of counties, cities and villages.

The purpose of the Project Evaluation portion of the plan is to identify procedures and schedules for determining project progress and accomplishment. This includes estimating pollutant load reductions resulting from the installation of Best Management Practices, and measuring changes in water quality.

Legal Status of the Watershed Plan

This plan has been prepared under the authority of the Wisconsin Nonpoint Source Water Pollution Abatement Program described in s. 144.25, Wisconsin Statutes, and Chapter NR 120 of the Wisconsin Administrative Code.

This plan is the basis for cost share and local assistance grants through the Nonpoint Source Water Pollution Abatement Program administered by the Wisconsin Department of Natural Resources. The Wisconsin Statutes and Chapter NR 120 of the Wisconsin Administrative Code, however, govern the conduct of the Nonpoint Source Water Pollution Abatement Program. In the event a discrepancy occurs between this plan and the statutes of the administrative rules or if the statutes or administrative rule are changed, the statutes and rules override this plan.

This plan, once approved through the procedures described in Chapter NR 121, Wisconsin Administrative Code, is an update of the Areawide Water Quality Management Plans for the Rock River Basin and for southeastern Wisconsin.

THE OCONOMOWOC RIVER PRIORITY WATERSHED PROJECT
WATERSHED ASSESSMENT

(CHAPTERS II - XIII)

A. GENERAL WATERSHED DESCRIPTION

CHAPTER II

WATERSHED CHARACTERISTICS INFLUENCING POLLUTANT GENERATION, POLLUTANT TRANSPORT, AND WATER QUALITY

INTRODUCTION

The water resource-related problems of a watershed, as well as the ultimate solutions to those problems, are a function of human activities and of the ability of the underlying natural resource base to sustain those activities. This concept is particularly pertinent in the identification, evaluation and ultimate resolution of nonpoint source pollution problems in an area as diverse as the Oconomowoc River Watershed. The purpose of this chapter is to describe the man-made and natural features of the watershed, with particular emphasis on those characteristics which influence water quality.

DESCRIPTION OF THE WATERSHED

The Oconomowoc River Watershed is a surface water drainage basin of approximately 128 square miles which drains portions of Dodge, Jefferson, Washington, and Waukesha counties. The watershed is relatively long and narrow, with its principal axis and direction of flow oriented in a northeasterly-southwesterly direction. The northeasterly boundary of the watershed marks the divide between the Oconomowoc River Watershed and the Cedar Creek Watershed. It also marks the divide between the Rock River Basin and the Milwaukee River Basin, and the subcontinental divide between the Mississippi River Basin and the Great Lakes Basin. The remainder of the boundaries of the Oconomowoc River Watershed mark divides between other watersheds of the Rock River Basin.

The Oconomowoc River Watershed has been divided, for the purposes of this planning effort, into 19 subwatersheds which are shown on Map II-1. The delineation of these subwatersheds is a particularly important element of this plan. The evaluation of site-specific nonpoint sources of pollution and the development of the methods and the associated costs to reduce their impact on water quality for a particular stream or lake can best be accomplished in these smaller surface drainage areas. Subwatershed evaluations in this watershed are also important because of the chain of lakes which the main stem of the Oconomowoc River flows through, with the resultant trapping of pollutants in the respective lake basins, and the associated benefit for water quality downstream.

Table II-1

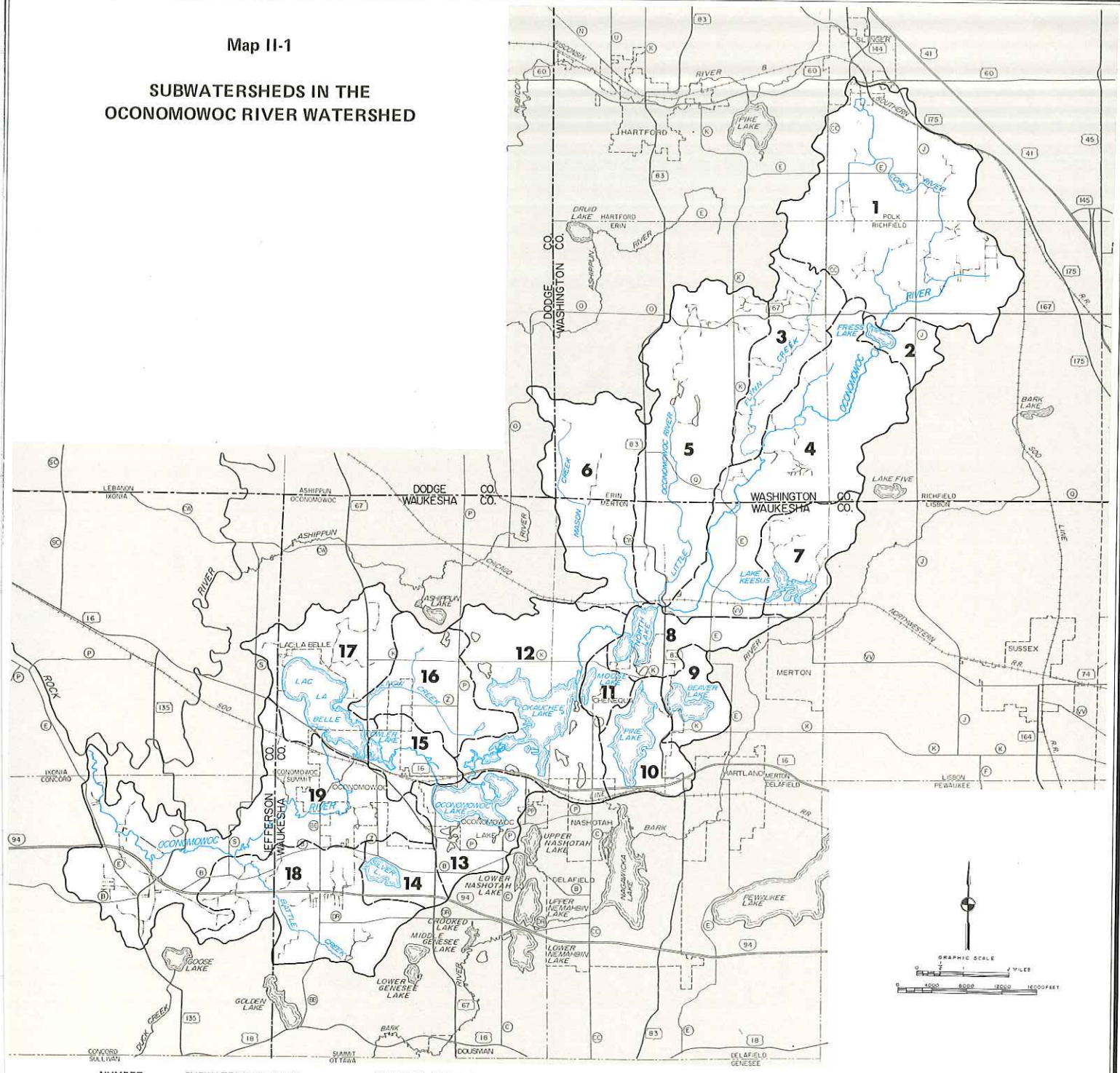
1980 LAND USE ACREAGE IN THE OCONOMOWOC RIVER WATERSHED: BY SUBWATERSHED, BY COUNTY

Subwatersheds By County	Residential	Commercial	Industrial	Extractive	Transportation	Recreation	Communication and Utilities	Government and Institutional	Agricultural	Woodlands	Wetlands	Water	Total
Jefferson County													
Lac La Belle	27	--	--	--	13	27	--	--	158	--	99	--	324
Lower Oconomowoc	82	--	--	--	282	--	--	--	4,316	129	1,504	31	6,344
Battle Creek	7	--	--	--	86	--	--	--	950	13	212	--	1 268
County Total	116	--	--	--	381	27	--	--	5,424	142	1,815	31	7.936
Dodge County													
Mason Creek	--	--	--	--	15	--	--	--	403	7	23	--	448
County Total	--	--	--	--	15	--	--	--	403	7	23	--	448
Washington County													
Coney River	275	3	--	93	373	113	--	5	8.218	1,136	1,369	22	11.607
Little Oconomowoc	191	--	--	6	174	24	--	1	3,299	927	1,139	66	5.827
Mason Creek	33	--	--	--	64	7	--	--	1,486	199	794	--	2 583
Flynn Creek	56	--	--	--	92	23	--	6	2,091	697	294	--	3,259
Friess Lake	112	--	--	--	45	8	--	--	536	137	15	116	969
Upper Oconomowoc	162	--	--	--	175	8	--	3	3,704	1,071	992	56	6,171
Lake Keesus	--	--	--	--	2	--	--	--	46	--	--	--	48
County Total	829	3	--	99	925	183	--	15	19,380	4,167	4,603	260	30.464
Waukesha County													
Lac La Belle	486	10	8	--	181	138	--	35	1,487	113	621	1,180	4 259
Rosenow Creek	395	--	--	69	183	84	--	19	2,130	47	260	62	3,249
Okauchee Lake	966	33	26	52	413	69	3	19	3,162	360	315	1 450	6.868
Oconomowoc Lake	415	2	6	--	145	--	16	28	872	229	240	807	2.760
Fowler Lake	368	71	32	--	123	66	--	60	306	46	250	103	1 425
Lower Oconomowoc	604	36	33	--	258	216	23	41	1,788	109	610	10	3.728
Silver Lake	125	--	--	--	150	196	--	--	516	70	99	217	1 373
Battle Creek	28	--	--	13	159	--	--	--	2,388	173	1,096	12	3.869
Mason Creek	38	--	4	--	78	--	--	--	1,862	104	110	--	2 196
Little Oconomowoc	49	--	--	5	49	--	--	--	996	299	370	9	1.777
Upper Oconomowoc	92	3	7	55	78	7	3	--	1,473	495	312	26	2 551
Lake Keesus	155	--	--	--	102	43	--	--	1,776	183	107	237	2,603
North Lake	221	--	1	--	87	48	--	8	907	322	53	433	2 080
Beaver Lake	340	--	--	--	98	102	--	8	388	134	7	321	1,398
Pine Lake	282	--	--	--	129	--	--	5	610	431	21	744	2.222
Moose Lake	81	3	--	--	28	10	--	--	253	165	26	84	650
County Total	4,645	158	117	194	2,261	979	45	223	20,914	3,280	4,497	5,695	43,008
Watershed Total	5,590	161	117	293	3,582	1,189	45	238	46,121	7,596	10,938	5,986	81,856

Source: SEWRPC

Map II-1

SUBWATERSHEDS IN THE OCONOMOWOC RIVER WATERSHED



NUMBER	SUBWATERSHED NAME	GENERAL LOCATION*
1	Coney River	Towns of Polk, Richfield
2	Friess Lake	Town of Richfield
3	Flynn Creek	Town of Erin
4	Upper Oconomowoc River	Towns of Richfield, Erin, and Merton
5	Little Oconomowoc River	Towns of Erin, Merton
6	Mason Creek	Towns of Erin, Merton
7	Lake Keesus	Town of Merton
8	North Lake	Town of Merton Village of Chenequa
9	Beaver Lake	Town of Merton Village of Chenequa
10	Pine Lake	Village of Chenequa
11	Moose Lake	Town of Merton
12	Okauchee Lake	Towns of Merton, Oconomowoc
13	Oconomowoc Lake	Village of Oconomowoc Lake
14	Silver Lake	Town of Summit
15	Fowler Lake	Town of Oconomowoc City of Oconomowoc
16	Rosenow Creek	Town of Oconomowoc City of Oconomowoc
17	Lac La Belle	Village of Lac La Belle City and Town of Oconomowoc
18	Battle Creek	Towns of Summit, Concord
19	Lower Oconomowoc River	City of Oconomowoc, Towns of Summit, Concord, and Ixonia

*Governmental units containing the major streams and lakes.

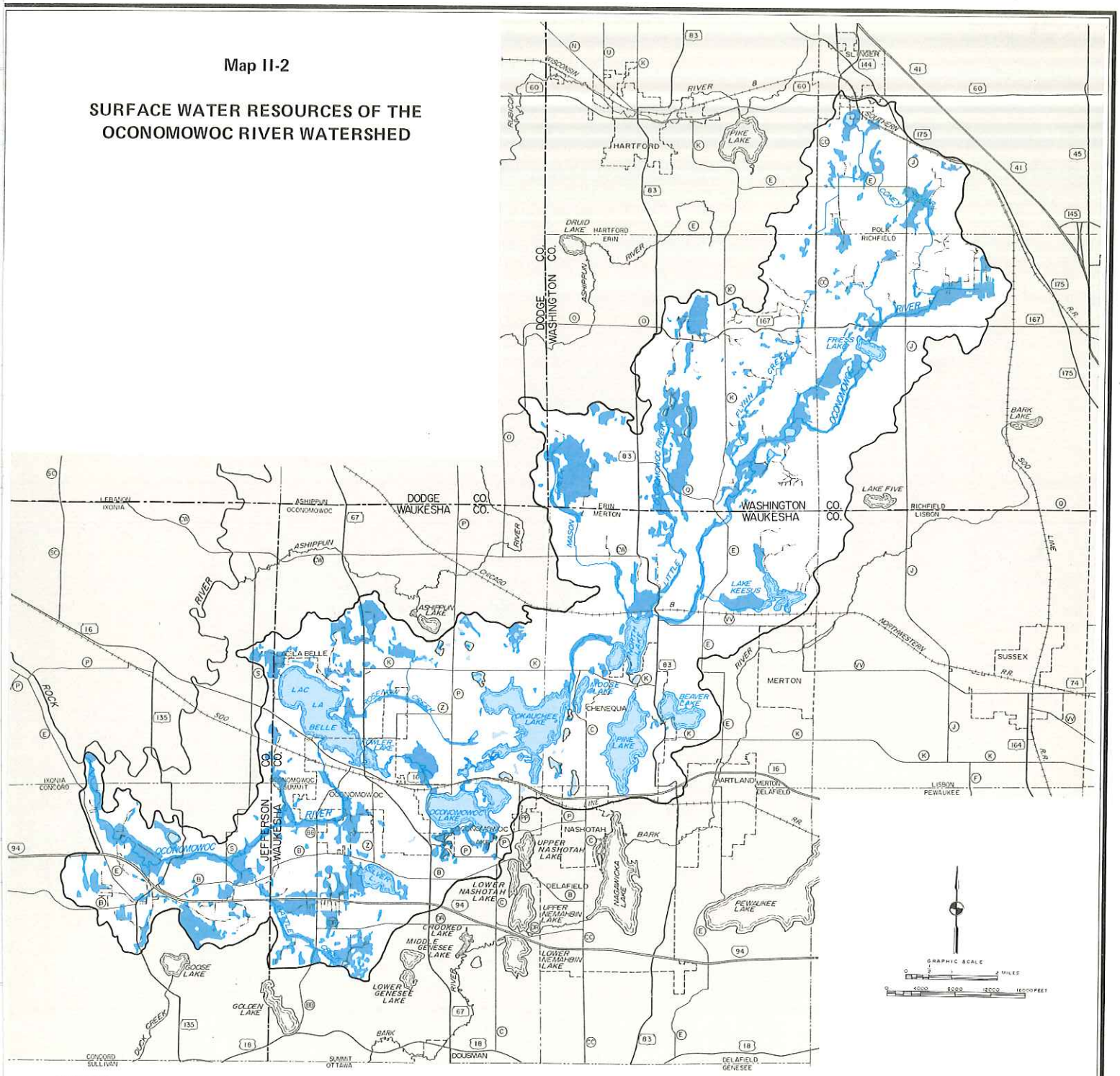
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

OCONOMOWOC RIVER WATERSHED

BASE MAP DESIGN: L.H. KREBLIN	
DRAWN BY: B.J. BLEHMER	DATE: FEB 15, 1984
CHECKED BY: L.H. KREBLIN	DATE: FEB 21, 1984
APPROVED BY:	DATE: FEB 28, 1984
REVISED BY: R.H. HEINEN	DATE: AUG 8, 1984

Map II-2

SURFACE WATER RESOURCES OF THE OCONOMOWOC RIVER WATERSHED



LEGEND

WETLANDS

LAKES AND STREAMS

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

OCONOMOWOC RIVER WATERSHED

BASE MAP DESIGN: L. H. KREBLIN	
DRAWN BY: B.J. FLEHIVER	DATE: FEB 15, 1984
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SURFACE WATERS

The surface water resources of the watershed--lakes, ponds, streams, and wetlands--are shown on Map II-2. As shown in Table II-1, the surface area of the lakes and ponds totals approximately 5,986 acres, about seven percent of the watershed. The Oconomowoc River Watershed has comparatively abundant surface water resources, given that lakes, ponds, and streams comprise only about 2.5 percent of the southeastern Wisconsin region. The watershed contains 11 major lakes ranging in size from 78 to 1,198 acres, and 75 miles of perennial streams ranging from 3.5 to 39.5 miles in length. Wetlands, which in this watershed are most commonly found adjacent to lakes and streams, comprise approximately 10,938 acres, or about 13 percent of the watershed area.

The Oconomowoc River, the principal stream which drains the watershed, rises in Section 10, Town of Richfield, Washington County, where it is formed by the confluence of farm ditches and drainage from field tile. From its source, the river flows in a southwesterly direction through six major lakes for approximately 39.5 miles before entering the Rock River in the Town of Ixonia, Jefferson County.

Major lakes in the watershed include Friess Lake in Washington County and Beaver, Fowler, Lac LaBelle, Keesus, Moose, North, Oconomowoc, Okauchee, Pine, and Silver lakes in Waukesha County. Beside the Oconomowoc River itself, major streams in the watershed include Coney Creek, Flynn Creek, Little Oconomowoc River, and Mason Creek in Washington County; Battle Creek, Little Oconomowoc River, Mason Creek, and Rosenow Creek in Waukesha County; and Battle Creek in Jefferson County.

RECREATIONAL USES

The Oconomowoc River Watershed, with its 11 major lakes and 75 miles of perennial streams, contains some of the most heavily utilized recreation areas in southeastern Wisconsin. As shown in Table II-2, publicly owned recreational lands total approximately about 1,098 acres, or 1.3 percent of the watershed. The lakes, streams, and wetlands in the watershed provide a wide diversity of recreational opportunities including boating, swimming, waterskiing, fishing, skating, and hunting. Upland portions of the watershed are used for camping, hiking, cross-country skiing, nature study, and hunting.

As shown on Map II-3 and Table II-2, there are three large, county-owned and operated parks in the watershed. These parks constitute the most important recreational lands in the watershed. Glacier Hills Park (Washington County), located adjacent to Friess Lake, and Nashotah Park (Waukesha County), located along the eastern shore of Okauchee Lake, are developed recreation sites offering opportunities for both water-dependent and upland activities. Monches Park, located adjacent to the main stem of the Oconomowoc River in the Town of Merton, Waukesha County, is undeveloped but used for nature study and hiking. Other recreational facilities in the watershed include publicly owned boat launching facilities on Lac La Belle and Okauchee Lake, publicly owned boat access sites on North Lake and Pine Lake, undeveloped Wisconsin Department of Natural Resources lands adjacent to Beaver Lake and Lake Keesus, city parks adjacent to Fowler Lake and Lac La Belle in the City of Oconomowoc, and a small portion of Pike Lake State Park in the Town of Polk. Other

Table II 2.

PUBLICLY OWNED PARK AND RECREATIONAL LANDS AND BOAT ACCESS SITES IN THE OCONOMOWOC RIVER WATERSHED: 1984

Facility Name	Map Reference Number	Location	Owner	Area Within Watershed (acres)
Pike Lake State Park	1	Section 24 T10N, R18E	Wisconsin Department of Natural Resources	30
Glacier Hills Park	2	Section 18 T9N, R19E	Washington County	140
Monches Park	4	Section 3 T8N, R18E	Waukesha County	278
Lake Keesus Preservation Area	5	Section 11 T8N, R18E	Wisconsin Department of Natural Resources	35
Beaver Lake Access	6	Section 28 T8N, R18E	Wisconsin Department of Natural Resources	1
Nashotah Park	7	Section 31 T8N, R18E	Waukesha County	437
Okauchee Lake Public Access	8	Section 35 T8N, R17E	Wisconsin Department of Natural Resources	1[a]
Bauer Street Public Access	9	Section 26	Town of Oconomowoc	1[a]
Pine Lake Public Access	10	Section 21 T8N, R18E	Village of Chenequa	1[a]
North Lake Public Access	11, 12	Sections 16 & 17, T8N, R18E	Town of Merton	1[a]
Parkview Place Park	13	Section 28	City of Oconomowoc	25
Roosevelt Park	14	Sections 4 & 5, T7N, R17E	City of Oconomowoc	99
Champion Field	15	Section 5 T7N, R17E	City of Oconomowoc	18
Five Road End Public Access Points	16	Section 32 T8N, R17E	City of Oconomowoc	1[a]
Lac La Belle Beach	17	Section 32 T8N, R17E	City of Oconomowoc	3
Lisbon Rd. Park	18	Section 33 T8N, R17E	City of Oconomowoc	1[a]
St. Paul Street Access	19	Section 33 T8N, R17E	City of Oconomowoc	1[a]
Mary Lane Access	20	Section 30 T8N, R17E	Town of Oconomowoc	1[a]

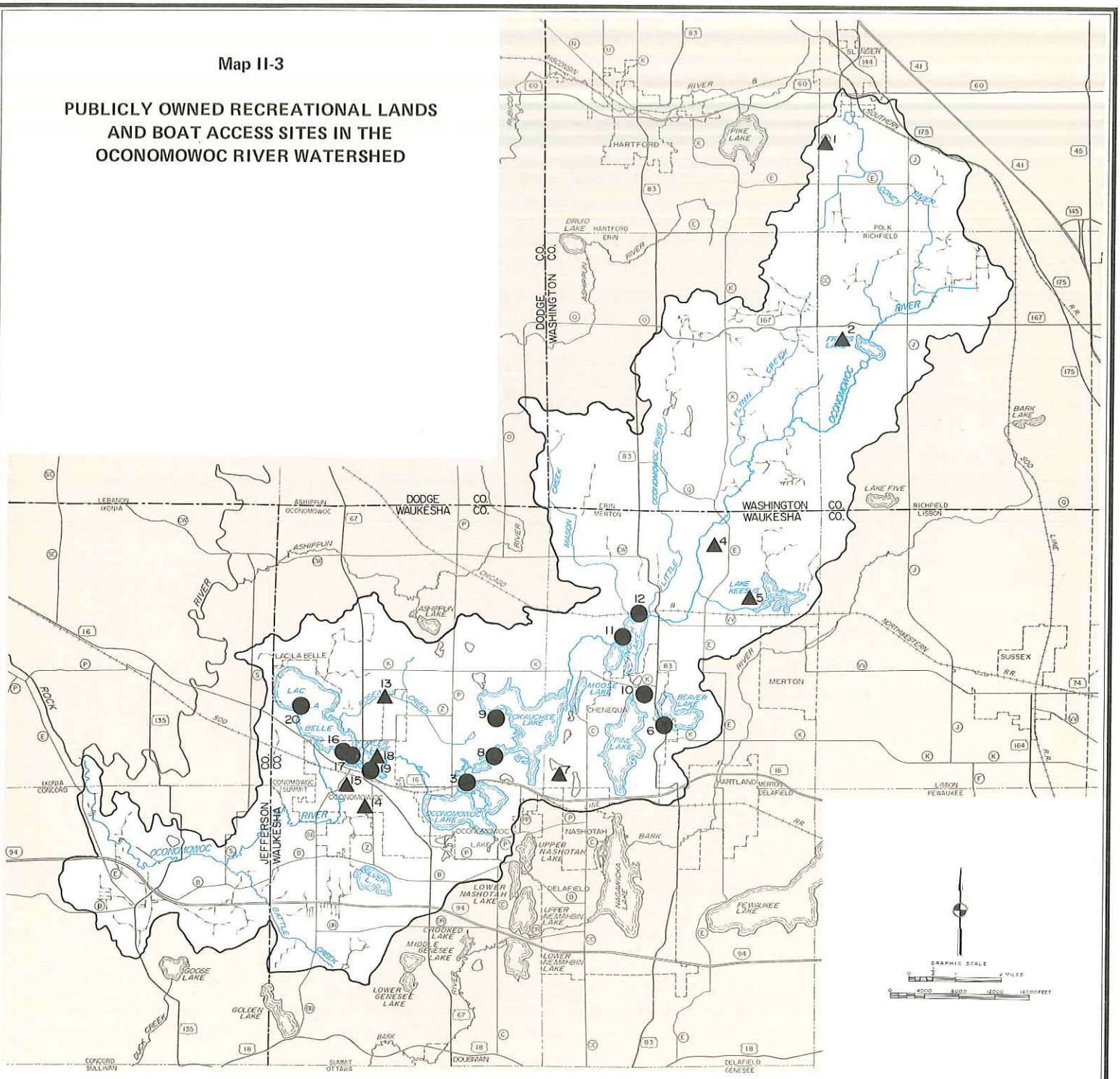
[a]These sites are between 0.1 acre and 0.5 acre in aereal extent.

Source: SEWRPC

7034A

Map II-3

PUBLICLY OWNED RECREATIONAL LANDS AND BOAT ACCESS SITES IN THE OCONOMOWOC RIVER WATERSHED



LEGEND

▲ PARK SITE

● BOAT ACCESS SITE

3 MAP REFERENCE NUMBER (SEE TABLE II-2)

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

OCONOMOWOC RIVER WATERSHED

BASE MAP DESIGN: L.H. KREDLIN	
DRAWN BY: B.J. RUEMMER	DATE: FEB 15, 1984
CHECKED BY: L.H. KREDLIN	DATE: FEB. 21, 1984
APPROVED BY: [illegible]	DATE: FEB 28, 1984
REVISED BY: R.H. HEINEN	DATE: AUG 8, 1984

recreational lands include the Zinn Nature Preserve located along the Little Oconomowoc River in Washington County (owned by the Nature Conservancy) and Holy Hill, a monastery located on the highest point in southeastern Wisconsin which is visited by thousands of tourists annually.

The diverse recreational opportunities provided by the surface waters of the watershed can be enhanced by improving or in some cases maintaining the quality of these waters as a result of the Nonpoint Source Control Program.

OTHER NATURAL RESOURCE FEATURES

Climate

The midcontinental location of southeastern Wisconsin gives the watershed a typical continental climate characterized by a progression of markedly different seasons and a wide range of annual temperatures and precipitation. Average monthly air temperatures range from a low of 16.9 F in January to a high of 72.1 F in July. Precipitation ranges in intensity, duration, and significance from gentle showers to destructive thunderstorms and major rainfall-snowmelt events, that can result in property damage, inundation of poorly drained areas, and an accelerated rate of soil erosion. The average annual total precipitation is about 29.60 inches. Average monthly precipitation rates range from a low of 0.81 inch in February to a high of 3.89 inches in July. Snow cover is most likely during December, January, and February, and averages about 45 inches annually.

Ground frost or frozen ground during winter influences hydraulic processes, particularly the proportion of rainfall or snowmelt that will run off the land into surface waters. Livestock manure applied to frozen ground is susceptible to a high degree of runoff in spring under snowmelt conditions. Frozen ground exists throughout the watershed for approximately four months each winter season, extending from late November through March, with a frost depth of more than six inches occurring during January, February, and the first half of March. Historical data indicate that the most severe frost conditions normally occur in February, when a frost depth of 15 or more inches can be expected.

Surface Geology and Topography

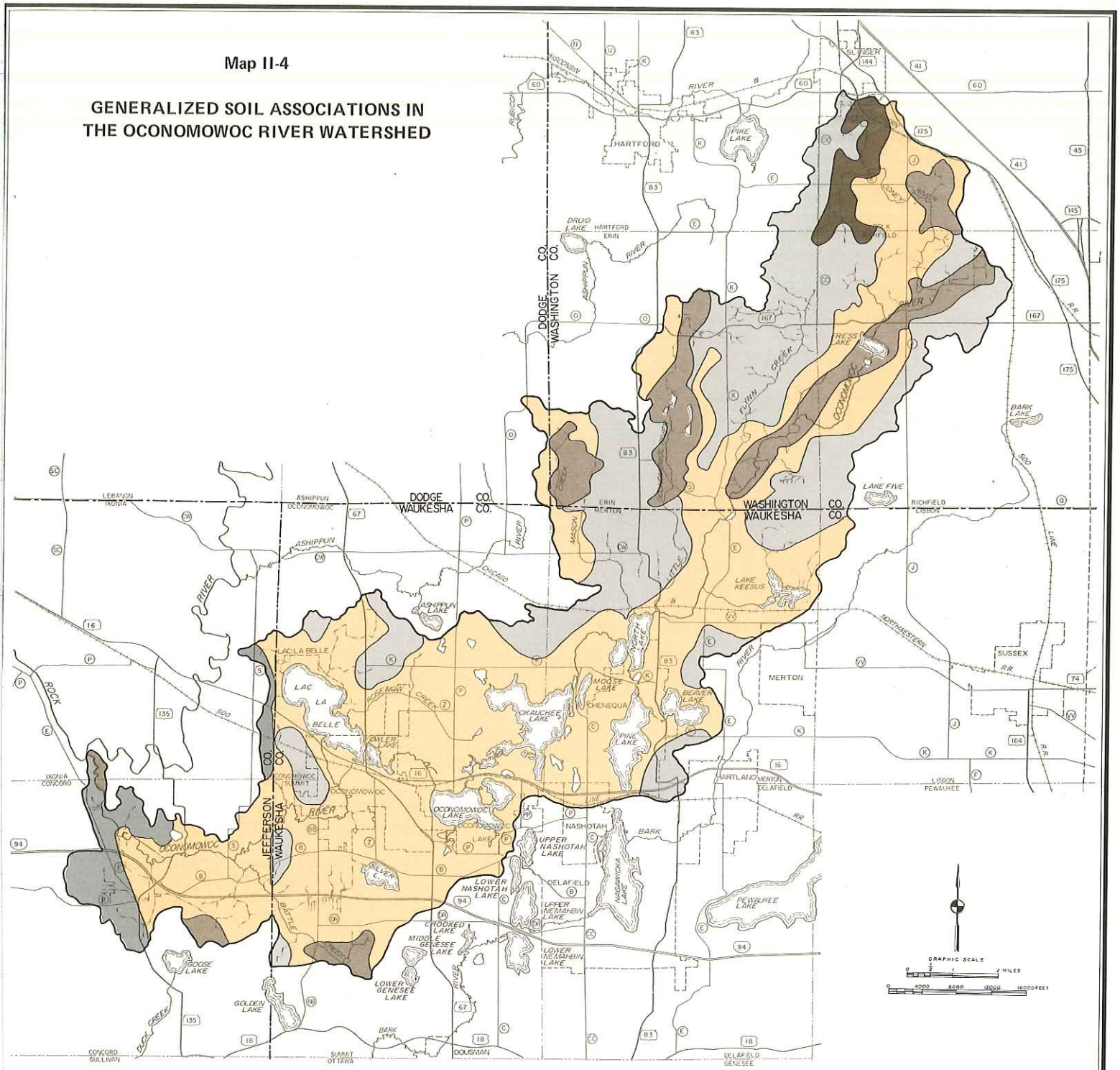
Surface geology is an important consideration in water quality management planning efforts associated with the control of nonpoint source pollution in the Oconomowoc River Watershed. Surface features determine the rate and quality of runoff and the nature of the drainage system, thus influencing the water quality of lakes and streams receiving such runoff. The nature of the underlying material also determines the minerals contained in, and the chemical characteristics of, ground and surface waters. The type and extent of the various bedrock formations underlying the watershed was determined primarily by the environments in which the sediments forming the rock layers were deposited. The surface of this varied system of rock layers was, moreover, eroded prior to being buried by a blanket of glacial deposits consisting of unconsolidated sand, silt, clay, gravel, and boulders. These materials were deposited during the Pleistocene age by the continental glaciers that last covered the watershed about 11,000 years ago.

Table II-3. Local Units of Government In The Oconomowoc River Watershed.

County or Civil Division	Subwatersheds (See Map)	Square Miles Within Watershed	% of Watershed	% of County or Civil Division Within Watershed
Waukesha County	4-19	67.2	52.5	11.6
City of Delafield	12	0.2	0.1	1.9
City of Oconomowoc	13-17,19	5.5	4.3	100.0
Village of Chenequa	8,9,10	4.6	3.6	97.9
Village of Lac LaBelle	17	0.5	0.4	100.0
Village of Merton	7,8	0.1	0.1	4.3
Village of Nashotah	10,12	0.4	0.3	25.0
Village of Oconomowoc Lake	13	3.1	2.4	100.0
Town of Merton	4-12	22.9	17.9	79.5
Town of Oconomowoc	12,15-17,19	18.0	14.1	53.9
Town of Summit	12-15,18,19	11.2	8.7	36.8
Town of Lisbon	7	0.7	0.6	2.1
Washington County	1-7	47.6	37.2	10.9
Village of Slinger	1	0.5	0.4	25.0
Town of Erin	1,3-6	23.7	18.5	65.8
Town of Hartford	1	0.9	0.7	2.6
Town of Polk	1	7.4	5.8	21.6
Town of Richfield	1-4,7	15.1	11.8	41.6
Jefferson County	17-19	12.4	9.7	2.1
Town of Concord	18-19	11.2	8.8	31.0
Town of Ixonia	17-19	1.2	0.9	3.2
Dodge County	6	0.7	0.6	0.1
Town of Ashippun	6	0.7	0.6	1.9
TOTAL WATERSHED	1-19	127.9	100.0	*

Map II-4

GENERALIZED SOIL ASSOCIATIONS IN THE OCONOMOWOC RIVER WATERSHED



LEGEND

- CASCO-FOX-RODMAN
- HOUGHTON-PALMS-ADRIAN
- BROOKSTON-PELLA-LAMARTINE
- HOCHHEIM-THERESA
- WACOUSTA-LAMARTINE-THERESA

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

OCONOMOWOC RIVER WATERSHED

BASE MAP DESIGN: L.H. FREBLIN	
DRAWN BY: B.J. RUCHTVLIR	DATE: FEB 15, 1984
CHECKED BY: L.H. FREBLIN	DATE: FEB 21, 1984
APPROVED BY:	DATE: FEB 28, 1984
REVISED BY: R.H. HEINEN	DATE: AUG 8, 1984

The deposits can be classified according to their origin into till and stratified drift. Till, a heterogeneous mixture of clay, silt, sand, gravel, and boulders, was deposited from ice without the sorting action of water. Much of the watershed is overlain by till in the form of ground moraine, and in the northwestern portion of the watershed by interlobate moraine. Stratified drift consists primarily of sand and gravel that was sorted and deposited as outwash of glacial melt water. Other materials, which consist of more recent alluvium (flood plain deposits) and marsh deposits occur along streams and in wetlands, constitute the remaining unconsolidated deposits covering the watershed surface.

Topography is also an important consideration in the evaluation of nonpoint pollution sources and the development of feasible land management control practices. The steepness and length of slopes determine, to a great extent, the rate at which runoff will travel and the associated erosion rate from a given area. In addition, the steepness of stream channels which feed into the Oconomowoc River, as well as the main stem itself, can contribute to the rate of streambank erosion and erosion of the stream bottom.

As described above, the topographic features of the Oconomowoc River Watershed have been determined by the underlying bedrock and the overlying unconsolidated glacial deposits. These glacial deposits form the surface topography of the watershed, which ranges from steeply sloped hills and ridges in the northern portion, to relatively level areas in the southwestern portion. Surface elevations within the watershed range from a high of approximately 1,320 feet above National Geodetic Vertical Datum (NGVD), or mean sea level datum, at Holy Hill in Washington County (the highest point in southeastern Wisconsin) to approximately 835 feet NGVD at the confluence of the Oconomowoc River with the Rock River in Jefferson County, giving a maximum relief of 485 feet. The areas of greatest local relief, or changes in elevation, are in the upper portions of the watershed in Washington County, which are part of the famous kettle moraine topography of southeastern Wisconsin.

Soils

Glaciation has been the primary determinant of the complex soil pattern occurring within the watershed. The soils of the watershed are generally sandy clay loams, with the exception of some poorly drained organic soils which occur primarily along the shorelines of the inland lakes, in the floodlands of the streams and watercourses, and in old lake beds. Most of the soils are suitable for a variety of urban land uses. However, intensive agricultural use of these soils without appropriate land conservation practices can result in an accelerated rate of soil erosion and associated adverse impacts on surface water quality.

As shown on Map II-4, the most common generalized soil association occurring in the watershed is the Casco-Fox-Rodman association. Soils in this generalized association comprise approximately 58 percent of the total area of the watershed. These well-drained to excessively well-drained soils generally have a clay loam subsoil underlain by sand and gravel and occur mainly on glacial outwash plains and on stream terraces. In the Jefferson County portion of the watershed, this association also includes areas of the somewhat poorly-drained Matherton soils.

Over one-half of the remaining soils, covering about an additional 27 percent of the total area of the watershed, belong to the Hochheim-Theresa association. These well-drained soils have a subsoil of clay loam underlain with loam or sandy loam and occur mainly on drumlins and ground moraines. Poorly-drained organic soils of the Houghton-Palms-Adrian association comprise 10 percent of the soils in the watershed. The remaining five percent of the watershed is also characterized by poorly drained soils in the Wacousta-Lamartine-Theresa and the Brookston-Pella-Lamartine associations.

Flooding

The Oconomowoc River Priority Watershed Project will not specifically address ways to reduce the extent and severity of flooding in the watershed. It is important to note, however, that the climatic conditions which cause floods -- heavy rain, rapid snowmelt -- can also result in severe nonpoint source pollutant loading to surface water from excessive and rapid rates of runoff from agricultural areas and construction sites, inundation of on-site sewage treatment systems, and streambank erosion. The installation of land management practices in the priority watershed project may, on a limited site specific basis, reduce the amount of runoff in a particular subwatershed or sub-basin. However, alleviation of flooding problems in the entire watershed will require the development of a comprehensive flood control plan.

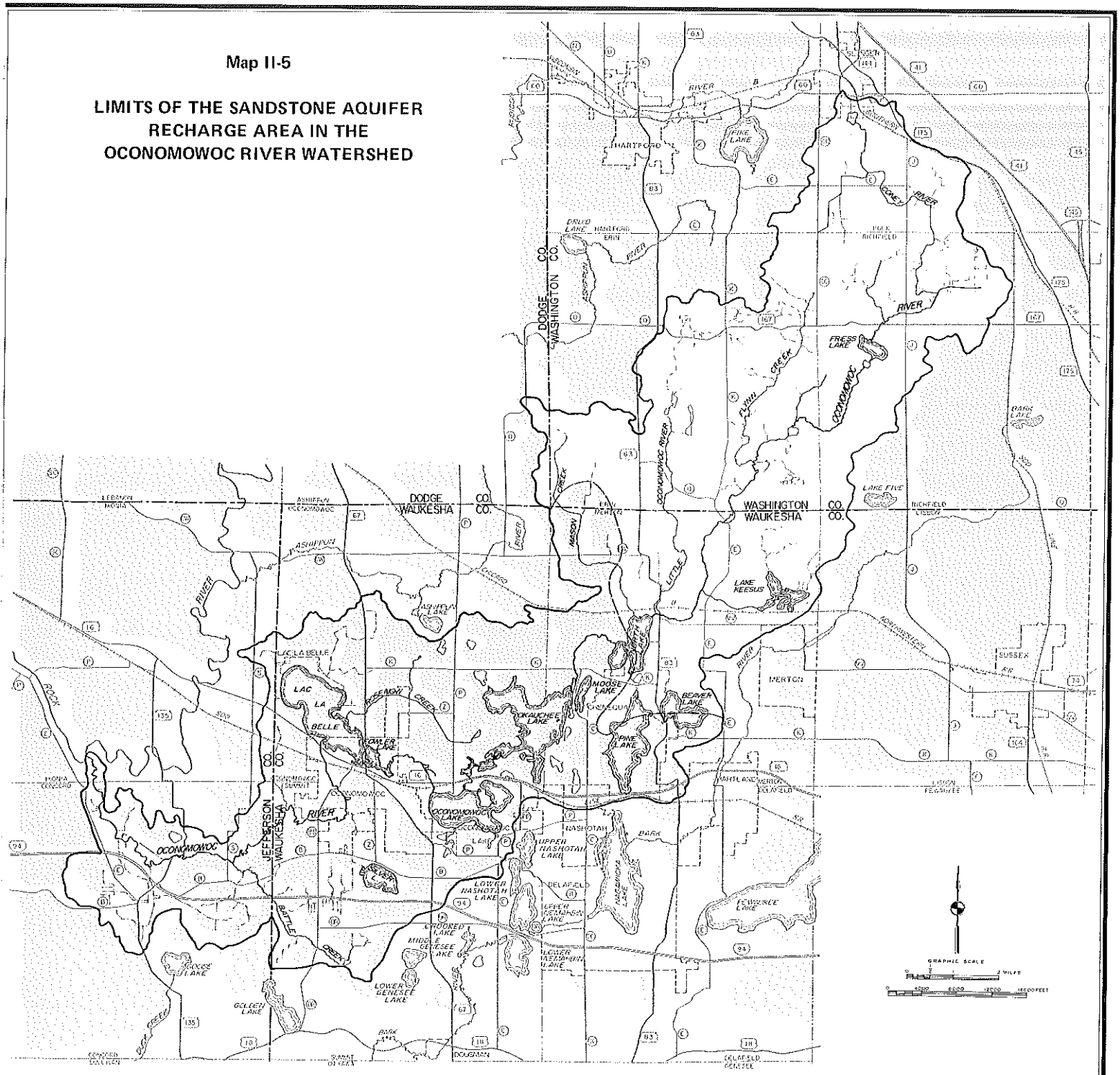
Flooding has been a recurrent problem in portions of the Oconomowoc River Watershed for many years. Floods which have caused property damage along the lower Oconomowoc River and the associated lakes are known to have occurred in March 1943, April 1959, March 1974, and March 1975. The most damaging flood in recent years was the March 1975 flood which inundated homes in the North Lake area along Reddelien Road, North Woods Drive, and North Lake Drive; and in the City of Oconomowoc near the downtown Community Center and along Blackhawk Drive, Nakoma Road, and Armor Road. These flood problems are believed to be the result of a combination of overland flooding, inadequate stormwater drainage, and in some cases, the attendant overflowing of sanitary sewers. The March 1975 flood is believed to have been a relatively moderate flood, and a far more severe flood could potentially occur within the watershed.

Some overland flooding of the Oconomowoc River has also occurred in the upper portions of the watershed, specifically in Sections 9 and 10 of the Town of Richfield and in Section 8 along State Highway 167. In addition, flooding has occurred along the south shore of Friess Lake, and along St. Augustine Road in Section 25 of the Town of Erin.

No comprehensive study of the flooding problems of the Oconomowoc River watershed has been completed. However, the U.S. Army Corps of Engineers has evaluated flood flows under existing land use and channel conditions and has defined attendant flood stages and areas subject to inundation for floodland zoning in the City of Oconomowoc (U.S. Army Corps of Engineers, 1975a). The U.S. Army Corps of Engineers also completed a reconnaissance report which evaluated alternative means to alleviate flooding of residences along the shoreline of North Lake. None of the six alternative flood control measures evaluated by the Corps in the above report was deemed to be economically feasible (U.S. Army Corps of Engineers, 1975b).

Map II-5

LIMITS OF THE SANDSTONE AQUIFER RECHARGE AREA IN THE OCONOMOWOC RIVER WATERSHED



LEGEND

SANDSTONE AQUIFER RECHARGE AREAS NOT COVERED BY THE MAQUOKETA SHALE

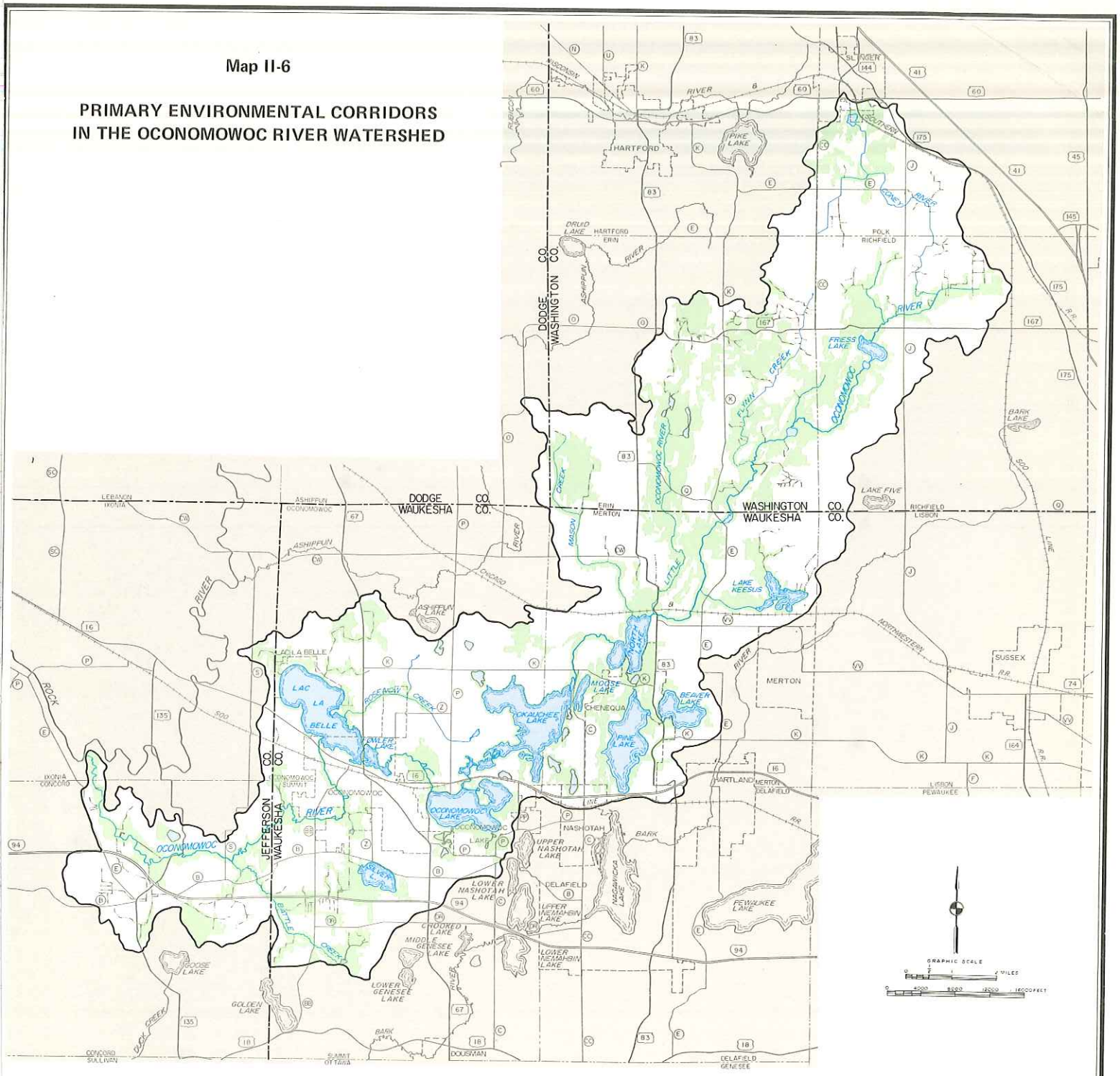
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

OCONOMOWOC RIVER WATERSHED

BASE MAP DESIGN: L.H. KERBER	
DRAWN BY: M.J. RIEHIVER	DATE: FEB. 1984
CHECKED BY: L.H. KERBER	DATE: FEB. 21, 1984
APPROVED BY:	DATE: FEB. 28, 1984
REVISED BY: R. KHEINER	DATE: AUG. 8, 1984

Map II-6

PRIMARY ENVIRONMENTAL CORRIDORS IN THE OCONOMOWOC RIVER WATERSHED



SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

OCONOMOWOC RIVER WATERSHED

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DRAWN BY: B.J. RUEHLER	DATE: FEB 15, 1984
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Groundwater

The source of all groundwater is precipitation, which infiltrates into aquifers either directly through the soil or by way of surface water bodies and wetlands. Three distinct aquifers underlie the southeastern Wisconsin area, namely the overlying sand and gravel aquifer, the shallow Niagara Dolomite (limestone) aquifer, and the deep sandstone aquifer.

The sand and gravel aquifer and the shallow limestone aquifer are hydraulically interconnected and are often regarded as a single aquifer. Municipal and private water supplies in the Oconomowoc River Watershed are derived almost exclusively from these two shallow aquifers (Personal Communication, T. Bosch, DNR). The two shallow aquifers are separated from the deeper sandstone aquifer throughout most of southeastern Wisconsin by a layer of relatively impervious shale called Maquoketa shale. However, as shown on Map II-5, significant portions of the Oconomowoc River Watershed lie west of the Maquoketa shale and water can percolate downward through the overlying glacial deposits into the sandstone aquifer. This recharge area within the watershed is bounded on the west by a groundwater divide, whose location can shift with pumpage from the aquifer; on the east and north by the western edge of the Maquoketa shale formation; and on the south by the Bark River Watershed divide. Groundwater moves generally eastward from this recharge area into major pumping centers, which includes many important municipal and industrial wells throughout southeastern Wisconsin which utilize the deep aquifer.

Environmental Corridors

An important consideration in planning for improved water quality is the identification and delineation of areas having high concentrations of natural, recreational, historic, aesthetic, and scenic resources which should be preserved and protected in order to maintain the overall quality of the environment. Such areas, as delineated by SEWRPC, are termed environmental corridors and include one or more of the following twelve elements related to the natural resource base which are essential to the maintenance of both the ecological balance and the natural beauty of the region: 1) lakes, rivers, and streams and the associated undeveloped shorelands and floodlands, 2) wetlands, 3 woodlands, 4) prairies, 5) wildlife habitat areas, 6) wet, poorly drained, and organic soils, 7) rugged terrain and high-relief topography, 8) existing outdoor recreation sites, 9) potential outdoor recreation and related open space sites, 10) historic, archaeological, and other cultural sites, 11) significant scenic areas and vistas, and 12) natural and scientific areas. Environmental corridor elements which are particularly important regarding the maintenance of water quality include undeveloped shorelands and floodlands adjacent to surface waters, and wet, poorly drained areas.

Primary environmental corridors include a wide variety of the above-mentioned important resource and resource-related elements and are, by definition, at least 400 acres in size, two miles in length, and 200 feet in width. As shown on Map II-6, primary environmental corridors in the Oconomowoc River Watershed in 1980 encompassed 25,598 or about 31 percent of the watershed area.

Table II-4

DISTRIBUTION OF POPULATION IN THE OCONOMOWOC RIVER WATERSHED BY CIVIL DIVISION: 1970, 1980, AND 2000

Civil Division	1970 Population	1970 Percent of Total	1980 Population	1980 Percent of Total	2000 Population	2000 Percent of Total
Washington County	3,528	14.2	4,468	14.9	7,209	16.2
Village						
Slinger	224	0.9	305	1.0	721	1.6
Towns						
Erin	1,170	4.7	1,599	5.3	2,809	6.3
Hartford	49	0.2	82	0.3	149	0.3
Polk	366	1.5	482	1.6	828	1.9
Richfield	1,719	6.9	2,000	6.7	2,702	6.1
Waukesha County	20,556	82.0	24,583	81.7	36,032	81.0
Cities						
Delafield	96	0.4	552	1.8	516	1.2
Oconomowoc	9,358	37.3	10,177	33.8	17,627	39.6
Villages						
Chenequa	541	2.2	531	1.8	1,229	2.9
Lac La Belle ...	262	1.0	420	1.4	1,309	2.9
Merton	4	0.1	4	0.1	4	0.1
Nashotah	142	0.6	101	0.3	180	0.4
Oconomowoc Lake	507	2.0	856	2.8	720	1.6
Towns						
Lisbon	53	0.2	72	0.2	53	0.1
Merton	3,709	14.8	4,809	16.0	7,000	15.7
Oconomowoc	5,041	20.1	6,192	20.6	6,306	14.2
Summit	843	3.4	873	2.9	1,088	2.4
Jefferson County	963	3.8	1,005	3.3	1,226	2.7
Towns						
Concord	465	1.8	371	1.2	465	1.0
Ixonia	498	2.0	634	2.1	761	1.7
Dodge County	21	0.1	21	0.1	21	0.1
Town						
Ashippun	21	0.1	21	0.1	21	0.1
Oconomowoc River Watershed	25,068	100.0	30,077	100.0	44,488	100.0

Source: U.S. Bureau of the Census, Wisconsin Department of Administration and SEWRPC.

The adopted regional water quality management plan for southeastern Wisconsin includes a land use plan element which recognizes the important roles of environmental corridors in the preservation of the natural resource base and in maintaining water quality. It is important to point out that, because of the many interrelationships between living organisms and their environment, the destruction or deterioration of one element of the total environment may lead to a chain reaction of unfavorable impacts. For example, construction site erosion, feedlot runoff, excessive erosion rates from agricultural areas, and drainage of wetlands may have far-reaching effects, as such activities may result in not only water quality degradation, but can also destroy fish spawning grounds, wildlife habitat, groundwater recharge areas, and the natural filtration and floodwater storage benefits of interconnecting lake and stream systems. Although the effects of any one of these environmental changes may not be overwhelming, the combined effects of many changes may eventually lead to the deterioration of both the underlying and supporting natural resource base and the overall quality of the environment.

CIVIL DIVISIONS, POPULATIONS, AND LAND USE

Geographic boundaries of the civil divisions are an important factor which must be considered in any watershed planning effort, since the civil divisions form the basic foundation of the decision-making framework within which intergovernmental, environmental, and developmental problems must be addressed. This is true because the local municipal units of government have important resource management responsibilities.

As shown on Map II-7, the watershed lies primarily in Waukesha, Washington, and Jefferson counties. The portions of the watershed lying within each of the 23 minor civil divisions are listed in Table II-3. The City of Oconomowoc and the Village of Lac LaBelle are the only governmental units lying entirely within the watershed.

The 1980 resident population of the watershed was estimated at about 30,077 persons, or about 1.7 percent of the southeastern Wisconsin region. As shown in Table II-4, the population of the watershed increased by about 5,009 persons, or 20 percent, between 1970 and 1980, while the region experienced a 0.5 percent increase. The higher population growth rate of the watershed reflects the redistribution of population which has been occurring within the region for many years. The redistribution involves the movement of urban residents from the metropolitan area of Milwaukee to rural portions of the watershed, as well as the conversion of seasonal residences, primarily around lakes, to permanent year-round homes.

The Southeastern Wisconsin Regional Planning Commission projects that the population of the Oconomowoc River Watershed will increase to approximately 44,500 persons, or by 48 percent, by the year 2000. This, in part, illustrates public preference for low-density residential development, especially in areas with abundant surface water, which has occurred in the past and will continue within this watershed. Such increased development and associated construction activities can result in increased rates of stormwater runoff and the potential for degradation of surface water quality.

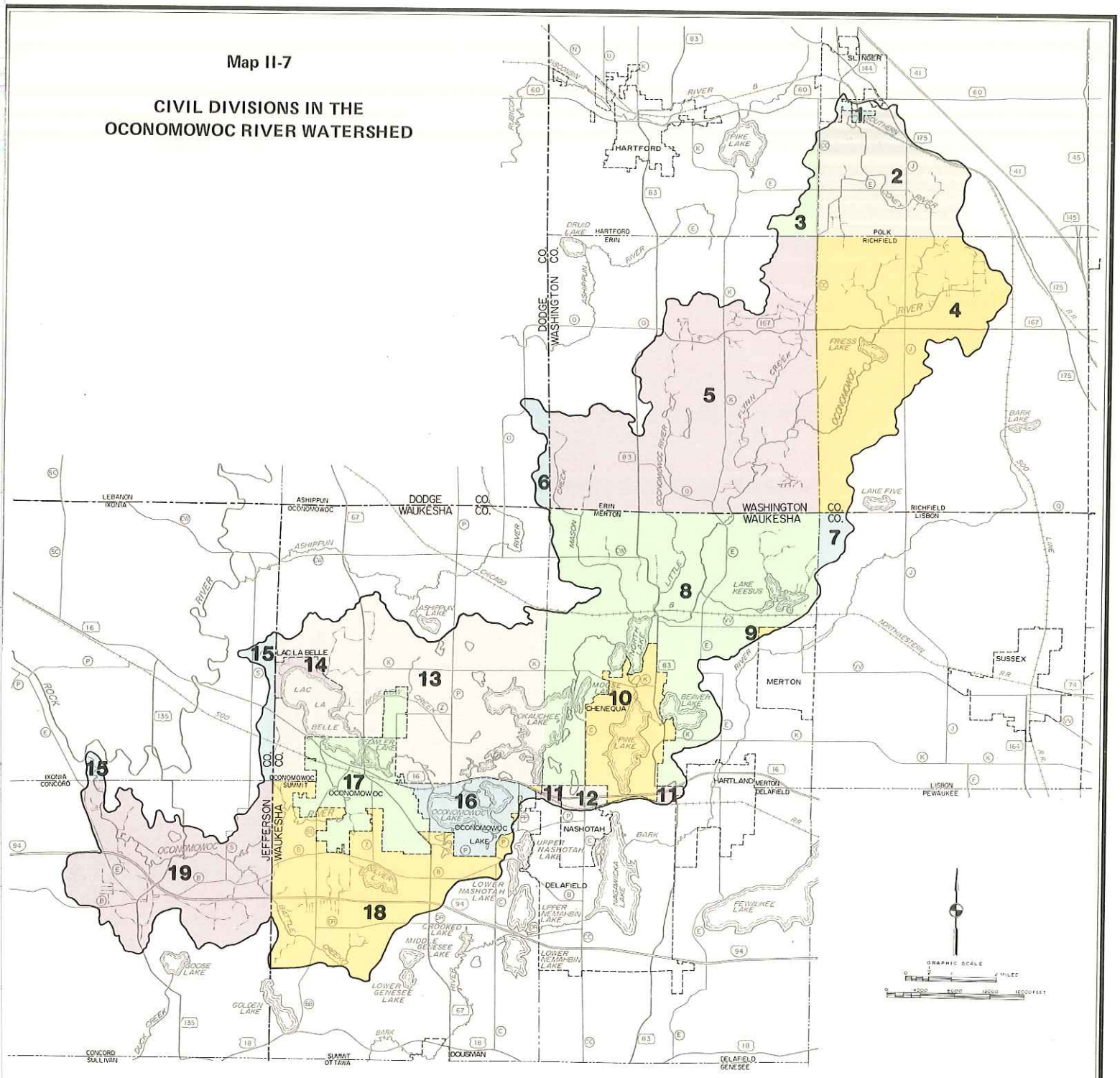
Land Use

An inventory of land uses in a watershed is important in developing a program to improve water quality, given that water resource quality can be correlated directly with the quantity, type, intensity, and spatial distribution of land uses. The generalized existing land use patterns within the Oconomowoc River watershed, as of 1980, are shown on Map II-8 and are quantified in the previously referenced Table II-1. In 1980, approximately 64,655 acres, or 79 percent of the watershed, were still in rural land uses, with the dominant rural land use being agricultural (encompassing 46,121 acres, or 71 percent of the rural area). Other rural land uses--woodlands and wetlands--comprised 18,534 acres, or 29 percent of the rural area. Surface water comprised approximately 5,986 acres, or seven percent of the watershed.

The majority of the urban lands in the watershed are located primarily in Waukesha County adjacent to Beaver, Fowler, Lac La Belle, North, Oconomowoc, Okauchee, and Pine lakes. Urban lands consisting of residential, commercial, industrial, extractive, transportation, and recreational land uses comprised 11,215 acres, or 14 percent of the watershed. Residential areas and transportation land uses were the predominant urban land uses, comprising 9,182 acres, or 82 percent of the urban area.

Map II-7

CIVIL DIVISIONS IN THE OCONOMOWOC RIVER WATERSHED



NUMBER	MINOR CIVIL DIVISION	NUMBER	MINOR CIVIL DIVISION	NUMBER	MINOR CIVIL DIVISION
1	Village of Slinger	8	Town of Merton	15	Town of Ixonia
2	Town of Polk	9	Village of Merton	16	Village of Oconomowoc Lake
3	Town of Hartford	10	Village of Chenequa	17	City of Oconomowoc
4	Town of Richfield	11	City of Delafield	18	Town of Summit
5	Town of Erin	12	Village of Nashotah	19	Town of Concord
6	Town of Ashippun	13	Town of Oconomowoc		
7	Town of Lisbon	14	Village of Lac La Belle		

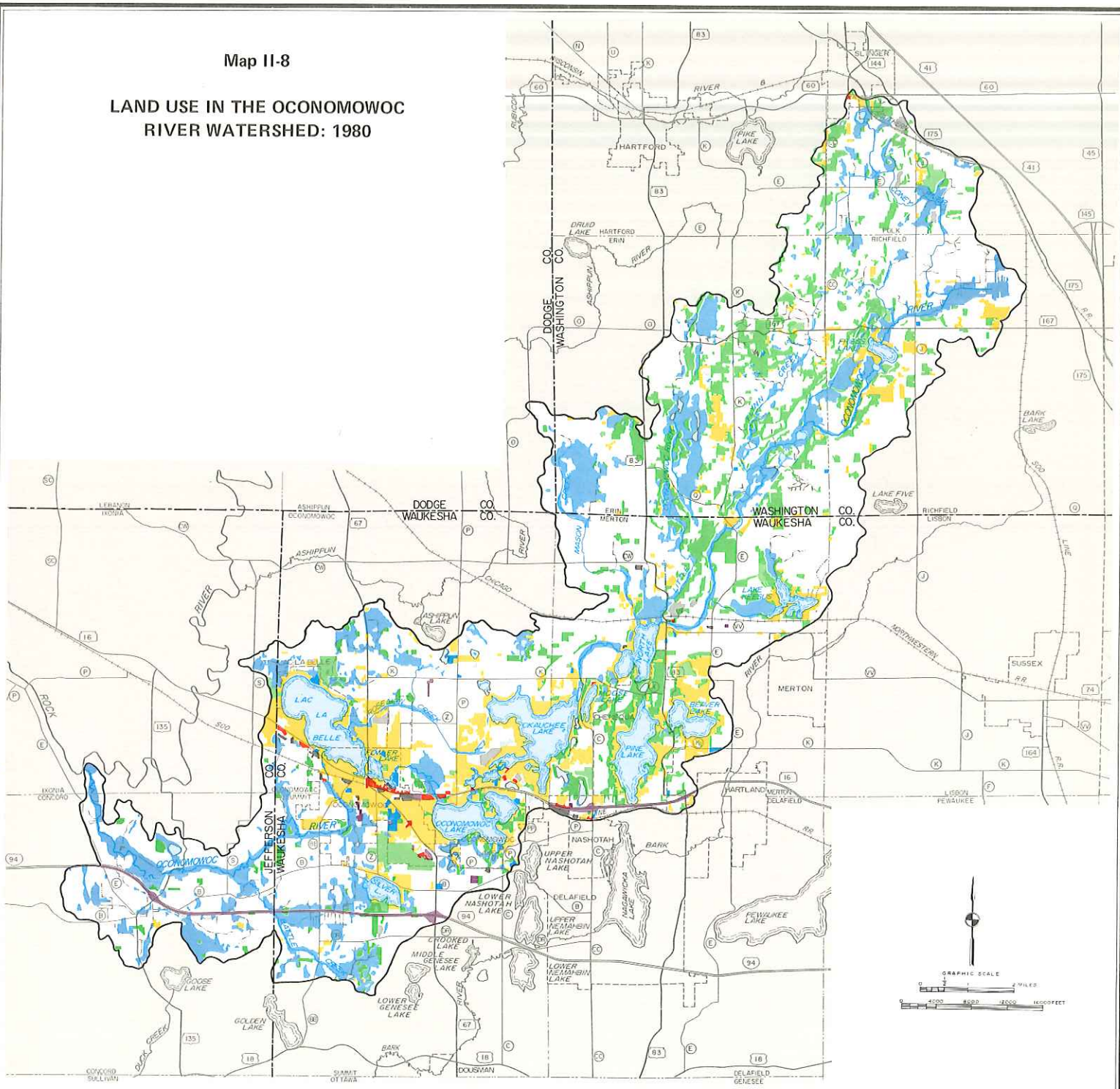
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

OCONOMOWOC RIVER WATERSHED

BASE MAP DESIGNED BY: H. KREELIN	
DRAWN BY: B.J. FLEHNER	DATE: FEB 15, 1984
CHECKED BY: L.H. KREELIN	DATE: FEB 21, 1984
APPROVED BY: [illegible]	DATE: FEB 28, 1984
REVISED BY: N.H. HEINEN	DATE: AUG 8, 1984

Map II-8

LAND USE IN THE OCONOMOWOC RIVER WATERSHED: 1980



LEGEND

URBAN LAND USE

- RESIDENTIAL
- COMMERCIAL
- INDUSTRIAL
- EXTRACTIVE AND LANDFILL
- TRANSPORTATION (INCLUDES AIRFIELDS, RAILROAD YARDS, TERMINALS, AND PARKING)
- RECREATION
- UTILITIES AND COMMUNICATION
- GOVERNMENT AND INSTITUTIONAL

RURAL LAND USE

- AGRICULTURAL AND OPEN LAND
- WOODLAND
- LAKES, PONDS, AND STREAMS
- WETLAND

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

OCONOMOWOC RIVER WATERSHED

BASE MAP DESIGN: L. H. KREBLIN	
DRAWN BY: D. J. PLEHOV	DATE: FEB. 15, 1984
CHECKED BY: L. H. KREBLIN	DATE: FEB. 21, 1984
APPROVED BY: Kurt Town	DATE: FEB. 28, 1984
REVISED BY: R. H. HEINEN	DATE: AUG. 8, 1984

WATERSHED ASSESSMENT

B. ANALYTICAL METHODS

CHAPTER III

ANALYTICAL METHODS USED IN DEVELOPING THE NONPOINT SOURCE CONTROL STRATEGY FOR THE OCONOMOWOC RIVER PRIORITY WATERSHED

INTRODUCTION

A three-step procedure was used to develop the nonpoint source pollutant control strategy for the Oconomowoc River Watershed. First, water quality problems occurring in lakes and streams were identified, and the pollutants which are either known to be causing the problem, or are commonly associated with the type of problem being seen, were identified. Second, the urban and rural nonpoint sources of pollution were inventoried and each pollutant source was assessed as to its relative importance. Finally, the information on water quality problems and pollutant sources was used to set water resources objectives and to develop a strategy to achieve the desired reduction of pollutants.

The analytical methods used in each of these three steps are described below, along with some general results of the analyses. More detailed results of the analyses are presented in following chapters. This chapter is often referenced in the following chapters.

STEP ONE: WATER RESOURCES ASSESSMENT

Water quality standards are a statement of the characteristics of water that must be maintained to support specified uses, such as recreation, fish and aquatic life, or aesthetics. The water quality standards established by the State of Wisconsin for inland waters, along with selected additional water quality criteria that have been adopted by the Southeastern Wisconsin Regional Planning Commission as part of the areawide water quality management plan, are presented in Table III-1.

The use of these standards by themselves is insufficient, however, to fully assess the water quality problems that affect the ability of lakes and streams to support specific uses. As a result, several additional methods were used to evaluate water resources in the Oconomowoc River Priority Watershed Project. These methods are discussed below, while the results of the water resources assessments made with these methods are presented in the following chapters.

Lakes

Phosphorus is generally recognized as the most important nutrient contributing to the eutrophication, or enrichment, of lakes. Excessive phosphorus concentrations can seriously impair the quality and variety of recreational, fish, and aquatic life uses of a lake. Phosphorus concentrations are positively correlated with algae growth, which in turn contributes to reduced

Table III-1. Selected State of Wisconsin Water Quality Standards and SEWRPC Proposed Standards for Streams and Lakes in the Oconomowoc River Watershed

Water Quality Parameter	Wisconsin Water Quality Standards: Recreational Use	Wisconsin Water Quality Standards: Warmwater Fish and Aquatic Life	Wisconsin Water Quality Standards: Coldwater Fish and Aquatic Life	SEWRPC Proposed Water Quality Standards: Recreational Use	SEWRPC Proposed Water Quality Standards: Warmwater Fish and Aquatic Life	SEWRPC Proposed Water Quality Standards: Coldwater Fish and Aquatic Life
Maximum Temperature (°F)	-	89[a]	-[a,b]	-	89[a]	-[a,b]
pH Range (s.u.)	-	6.0-9.0[c]	6.0-9.0[c]	-	6.0-9.0[c]	6.0-9.0[c]
Minimum Dissolved Oxygen (mg/l)	-	5.0	6.0[d]	2.0	5.0	6.0[d]
Maximum Fecal Coliform (counts/100 ml)	200-400[e]	-	-	200-400[e]	-	-
Maximum unionized Ammonia Nitrogen (mg/l)	-	-[e]	-[e]	-	.02	.02
Maximum Total Phosphorus (mg/l)[g]						
Streams	-	-	-	.10	-	-
Lakes	-	-	-	.02	-	-
Other	-	[h]	[h,i]	-	[h]	[h,i]

[a] There shall be no temperature changes that may adversely affect aquatic life. Natural daily and seasonal temperature fluctuations shall be maintained.

[b] There shall be no significant artificial increases in temperature where natural trout or stocked salmon reproduction is to be protected.

[c] The pH shall be within the range of 6.0 to 9.0 standard units, with no change greater than 0.5 unit outside the estimated natural seasonal maximum and minimum.

[d] Dissolved oxygen shall not be lowered less than 7.0 mg/l during the trout spawning.

[e] Shall not exceed a monthly geometric mean of 200 counts per ml based on not less than five samples per month, nor a monthly geometric mean of 400 counts per 100 ml in more than 10 percent of all samples during any month.

[f] Unauthorized concentrations of substances are not permitted that alone or in combination with other materials present are toxic to fish or other aquatic life. Maximum unionized ammonia concentrations for protection of warm water and cold water streams are .04 mg/l and .02 mg/l respectively.

[g] The values presented for lakes are the critical total phosphorus concentrations which apply only during spring, when maximum mixing is underway. In streams classified for recreational use, the total phosphorus concentrations shall not exceed 0.1 mg/l. A phosphorus standard does not apply to streams and lakes classified for limited recreational use.

[i] Streams classified as trout waters shall not be altered from natural background by effluent that influence the stream environment to such an extent that trout populations are adversely affected.

[h] Unauthorized concentrations of substances are not permitted that alone or in combination with other materials present are toxic to fish or other aquatic life. The determination of the toxicity of a substance shall be based upon the available scientific data base. References to be used in determining the toxicity of a substance shall include, but not be limited to, Quality Criteria for Water, EPA0440/9-76-003, U.S. Environmental Protection Agency, Washington, D.C., 1976, and Quality Criteria 1972, EPA-R3-73-003, National Academy of Sciences, National Academy of Engineering, U.S. Government Printing Office, Washington, D.C., 1974. Questions concerning the permissible levels, or changes in the same, of a substance, or combination of substances or undefined toxicity to fish and other biota, shall be resolved in accordance with the methods specified in Water Quality Criteria 1972 and Standard Methods for the Examination of Water and Wastewater, 14th Edition, American Public Health Association, New York, 1975, or other methods approved by the Department of Natural Resources.

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water clarity. Other problems in Wisconsin lakes associated with high phosphorus levels include low dissolved oxygen concentrations in the deeper lake waters during periods of summer or winter stratification. These reduced oxygen concentrations can affect the composition of the fish community as well as the benthic (bottom dwelling) organisms, and zooplankton (minute aquatic animals), on which some fish species feed. Nuisance growths of rooted aquatic plants can also be stimulated by high phosphorus concentrations.

Lakes are commonly classified according to their trophic status. This status reflects a level of nutrient enrichment in a lake. Oligotrophic lakes have relatively low concentrations of nutrients. These lakes are characterized by very low levels of algae and rooted aquatic plants and have generally excellent water clarity, making them excellent for general recreation. However, oligotrophic lakes often lack productive fisheries. There are relatively few oligotrophic lakes in southeastern Wisconsin. Mesotrophic lakes are moderately fertile. They can support abundant growths of algae and rooted aquatic plants, but these growths are not generally considered to create nuisance conditions restricting general recreation. Mesotrophic lakes may support productive fisheries. Eutrophic lakes are nutrient rich. In eutrophic lakes, excessive algae and rooted aquatic plant growth are common, interfering with recreation and causing aesthetic problems as well. Dissolved oxygen reduction can lead to winterkill of some fish species, and can lead to a change in the lake's fish community as cold water fish species disappear. Nonetheless, eutrophic lakes often contain very productive fisheries.

Phosphorus concentrations, chlorophyll a concentrations (a measure of algae production), and secchi depth measurements (a measure of water clarity) were used when available to assess the water quality of lakes in the watershed. Carlson's Trophic Status Index (Carlson, 1977), and a water quality index developed for Wisconsin lakes (Lillie and Mason, 1983) were used to evaluate these three parameters. These indices are presented in Table III-2.

For each lake, separate trophic status and water quality indices were calculated based on phosphorus, chlorophyll a, and secchi depth. Although theoretically the indices for each lake should agree, this is often not the case. Interrelationships between the three parameters, upon which the indices are based, are often inconsistent due to natural daily, seasonal, and annual variations that occur in lakes. To evaluate the eutrophic potential of these lakes, the theoretical chlorophyll concentrations and secchi depth "expected" in association with the measured phosporous concentrations were determined using general relationships developed for lakes in southeastern Wisconsin (Lillie and Mason, 1983).

This information, in conjunction with data concerning dissolved oxygen concentrations, extent of lake weed growths, characteristics of the fish and benthic communities, and the history of attempts to control algae and weed growths by lake residents, was used to assess the existing status of each lake. The data base is excellent for Friess Lake, North Lake, Okauchee Lake, Oconomowoc Lake, Fowler Lake, and Lac LaBelle. This data has been summarized and interpreted in five separate lake plans prepared by the Southeastern Wisconsin Regional Planning Commission (SEWRPC: 1980, 1981, 1982, 1983, 1985). These plans are referenced frequently throughout this watershed plan. Information for Pine Lake, Beaver Lake, Silver Lake, and Lake Keesus is more limited, but the same approach was used to the extent allowed by the data.

Table III-2. Apparent Water Quality Index For Wisconsin Lakes Based On Water Clarity, Chlorophyll-a Content, and Total Phosphorus Concentrations*

Water Quality Index	Water Clarity(M)	Chloro-phyll-a (ug/l)	Total Phosphorus (ug/l)	TSI Equivalent (1.)
Excellent	>6.0	<1	<1	<34
Very Good	3.0-6.0	1-5	1-10	34-44
Good	2.0-3.0	5-10	10-30	44-50
Fair	1.5-2.0	10-15	30-50	50-54
Poor	1.0-1.5	15-30	50-150	54-60
Very Poor	<1.0	>30	>150	>60

*From Lillie, R.A., and J.W. Mason. 1983. Limnological Characteristics of Wisconsin Lakes. DNR Technical Bulletin 138. 116 p.

1.After Carlson's Trophic Status Index. Ratings less than 35 are indicative of oligotrophic, or nutrient poor, lakes; ratings of 35-50 are indicative of mesotrophic, or moderately enriched, lakes; ratings higher than 50 are indicative of eutrophic, or nutrient rich, lakes.

Since the 1960s, limnologists (those who study conditions in fresh waters) have been developing computer models that allow scientists to predict how the phosphorus concentration in a lake will change as the mass loading of phosphorus to the lake is either increased or decreased. These models have been used to estimate existing nutrient loads to lakes and to estimate the phosphorus load reduction necessary to achieve desired levels of water quality (Dillon and Rigler, 1977; Garn and Perrot, 1977). The Southeastern Wisconsin Regional Planning Commission has estimated existing phosphorus loads to lakes in the region. This information was used, in conjunction with the Dillon and Rigler Model, to estimate the existing average annual phosphorus load to lakes in the Oconomowoc River Watershed. The Dillon and Rigler Model was also used to estimate the percent reduction needed to achieve the inlake phosphorus criterion of .02 milligrams per liter (mg/l) established by the planning commission (SEWRPC, 1979). In addition, the percent phosphorus load reduction needed to achieve a .03 mg/l inlake phosphorus concentration was determined. This concentration, recommended as a secondary standard for southeast Wisconsin lakes (Lillie and Mason, 1983), serves in the Oconomowoc River Watershed as a preliminary objective to be met where the .02 mg/l standard can not be achieved.

General relationships known to occur in southeastern Wisconsin lakes were used to predict the change in algae production and water clarity associated with the reduced phosphorus loadings (Lillie and Mason, 1983). This information was in turn interpreted using the Carlson Trophic Status Index and the water quality index developed by Lillie and Mason for Wisconsin lakes.

The results of water resources assessments for lakes in the Oconomowoc River Watershed are presented as part of the subwatershed discussions included in later chapters of this plan.

Streams

A variety of information is required to determine a stream's existing aquatic community and the type of aquatic community the stream is capable of supporting providing that pollution sources are controlled and necessary rehabilitative measures are taken. Necessary information includes: 1) existing stream biota, such as fish and aquatic invertebrates; 2) water quality, such as dissolved oxygen, temperature, pH (degree of acidity) and toxic materials; 3) streamflow; 4) habitat structure, including information about bank erosion, bank vegetation, channel capacity, bottom scouring and deposition, and the configuration of pools and riffles.

Principle data sources used in compiling water resource information on streams in the watershed include the areawide water quality management plan prepared for the area by the Southeastern Wisconsin Regional Planning Commission (SEWRPC, 1979); surface water resources reports prepared by the Department of Natural Resources for Washington, Waukesha, and Jefferson counties (Poff and Threinen: 1963a, 1963b, and Poff et al. 1968); biotic index data collected and analyzed by the Department of Natural Resources (DNR files), fish survey distribution data compiled for the Rock River Basin (Fago, 1982); inlet data for major lakes in the Oconomowoc chain of lakes, summarized by SEWRPC in its lake management reports (SEWRPC: 1980, 1981, 1982, 1983, 1985); and Department of Natural Resources file information collected during past water resources assessments.

Table III-3. Water Quality Determinations From Biotic Index Values*

HBI Range	Water Quality	Degree of Organic Pollution
0-1.75	Excellent	None
1.76-2.25	Very Good	Slight
2.26-2.75	Good	Some
2.76-3.50	Fair	Significant
3.51-4.25	Poor	Very Significant
4.26-5.00	Very Poor	Severe

*From: Hilsenhoff,W. 1982. Using A Biotic Index To Evaluate Water Quality In Streams. DNR Technical Bulletin 132. 22 p.

An evaluation system for classifying the use potential of streams has been developed by the Wisconsin Department of Natural Resources (Ball, 1982). Although the information needed to make a formal evaluation is generally not available for streams in the Oconomowoc River Watershed, some of the interpretive criteria contained in the stream classification guidelines were applied to the available data in order to prepare a general assessment of streams in the watershed. In addition, water quality standards and criteria, presented in Table III-1, were used in assessing the existing condition of the water resources in the watershed.

Assessing the existing community of aquatic macroinvertebrates is part of the stream assessment procedure. The Hilsenhoff Biotic Index (Hilsenhoff, 1982) is an interpretive tool commonly used in Wisconsin to assess the water quality conditions in streams. The index is based on the fact that certain species of macroinvertebrates are very tolerant of organic pollution, while others are very sensitive to it. In the absence of organic pollution, the macroinvertebrate community will be diverse and represented mainly by organisms that are intolerant of pollution. Organic pollution puts these sensitive organisms at a competitive disadvantage, and the composition of the macroinvertebrate community shifts to favor the pollution-tolerant forms. The macroinvertebrate community is a continuing record of past water quality impacts, and as such provides a more reliable means of assessing water quality than periodic sampling for water chemistry. Table III-3 presents the range of calculated index values and their association with varying levels of organic pollution.

The results of water resources assessments for streams in the Oconomowoc River Watershed are presented as part of the subwatershed discussions included in later chapters of this plan.

STEP TWO: ASSESSMENT OF NONPOINT POLLUTANT SOURCES

The objectives of the nonpoint source assessment are to identify sources of urban and rural nonpoint pollutants, and to determine the relative contribution that each source makes towards the pollution problem so that a control strategy can be developed.

Site specific pollutant sources were identified in each of five separate categories: 1) upland sheet and rill erosion, 2) streambank and lakeshore erosion, 3) barnyard runoff, 4) winterspread manure runoff, and 5) urban runoff. The inventory and assessment of existing urban area conditions was conducted by the Southeastern Wisconsin Regional Planning Commission. Waukesha County was responsible for conducting the inventory in the rural areas, consistent with guidelines established by the Department of Natural Resources. Assistance was provided by the Washington and Jefferson County Land Conservation Committee (LCC) staffs for their respective counties.

The Oconomowoc River Watershed was divided into subwatersheds for purposes of data collection. This allowed for the evaluation of each pollution source in terms of its impact on a specific waterbody. Because there are a large number of lakes and several important stream segments in the watershed, 19 subwatersheds were delineated, as mentioned earlier. These subwatersheds are shown in Map II-1.

Table III-4. Portions of the Oconomowoc River Priority Watershed Inventoried For Nonpoint Pollution Sources

Subwatershed Name	Subwatershed Area (ac.)(1.)	Urban Area Inventoried (ac.)	Percent of Subwatershed	Rural Area Inventoried (ac.)	Percent of Subwatershed	Total Inventory Area (ac.)	Percent of Subwatershed
Coney River	11607	637	5.5%	4865	41.9%	5502	47.4%
Friess Lake	969	144	14.9%	254	26.2%	398	41.1%
Flynn Creek	3259	100	3.1%	1640	50.3%	1740	53.4%
Upper Ocon. River	8722	382	4.4%	3349	38.4%	3731	42.8%
Little Ocon. River	7604	394	5.2%	4025	52.9%	4419	58.1%
Mason Creek	5227	87	1.7%	1690	32.3%	1777	34.0%
Lake Keesus	2651	379	14.3%	744	28.1%	1123	42.4%
North Lake	2080	361	17.4%	379	18.2%	740	35.6%
Beaver Lake	1398	619	44.3%	309	22.1%	928	66.4%
Pine Lake	2222	491	22.1%	193	8.7%	684	30.8%
Moose Lake	650	138	21.2%	137	21.1%	275	42.3%
Okauchee Lake	6868	1538	22.4%	1823	26.5%	3361	48.9%
Oconomowoc Lake	2760	731	26.5%	586	21.2%	1317	47.7%
Silver Lake	1373	103	7.5%	282	20.5%	385	28.0%
Fowler Lake	1425	794	55.7%	512	35.9%	1306	91.6%
Rosenow Creek	3249	354	10.9%	1389	42.8%	1743	53.6%
Lac LaBelle	4583	847	18.5%	2259	49.3%	3106	67.8%
Battle Creek	5137	88	1.7%	3115	60.6%	3203	62.4%
Lower Ocon. River	10072	598	5.9%	5461	54.2%	6059	60.2%
TOTAL WATERSHED	81856	8785	10.7%	33012	40.3%	41797	51.1%

1. Surface areas of lakes are included in subwatershed acreages.

The portion of the pollutants generated by a source that actually gets delivered to a waterbody is expressed as a delivery ratio. The delivery ratio is usually far less than 100 percent, and is dependant on a complex interaction of factors including: 1) rainfall and runoff dynamics, and 2) the flow distance, land cover, and topography between the pollutant source and the receiving water. The delivery ratio could not be modelled for every site generating pollutants in the watershed. An assumption is therefore implied in the analysis that all sites of cropland erosion and all critical lands where winterspreading of manure occurs will have a similar pollutant delivery ratio in any given subwatershed, provided the sites are all relatively close to a pollutant conveyance channel such as a stream or ditch.

Prior to conducting the rural inventory, the intermittent and perennial channel network, including lakes, was delineated for the watershed by the Southeastern Wisconsin Regional Planning Commission. An inventory corridor was then delineated to include all lands within 1/8 mile, or 660 feet, from the edge of a channel or the landward edge of an associated wetland. This corridor was also established around the urban areas in the watershed. Lands outside the corridor were generally not inventoried, since their pollutant contribution in a watershed with soils and topography like that of the Oconomowoc was considered to be negligible. An exception was made for barnyards. All barnyards were inventoried because the assessment tool used contains an evaluation of overland buffering effects on pollutant delivery.

The proportion of rural lands inventoried in each subwatershed is presented in Table III-4.

Rural Upland Erosion Inventory

Upland erosion is a major contributor of sediment to streams and lakes in the watershed. Suspended sediment can make it difficult for some fish to feed, and can cause gill abrasion and increased susceptibility to disease. In addition, suspended sediment can contribute to elevated water temperatures and lowered dissolved oxygen concentrations. Sediment that settles out in streams can destroy fish habitat by covering spawning areas and filling in pools needed for cover. Sediment settling out in lakes can decrease the depth of bays and provide large areas conducive to the growth of rooted aquatic weeds. Soil eroded from cropland also carries plant nutrients and pesticides into waterways, leading to eutrophication and toxic conditions for aquatic biota.

Rural sheet and rill erosion was quantified for all croplands, woodlots, pastures, and grasslands in the inventory corridor. The Universal Soil Loss Equation was used, which provided an estimate of the average annual unit area soil loss (tons/acre/year or t/a/y) for each parcel inventoried. Parcels were delineated based on homogeneity of the land characteristics, landownership, and subwatershed. Over 2,000 parcels, ranging in size from one to 25 acres, were assessed using this technique. In most cases, these 2000 parcels were farm fields. An additional 1000 parcels, including wetland and farmstead land uses, were inventoried but soil loss was not calculated.

This data was used for several purposes. It was used to calculate general land use and soil loss characteristics in the nineteen subwatersheds. This information is presented in Tables III-5 and III-6. The information was also

Table III-5. Agricultural Land Use Distribution in Subwatersheds of the Oconomowoc River Watershed(1.)

Land Use		UpOc Ri.	LoOc Ri.	Friess L.	Coney Ri.	Flynn Cr.	LitOc Ri.	Keesus L.	Mason Cr.	North L.	Beaver L.	Pine L.	Okau L.	Silver L.	Battle Cr.	LaBelle L.	Moose L.	Ocon L.	Rosenow Cr.	Fowler L.	WATERSHED
Continuous Row Crop	Acres	119	881	0	899	165	299	166	315	22	18	18	346	76	613	946	0	156	214	176	5429
	% Total	4%	16%	0%	18%	10%	7%	22%	19%	6%	6%	9%	19%	27%	20%	42%	0%	27%	15%	34%	16%
Rotated Row Crop	Acres	796	1953	88	1765	628	815	298	503	68	56	10	640	9	880	215	3	22	679	16	9444
	% Total	24%	36%	35%	36%	38%	20%	40%	30%	18%	18%	5%	35%	3%	28%	10%	2%	4%	49%	3%	29%
Woodlot	Acres	746	281	78	531	319	910	112	74	250	84	75	227	70	377	143	88	163	38	7	4573
	% Total	22%	5%	31%	11%	19%	23%	15%	4%	66%	27%	39%	12%	25%	12%	6%	64%	28%	3%	1%	14%
Pasture	Acres	25	74	7	81	8	141	2	61	0	27	3	81	50	58	20	0	25	45	0	808
	% Total	1%	1%	3%	2%	0%	4%	0%	4%	0%	9%	2%	4%	18%	2%	1%	0%	4%	3%	0%	2%
Wetland	Acres	1322	1837	48	1151	366	1574	83	699	34	5	16	224	38	902	708	15	159	300	226	9707
	% Total	39%	34%	19%	24%	22%	39%	11%	41%	9%	2%	8%	12%	13%	29%	31%	11%	27%	22%	44%	29%
Grassland	Acres	301	361	27	302	108	232	72	15	5	119	71	295	37	280	205	31	61	88	85	2695
	% Total	9%	7%	11%	6%	7%	6%	10%	1%	1%	39%	37%	16%	13%	9%	9%	23%	10%	6%	17%	8%
Farmstead	Acres	40	74	6	136	46	54	11	23	0	0	0	10	2	5	22	0	0	25	2	462
	% Total	1%	1%	2%	3%	3%	1%	1%	1%	0%	0%	0%	1%	1%	0%	1%	0%	0%	2%	0%	1%
TOTAL ACRES		3349	5461	254	4865	1640	4025	744	1690	379	309	193	1823	282	3115	2259	137	586	1389	512	33118
		10%	16%	1%	15%	5%	12%	2%	5%	1%	1%	1%	6%	1%	9%	7%	0%	2%	4%	2%	

1. Land Use Distribution is for the inventory corridor only.

used to determine the percent pollutant load reduction that could most likely be achieved in each subwatershed, the acres and types of control practices needed, and the relative importance of each landowner in meeting the subwatershed pollutant load reduction objectives.

Only a portion of the existing total soil loss in each subwatershed can be controlled with conservation practices, since even well managed land loses soil. In the Oconomowoc River Watershed, a target level representing a generally acceptable soil loss tolerance was chosen based on water quality considerations and on what conservation practices landowners would most likely accept. This target level was developed for two purposes: as a design goal to be used in the application of management practices, and as a determinant in assessing the relative pollution potential posed by each landowner in any given subwatershed. The tolerable, or target, soil loss chosen was three tons/acre/year. This level is consistent between subwatersheds due to concerns by the local land conservation staff that a consistent approach be used during plan implementation.

Table III-7 shows the percent soil loss reduction achievable for each subwatershed in the Oconomowoc River Watershed, and the acreages of conservation practices that will be needed. The table assumes that reduced tillage placed on the contour will be the major cropland practice used, along with some woodlot fencing and pasture management. Although other practices were not assumed in preparing Table III-7, the table shows that additional practices will be needed to reduce all unit area erosion rates to three tons/acre/year. Although other practices are eligible for cost sharing, they were not expected to receive widespread use and hence were not used in preparing the table.

Detailed results of cropland erosion potential and a strategy for controlling cropland erosion is presented in the chapters on individual subwatersheds.

Gully erosion was not assessed as part of the inventory, due to a lack of inventory techniques, and problem areas will be identified by local staffs during the implementation of this plan.

Barnyard Runoff Inventory

Runoff from barnyards carries nutrients, organic materials, and pathogens which can cause water quality problems. Nutrients will promote weed and algae growth in lakes and streams. The organic materials use oxygen from the water as they decompose, and can seriously deplete the oxygen that the fish and other aquatic populations need to thrive. The pathogens found in livestock waste can be harmful to both other livestock and humans if carried in sufficient quantities to lakes and streams.

A variety of factors determines the potential of an individual barnyard to pollute surface waters. One factor is the amount of manure generated on the barnyard surface, which is determined by the number and type of animals, how much time they spend in the barnyard, and the size of the barnyard surface. A second factor is the amount of water that flows across the barnyard during a rainfall event. This water transports the pollutants to the edge of the barnyard. The volume of water depends on the acreage and land cover of the

Table III-6. Soil Erosion In the Rural Inventory Corridor, Oconomowoc River Priority Watershed.

Subwatershed	Upland Erosion (Tons/Year)	Percent of Soil Erosion Coming From Lands Losing: 0-3 T/A/Y*	3-5 T/A/Y	5-10 T/A/Y	Over 10 T/A/Y
Coney R.	7428	52	18	16	14
Friess L.	316	74	26	0	0
Flynn Cr.	3564	28	7	42	23
Upper. Ocon. R.	3235	60	19	7	14
Little Ocon. R.	4873	32	19	34	15
Mason Cr.	2134	61	30	9	0
Keesus L.	1382	32	28	39	0
North L.	339	54	7	39	0
Beaver L.	301	51	11	29	9
Pine L.	199	29	0	71	0
Moose L.	36	100	0	0	0
Okauckee L.	2030	31	2	54	13
Oconomowoc L.	1682	8	1	73	18
Silver L.	564	26	0	74	0
Fowler L.	1661	16	4	62	18
Rosenow Cr.	2894	41	24	34	0
LaBelle L.	13006	7	3	18	72
Battle Cr.	3614	51	5	44	0
Lower Ocon. R.	9859	32	16	17	35

*Tons/Acre/Year

1. Statistics do not include erosion on internally drained lands.

area draining to the barnyard. Finally, the effectiveness of the lands between the barnyard and a channel in filtering pollutants from the runoff water will have a significant impact on the pollution potential of the barnyard. The length of the filtering area, its land cover, and its slope all affect this ability to buffer pollutants. Because all of these factors vary from one barnyard to the next, the relative pollution potential of barnyards is not easy to assess without a quantitative tool that considers all of these factors.

A model developed by the Agriculture Research Service (Young et al., 1982) and modified by the Wisconsin Department of Natural Resources was used in the Oconomowoc River Watershed to determine the relative pollution potential of barnyards. The model simulates the mass loading of total phosphorus and chemical oxygen demand from each barnyard to the nearest waterway. The 10 year-24 hour rainfall event was used in assessing the relative pollution potential of barnyards in each subwatershed. Phosphorus was used as the primary indicator, since phosphorus loading to surface waters is a key concern in this watershed. It is important to note that the numbers generated by the model are being used to determine the relative importance of each barnyard, not to quantify actual pollutant loads.

Table III-8 summarizes the distribution of barnyards in the watershed, and the proportion of barnyards that are of concern for purposes of surface water protection.

More detailed results of the barnyard runoff model are presented in the following chapters.

Manure Spreading Inventory

The improper storage and spreading of manure can result in the same water quality problems as barnyard runoff. Although manure runoff to surface waters can occur at any time of the year, the period of greatest concern is during the spring when winterspread manure can be carried to surface waters by runoff.

Not all lands pose the same risk when winterspread with manure. In general, manure should only be applied to frozen soils if they have slopes less than six percent and are protected from upslope runoff. In addition, manure should not be applied within the 10 year floodplain, or within 200 feet of lakes or streams, unless it is immediately incorporated into the soil. If these sensitive areas are avoided during the winter, and if application rates are consistent with the crop needs and the existing soil fertility, then the pollutant load from manure-spread lands to the surface waters in the watershed should be minimized (Petersen et al., 1984).

Information collected during the upland sheet and rill erosion inventory was combined with that collected during the barnyard runoff inventory to develop an indicator of the pollution potential associated with manure spreading for each landowner owning livestock in the watershed. The indicator chosen is the expected number of critical acres spread by each livestock operator in the inventory corridor during the winter period.

Table III-7. Estimated Upland Sheet and Rill Erosion In the Oconomowoc River Priority Watershed, And the Potential Reduction Resulting From Proposed Controls(1.)

Subwatershed	Estimated Existing Soil Loss (t/y)	Predicted Soil Loss With Practices (t/y)	Predicted Soil Loss Reduction (t/y)	Predicted % Change in Soil Loss	Acres of Basic Conservation Tillage	Acres of Modified No-Till	Acres of Pasture Management	Acres of Woodlot Fencing	TOTAL ACRES NEEDING TREATMENT	Number of Acres Where Specified Practices Will Not Be Adequate	Additional Tons of Soil Loss Control Needed To Meet 3 T/A/Y Target On All Lands
Coney Ri.	7428.0	5124.0	2304.0	31%	513.0	0.0	22.0	44.0	579.0	115.0	191.0
Freiss L.	316.0	257.0	59.0	19%	10.0	0.0	8.0	0.0	18.0	0.0	0.0
Flynn Cr.	3564.0	2328.0	1236.0	35%	323.0	0.0	0.0	0.0	323.0	179.0	475.0
Upper Oc. Ri.	3235.0	2347.0	888.0	27%	221.0	0.0	0.0	0.0	221.0	34.0	60.0
Little Oc. Ri.	4873.0	2756.0	2117.0	44%	450.0	0.0	90.0	0.0	540.0	150.0	179.0
Mason Cr.	2134.0	1547.0	587.0	28%	182.0	0.0	11.0	0.0	193.0	9.0	13.0
L. Keesus	1382.0	638.0	744.0	54%	183.0	0.0	0.0	0.0	183.0	0.0	0.0
North L.	339.0	224.0	115.0	34%	15.0	0.0	0.0	0.0	15.0	0.0	0.0
Beaver L.	301.0	204.0	97.0	32%	14.0	0.0	4.0	0.0	18.0	2.0	21.0
Pine L.	199.0	91.0	108.0	54%	18.0	0.0	0.0	0.0	18.0	0.0	0.0
Moose L.	36.0	36.0	0.0	0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
L. Okauchee(2.)	2030.0	1095.0	935.0	46%	108.0	0.0	18.0	0.0	126.0	0.0	0.0

Table III-7 Continued.

Subwatershed	Estimated Existing Soil Loss (t/y)	Predicted Soil Loss With Practices (t/y)	Predicted Soil Loss Reduction (t/y)	Predicted % Change in Soil Loss	Acres of Basic Conservation Tillage	Acres of Modified No-Till	Acres of Pasture Management	Acres of Woodlot Fencing	TOTAL ACRES NEEDING TREATMENT	Number of Acres Where Specified Practices Will Not Be Adequate	Additional Tons of Soil Loss Control Needed To Meet 3 T/A/Y Target On All Lands
Ocon. Lake	1682.0	402.0	1280.0	76%	140.0	16.0	7.0	0.0	163.0	0.0	0.0
Silver L.	564.0	223.0	341.0	61%	43.0	0.0	0.0	0.0	43.0	0.0	0.0
L. Fowler	1661.0	616.0	1045.0	63%	174.0	0.0	6.0	0.0	180.0	16.0	90.0
Rosenow Cr.	2894.0	1653.0	1241.0	43%	249.0	0.0	23.0	0.0	272.0	20.0	3.0
LacLaBelle	13006.0	3270.0	9736.0	75%	491.0	267.0	9.0	0.0	767.0	139.0	784.0
Battle Cr.	3614.0	2184.0	1430.0	40%	248.0	0.0	11.0	0.0	259.0	0.0	0.0
Lower Oc. Ri.	9859.0	4798.0	5061.0	51%	662.0	91.0	9.0	0.0	762.0	81.0	260.0
AREAS DRAINING TO:											
FREISS LAKE(3.)	7744.0	5381.0	2363.0	31%	523.0	0.0	30.0	44.0	597.0	115.0	191.0
NORTH LAKE(3.)	14145.0	9202.0	4943.0	35%	1191.0	0.0	101.0	0.0	1292.0	372.0	727.0
LAC LABELLE(3.)	15900.0	4923.0	10977.0	69%	740.0	267.0	32.0	0.0	1039.0	159.0	787.0
LOWER OC. RI.(3.)	13473.0	6982.0	6491.0	48%	910.0	91.0	20.0	0.0	1021.0	81.0	260.0

1.Conservation tillage, woodlot management, and pasture practices needed to reduce soil loss to 3 t/a/y.
2. Statistics do not include data from internally drained areas.
3.See text for contributing subwatersheds.

Table III-8. Barnyard Runoff To Surface Waters In The Oconomowoc River Watershed

Subwatershed	Total Number of Livestock Operations	Number of Internally Drained Operations	Operations Discharging to Surface Waters	
			Number Having Zero Phosphorus Loading	Number Having Some Phosphorus Loading
Coney River	31	12	8	11
Freiss L.	3	0	0	3
Flynn Cr.	4	0	1	3
Upper Oc. Riv.	5	2	1	2
Little Oc. Riv.	11	4	3	4
Mason C.	12	4	5	3
Lake Keesus	6	2	3	1
North Lake	1	0	0	1
L. Okauchee	5	3	1	1
Silver L.	1	0	0	1
Rosenow C.	4	2	1	1
LacLaBelle	2	1	1	0
Battlr C.	7	6	1	0
Lower Oc. Ri.	13	3	1	9
AREAS DRAINING TO:				
FREISS LAKE(2.)	34	12	8	14
NORTH LAKE(2.)	33	10	10	13
LAC LABELLE(2.)	6	3	2	1
LOWER OC. RI.(2.)	20	9	2	9

1. Although runoff water from these barnyards reaches surface waters, the barnyards are so well buffered that phosphorus concentrations are reduced completely before reaching the channel network.
2. See text for a listing of subwatersheds in each of these areas.

This indicator was developed for each landowner, taking into consideration the mass of manure produced over a six month period, the number of acres per year needed to spread the manure (assuming an application rate of 25 tons of manure/acre/year), and the proportion of cropland acres on the farm that are critical either because of their slope or their proximity to a stream, lake, or pollutant conveyance channel. Random spreading of manure on the available cropland acreage owned by the landowner was assumed, since more detailed information was not available. The basic results of manure spreading activities in the Oconomowoc River Watershed are summarized, by subwatershed, in Table III-9. This table does not take into account the potential hazard posed by improper waste storage and spreading during other times of the year. Where such problems exist, they will be identified during project implementation.

More detailed information concerning the importance of manure spreading as a pollutant source is presented in following chapters which discuss subwatersheds in the Oconomowoc River Watershed.

Urban Area Assessment

To assess the potentially complex picture of urban runoff in the watershed, a computer program called the Wisconsin Urban Runoff Model (WURM) was used. This model was developed to predict pollutant loadings from urban areas (Hansen, et al., 1983). Data required as input to the model include: 1) land use, such as the density of residential development or the presence of commercial or industrial areas; 2) percent impervious surfaces; 3) percent directly connected impervious surfaces; 4) amount of vehicle traffic; 5) atmospheric fallout of pollutants; 6) rainfall characteristics; and 7) soil characteristics. For areas where soil loss may occur, information necessary to operate the Universal Soil Loss Equation (USLE) was also collected.

Information generated by the model includes the expected runoff due to precipitation and the concentrations and loadings of pollutants contained in the runoff water. Pollutants assessed using the model include suspended solids, nitrogen, phosphorus, and lead.

The WURM model was used to simulate the pollutant loads coming from storm sewered areas within the City of Oconomowoc. This area covers about one-half the storm-sewered area in the Oconomowoc River Watershed, and drains primarily to Fowler Lake, Lac LaBelle, and the Oconomowoc River below the Lac LaBelle Dam. This simulation area was divided into 47 separate drainage basins for purposes of data collection, based on urban storm sewer basin divides and land use.

Pollutant loadings were simulated for each of the 47 basins. This information was in turn used to simulate loadings in other urban areas throughout the watershed, by calculating unit area loads for the 47 areas and applying them appropriately to other urban lands in the inventory corridor.

Urban area loadings of suspended solids, nitrogen, phosphorus, and lead were thus estimated for all of the 19 major subwatersheds in the Oconomowoc River Watershed. In storm sewered areas, most of the estimated pollutant loading can be expected to make its way to surface waters. In areas that are not

Table III-9. Pollution Hazard Posed By Estimated Extent Of Winterspread Manure In The Oconomowoc River Priority Watershed(1.).

	Coney River	Freiss Lake (Direct)	Upper Ocon. River	Flynn Creek	Little Ocon. River	Mason Creek	North Lake (Direct)	Lake Kesus	Lake Okauchee	Rosenow Creek	Lac LaBelle (Direct)	Silver Lake	Battle Creek	Lower Ocon. River	TOTAL
Number of Operators Spreading Manure In The Subwatershed	25	1	1	4	8	10	1	3	4	4	2	0	5	12	81
Number of Operators Winterspreading Manure On Critical Acres	23	0	1	4	6	10	0	1	0	4	1	0	3	10	63
Total Number of Critical Acres Winterspread With Manure	233	0	1	22	45	34	0	13	0	19	18	0	4	49	438
Acres Within 200 Feet of A Channel	71	0	1	7	23	34	0	13	0	16	18	0	3	33	229
Acres On Slopes Of 6% or Greater	162	0	0	15	22	0	0	0	0	3	0	0	1	16	219

1. Estimates are based on the size of the animal herd for each operator, and the proportion of his lands that is critical. Actual inventories of where each landowner spreads his manure were not made.
2. Pollution hazards may occur where manure is improperly stored or spread at during other seasons of the year. Hazards other than those posed by winterspreading were not assessed, but will be controlled through the Nonpoint Source Program where found.

sewered, which includes most of the urban area outside the City of Oconomowoc, the proportion of the estimated pollutant load that actually makes it to surface waters will vary greatly.

Table III-4 shows the percent of the urban area contained in the inventory corridor for each subwatershed. Table III-10 shows the unit area loads for the major urban pollutants used to estimate the pollutant loading in each of the subwatersheds where the WURM was not used directly. Table III-11 shows the estimated pollutant loadings generated within the urban inventory corridor.

More detailed information on urban pollutant generation and the potential for its control is presented in following chapters concerning subwatersheds in the Oconomowoc River Watershed.

STEP THREE: DEVELOPING THE CONTROL STRATEGY

As mentioned in the introduction to this chapter, developing a nonpoint source control strategy for the Oconomowoc River Priority Watershed Project was a three step process. So far, step one, the identification of water quality problems and pollutants, and step two, the inventory of rural and urban nonpoint pollutant sources have been discussed. This section is a discussion of the third step, which involves using the information collected to develop the control strategy. Specific details for each subwatershed are discussed in Chapters IV through XIII.

Phosphorus is contributed by many sources in the watershed. Ideally, the actual phosphorus contribution from each pollution site in the watershed would be known, and the information would be used to develop a control strategy. This information is not generally known, however. Instead, the methods described in this chapter are generally limited to to evaluating the relative importance of sites within a source category. For example, the Agriculture Research Service (ARS) model can be used to identify the relative importance of several barnyards, but it cannot be used at this time to calculate the actual phosphorus load from a barnyard, and cannot be used to compare a barnyard with, say, an eroding farm field. Likewise, the soil loss on uplands in the watershed can be used to indicate the relative pollution potential of upland sites, but cannot be used to determine site specific phosphorus loadings.

In light of these limitations in our knowledge of absolute pollutant loadings, the following method was chosen to determine the best approach to controlling phosphorus. First, <u>the relative importance of major source categories</u>, such as barnyard runoff, cropland erosion, manure spreading, urban runoff, septic systems, and atmospheric deposition, was determined. Second, <u>the relative importance of specific sites within each category</u> was determined, by ranking sites from the highest to the lowest pollution potential within each source. Using these estimates, the percent reduction in the phosphorus loading to a waterbody can be estimated given a percent reduction from each source category.

The results of this analysis are presented in the subwatershed discussions for each lake, which follow in later chapters of this plan.

Table III-10. Oconomowoc River Watershed: Representative Unit Area Pollutant Loads From Urban Land Uses(Pounds/Acre/Year)

Land Use Category	Suspended Solids	Total Nitrogen	Total Phosphorus	Lead
Low Density Residential	20	0.6	0.04	0.01
Medium Density Residential	160	2.0	0.41	0.18
High Density Residential	300	4.0	0.84	0.42
Commercial	700	7.5	1.54	1.56
Industrial	490	5.5	0.85	1.28
Recreation	30	0.6	0.04	0.07
Construction	1570	19.2	2.97	0.08
Open Land	20	0.4	0.04	0.01

Determining The Relative Importance Of Source Categories

Phosphorus is the principle pollutant for which the relative contribution of source categories was determined. An estimate of the total phosphorus load was made for each category, then a percentage was calculated for each based on its contribution to the whole. The calculations were done for each subwatershed. The loading from urban areas was taken directly from Table III-11. The contribution from septic systems was determined only for the direct drainage area to lakes, and was taken from the lake management plans prepared by the SEWRPC. Atmospheric deposition of phosphorus to each lake has also been calculated by the SEWRPC.

Rural sources of phosphorus include barnyard runoff, stacked manure, winterspread manure, and upland runoff. Upland runoff in turn contains phosphorus that is associated with eroded soil, and phosphorus that moves independently of eroded soil. Techniques to determine the relative phosphorus contribution from these agricultural sources were developed for the southeastern portion of Wisconsin, and have been applied to small watersheds in Washington County (Miller, 1979; Moore, 1979; Madison, et al., 1979). These techniques were applied to data collected from the inventory corridor in the Oconomowoc River Watershed.

Determining the Relative Importance of Sites Within Each Source Category

In order to determine the relative importance of sites within each source category, landowner lists for each subwatershed were first prepared, then the proportion of the source category pollutant load contributed by each site was determined. The landowners for each source category were ranked based on this relative contribution so that the most important sources appear first on the list and the least important sources appear last. Landowner rankings in each source category were based on the following information:

1. Barnyard runoff: pounds of phosphorus produced, as determined by the ARS Model,

2. Cropland runoff: portion of the soil loss occurring at a rate exceeding three tons/acre/year. This portion was totalled for each farm and expressed as "tons soil loss targeted for control/farm/year".

3. Runoff of winterspread manure: the number of critical acres estimated to be spread per year.

4. Roadside, streambank, lakeshore erosion: inventory data is subjective, and therefore no rankings were developed.

Some of the subwatersheds were combined for this data analysis. The direct drainage area to Friess Lake was combined with the Coney River Subwatershed in order to develop the ranking for pollutant sources affecting Friess Lake. Five subwatersheds were combined to assess the impacts on North Lake. These are the Little Oconomowoc River, Upper Oconomowoc River, Mason Creek, Flynn Creek, and the North Lake subwatersheds. The Battle Creek Subwatershed and the Lower Oconomowoc River Subwatershed were also combined for ranking landowners affecting the Lower Oconomowoc River.

Table III-11. Pollutant Generation (Pounds) In The Oconomowoc River Watershed Urban Inventory Corridor(1.)

Subwatershed	Suspended Solids	Total Nitrogen	Total Phosphorus	Lead
Coney R.	35800	590	75	43
Friess L.	10300	160	25	12
Flynn Cr.	5800	90	12	9
Upper. Ocon. R.	26400	410	55	44
Little Ocon. R.	14700	290	28	6
Mason Cr.	3800	70	8	1
Keesus L.	24400	390	58	27
North L.	30200	460	69	39
Beaver L.	37000	610	86	42
Pine L.	19900	430	39	23
Moose L.	17500	230	41	26
Okauckee L.	312100	4390	655	254
Oconomowoc L.	40200	700	80	56
Silver L.	12100	160	28	24
Fowler L.	130000	*	260	196
Rosenow Cr.	10500	*	20	10
LaBelle L.	54500	*	106	65
Battle Cr.	2000	*	4	1
Lower Ocon. R.	71200	*	50	73

1.Based upon precipitation data for 1981.
The pollutant loads generated in the Fowler Lake, LacLaBelle, and Lower Oconomowoc River Subwatersheds will have a high degree of delivery to surface waters since these areas are served to a significant extent by storm sewers. Other subwatersheds will experience less delivery, and hence actual loading will be less than those shown in this table.

*Not calculated

The Priority Management Area

The Priority Management Area (PMA) is that area in which nonpoint pollutant sources, including those known at this time and those yet to be discovered, are eligible for cost sharing. For upland erosion, improper manure spreading, and urban areas outside the City of Oconomowoc, the Priority Management Area is considered to be a corridor one-eighth mile wide on either side of the defined channel network. In the City of Oconomowoc, this corridor was expanded to include any lands draining to the storm sewer network. The Priority Management Area for barnyards is not limited to this corridor. Any barnyard that contributes pollutants to the surface channel network can be considered in the Priority Management Area.

Pollutant Management Categories

In the Nonpoint Source Control Program, each landowner must agree to control all of the significant nonpoint pollutant sources, or cost sharing assistance will be denied. This is known as the "total package approach".

In any pollutant source category, such as barnyard runoff or cropland erosion, some sites are relatively important whereas others are relatively insignificant. Management categories have been developed for sites within each pollutant source category to guide the project staff in making decisions concerning what pollutant sites must be controlled as part of any cost share agreement. Each management category is described below.

> Management Category I is reserved for specific sources that comprise a significant portion of the pollutant load to the waterways within a subwatershed. Sources in this management category are eligible for cost sharing, and in fact must be controlled as part of any cost share agreement.
>
> Management Category II is reserved for eligible, but less significant sources. These sources are eligible for cost sharing, but the inclusion of practices on the cost share agreement is optional. The project staff should strongly encourage the inclusion of practices for these sources on cost share agreements, since control of these sources is needed to meet the water quality objectives.
>
> Management Category III sources are not eligible for cost sharing.

Management categories have been assigned to each site inventoried in the Oconomowoc River Watershed. Project staff will assign a management category to any new source identified during implementation. In addition, management categories assigned to specific sites in this plan may be amended by project staff to reflect changes in existing land management, so long as the amendments are made consistent with decision criteria established for each subwatershed.

WATERSHED ASSESSMENT

C. SUBWATERSHED POLLUTANT SOURCES, WATER RESOURCES OBJECTIVES AND CONTROL STRATEGIES

(CHAPTERS IV - XIII)

CHAPTER IV

THE AREA DRAINING TO FRIESS LAKE:
The Coney River Subwatershed
Friess Lake Subwatershed

EXISTING WATER RESOURCE CONDITIONS

The area draining to Friess Lake includes two subwatersheds. The Coney River Subwatershed encompasses 11,607 acres, making it the largest in the Oconomowoc River Watershed. The Friess Lake Subwatershed, including the surface area of the lake, covers 969 acres. Water resources in the area draining to Friess Lake include Mud Lake, the Coney River, the Oconomowoc River above Friess Lake, and Friess Lake. These subwatersheds are shown on Map II-1 in Chapter II.

Mud Lake

Mud Lake is a 23 acre landlocked lake formed in a kettle basin located near the headwaters of the Coney River. The maximum depth of Mud Lake is only five feet, and it is approaching extinction from rapidly encroaching wetlands. Winterkill of fish is common, and the lake's main benefit is for supporting waterfowl. There is no public access to Mud Lake.

Coney River and the Oconomowoc River Above Friess Lake

The Coney River originates just south of Mud Lake in the Town of Richfield and flows 6.2 miles towards its confluence with the Oconomowoc River. The main channel of the river is extensively ditched, and is in turn fed by an extensive system of agricultural drainage ditches that drain the organic soils prevalent in this area.

Recent water quality information is not available for the Coney River. The fish community, however, was sampled in 1976 at the Pleasant Hill Road bridge located in section 4 of Richfield Township (Fago, 1982). Seventeen species of fish were collected. The fish community sample showed a mix of species tolerant and intolerant of water pollution. There were seven species of forage fishes that need fairly clean water to thrive. These included several species of daces and darters. Those species intolerant of water pollution dominated the community. No endangered or watch species were found.

The Oconomowoc River originates in Section 10 of Richfield Township, receiving flow at its headwaters from several agricultural drainage ditches. The river flows five miles before entering Friess Lake. The upper half of the river has been straightened, while the lower portion, below Pleasant Hill Road, retains much of its natural meander. A major drainage channel enters the river from the north in section 8 of Richfield Township.

The Oconomowoc River was sampled biweekly from May 1976-April 1977 at the U.S. Highway 167 bridge located .5 miles north of the lake (SEWRPC, 1983). Dissolved oxygen concentrations ranged from 2.4-15.2 milligrams per liter (mg/l); 20 percent of the samples showed dissolved oxygen concentrations below the 5 mg/l standard established to support full fish and aquatic life uses. Dissolved oxygen saturations varied from a low of 27 percent to a high of 168 percent. This wide variation is typical of nutrient-enriched waters where heavy plant growths occur. Decomposing organic materials may also be partly responsible for the low saturations measured. The total phosphorus concentrations measured during this period also indicate a nutrient-rich river. Concentrations averaged 1.0 mg/l, ranging from <.01 mg/l to .31 mg/l. Finally, bacteriological samples show counts ranging as high as 80,000 MFFC/100ml (Membrane Filter Fecal Count) sample; 40 percent of the samples exceeded 400 MFFC/100 ml sample.

In 1979 the Department of Natural Resources collected aquatic invertebrates from the river at the U.S. Highway 167 bridge in order to assess the overall water quality. The biotic index was 2.87 for the spring sample, and 2.61 for the fall sample, indicating fair to good water quality.

Although the resident fish community in this portion of the Oconomowoc River is restricted to forage species, the wetlands along the river near Friess Lake are used as spawning grounds by northern pike.

Friess Lake

Friess Lake is the first of six major lakes in a chain connected by the Oconomowoc River. The lake has a surface area of 119 acres, an average depth of 26 feet, and a maximum depth of 48 feet. The Oconomowoc River provides 75 percent of the inflow to the lake, entering on the lake's north shore. A small perennial stream enters the lake from the east, contributing 2 percent of the inflow to the lake. Groundwater flows into the lake from all directions, contributing 17 percent of the inflow. The remaining inflow to the lake is from overland flow and precipitation. The residence time of water in the lake is approximately four months during a year of normal precipitation, meaning the lake is flushed about three times per year (SEWRPC, 1983).

There are two privately owned public access sites on Friess Lake. These sites were evaluated during 1976 by the Department of Natural Resources to determine their adequacy. Although these sites were found to be well maintained and in good condition, the access sites were both deemed marginal since they were not publicly owned (SEWRPC, 1983).

Water resources information collected from May 1976 to April 1977 and summarized in the water quality management plan for Friess Lake indicates that the lake is moderately fertile (mesotrophic) but may become increasingly eutrophic (excessively fertile) (SEWRPC, 1983). Nuisance aquatic weed growths have not been reported in Friess Lake over the past 15 years. Densities of rooted aquatic plants were also low during the sampling period, although increasing densities of plants along the northern shore are becoming a concern. This increase may be attributed to deposition of sediment carried into the lake by the Oconomowoc River. This sediment forms a substrate on

which the plants can grow. Generally, however, these plant densities do not significantly impair recreational uses, and in fact form important cover for the lake's fish.

Blue-green algae formed the most abundant algae group found in the lake during the sampling period. These algae are common during late spring to early fall in lakes which are rich in nutrients. These algae are not favored food for fish or zooplankton, and their dominance can affect the diversity and health of these animal communities. In addition, decomposing algae can result in the depression of oxygen in the bottom waters of a lake. Blooms of blue-green algae have occurred on Friess Lake, occasionally resulting in conditions that have precluded swimming. Dissolved oxygen measurements taken in the lake during the sampling period indicate that there is total oxygen depletion in the bottom waters during the period of summer (June-August) stratification. During winter, however, oxygen concentrations are adequate at most depths to support fish and other aquatic life.

The benthic, or bottom dwelling, macroinvertebrates were also sampled to determine if low dissolved oxygen levels in the bottom waters were adversely affecting the benthic community. The low diversity and type of organisms found indicates that the benthic community is severely stressed.

Friess Lake appears to have healthy populations of several sport fish including walleye, northern pike, and largemouth bass. Panfish populations of bluegills, black crappies, and rock bass are also healthy. Spawning areas in the wetlands along the Oconomowoc River and in the sand and gravel lake bed along the shoreline are abundant.

Table IV-1 summarizes phosphorus, chlorophyll, and secchi depth measurements made during the 1976-1977 study period. These three parameters are commonly used to assess the trophic status of lakes (see Chapter III). Based on the phosphorus concentrations, the lake is considered to be excessively fertile, or eutrophic. These concentrations normally result in poor water quality. However, the chlorophyll measurements, which quantify the presence of algae, were not as high as normally expected given these phosphorus concentrations. Based on chlorophyll concentrations and water clarity measurements, the lake was considered to be meso-eutrophic during the study period.

Table IV-2 shows the chlorophyll and water clarity conditions that would be expected in Friess Lake as a result of the high phosphorus concentrations. This table shows the potential of the lake to develop increasingly poor water quality given the existing levels of nutrient enrichment. The reason the lake has not shown as much water quality degradation as expected is unclear, although this phenomenon is typical of lakes in southeastern Wisconsin (Lillie and Mason, 1983).

LAND USE AND NONPOINT POLLUTANT SOURCES

Table III-4 shows that 47 percent of the area draining to Friess Lake was inventoried for nonpoint pollutant sources. Rural land uses dominate the inventory corridor in this area, comprising 5,119 acres or 87 percent of the area. Urban land uses cover 781 acres, or 13 percent of the area.

Table IV-1. Existing Water Quality Conditions For Friess Lake(1.)

Water Quality Parameter	Range	Average	Trophic Status Index	Wisconsin Lakes Water Quality Index (2.)
Total Phosphorus(3.) (mg/l)	.02 to .09	0.05	61 (eutrophic)	fair to poor
Chlorophyll-a(4.) (ug/l)	2.2 to 9.6	5.7	48 (meso-eutrophic)	good
Secchi Disc Depth(4.) (feet)	3.0 to 7.0	5.3	53 (meso-eutrophic)	fair

1. Water quality data from the Friess Lake Management Plan prepared by the Southeastern Wisconsin Regional Planning Commission.
2. See Table III-2.
3.Concentration during spring turn-over.
4.Average summer values.

Table IV-2. Expected Algae and Water Clarity Conditions In Friess Lake Resulting From Total Phosphorus Concentrations Measured In The Lake

Parameter	Measured Value	Calculated Value	Trophic Status Index	Wisconsin Lakes Water Quality Index(1.)
Total Phosphorus (mg/l)	0.05			
Chlorophyll-a (ug/l)		17	58 (eutrophic)	poor
Secchi Disc Depth (feet)		3.6	59 (eutrophic)	poor

1. See Table III-2.

Table III-5 shows the composition of rural lands inventoried in the area. Acreage in continuous row crops or crop rotations covers 53 percent of the area. Little of this cropland has erosion control practices applied at this time. Wetlands are the next most prevalent land use, covering 23 percent of the inventoried area. The remaining acreage covers 24 percent of inventoried rural area, and is comprised of pastures, grasslands, woodlots, and farmsteads. Table III-6 shows that 53 percent of the sheet and rill erosion in this area occurs at a rate less than three tons/acre/year, and is not specifically targeted for erosion control practices. Table III-7 shows that 7747 tons of soil are lost in this area each year as a result of upland sheet and rill erosion.

A detailed assessment of gully erosion could not be made during the upland erosion inventory. Problem sites will be identified by local staff during project implementation. A determination was made during the initial phases of the inventory that roadside erosion and streambank erosion were not widespread enough to warrant a detailed survey. Eroding roadsides and streambanks needing protection will be identified by LCC staff during plan implementation.

There are approximately 320 acres of cropped organic soils in the area draining to Friess Lake. Most of this occurs in the Coney River Subwatershed, and includes some sod farming. Some of this area has been ditched or tiled for drainage purposes, and has a significant potential to contribute soluble phosphorus to surface waters if fertilizer applications are not properly managed.

Tables III-8 and III-9 show the pollution potential from animal waste in the area draining to Friess Lake. Table III-8 shows that of the 35 livestock operations in this area, 22 have a connection with surface waters. The significance of barnyards as a pollution source is further reduced, since eight of these 22 barnyards are so well buffered from the surface waters that phosphorus is expected to be completely filtered from the runoff water before it reaches a surface channel. Therefore, only 14 of the 35 livestock operations in the area draining to Friess Lake contribute phosphorus to surface waters as a result of barnyard runoff.

Table III-9 shows the predicted distribution of critical lands where manure may be spread during winter. It is estimated that 233 critical acres per year are winterspread with manure. Virtually all of these critical lands are in the Coney River Subwatershed. Most of these acres are critical because they are on slopes of six percent or more and spring thaw results in movement of the pollutants to the surface channel network. About one-fourth of the acres are critical because they are within 200 feet of a channel and pose a hazard for winterspreading, even at slopes less than six percent. Improper storage or spreading of manure at other times of the year may also pose a pollution hazard. Any such problems will be identified by local staff during project implementation.

Table III-11 shows that urban pollutant generation is relatively small in this area. These statistics do not include the contribution from septic systems located on unsuitable soils, which is estimated to be 11 percent of the phosphorus load.

Table IV-3.Estimated Pollutant Generation From Urban Land Uses In The Area Draining To Friess Lake(1.)

Land Use	Area(acres)	Pollutant Generation(Lbs./Year)		
		Suspended Solids	Phosphorus	Lead
Low Density Residential	278	6234	11	3
Medium Density Residential	47	7333	19	8
High Density Residential	19	5643	16	8
Commercial	16	11355	25	26
Industrial	0	0	0	0
Construction	4	6279	12	0
SUBTOTAL	364	36844	83	45
Other(2.)	418	9279	17	10
TOTAL	782	46123	100	55

1. Data compiled by the Southeastern Wisconsin Regional Planning Commission.
2. These lands include rural land uses contained within the urban area. Wetlands, woodlands, recreation lands, and open lands are included.

Table IV-3 shows the composition and pollution potential of urban land uses in the area draining to Friess Lake. The major urban land use is residential, with low density residential areas predominating. Commercial land uses are minor, and industrial land uses are not present.

These urban land uses are concentrated in three areas. One area is located in Polk Township to the north and northwest of Mud Lake. The urban land use in this area includes a high density trailer park, and a small commercial development. Runoff from both types of urban development are well buffered from the Coney River, and most of the pollutant generation reflected in Table IV-5 is probably filtered from the drainage water before it enters the surface channel network. The second area is located about .5 miles south of the Oconomowoc River in Section 10 of Richfield Township. This development is low density urban, and is also well buffered from the channel system. The third area is located in the direct drainage area to Friess Lake, both along the lakeshore and to the east of the lake. This area is primarily low and medium density residential, but is not well buffered from the lake. Excessive application of lawn chemicals, improper disposal of leaves and grass clippings, and negligent use and disposal of hazardous household materials are all potential contaminants from these areas.

In addition to the pollutant generation predicted for these urban land uses, there are several areas of waterway and roadside erosion identified in A Water Quality Management Plan For Friess Lake (SEWRPC, 1983). This table identifies 1500 feet of waterway erosion and 400 feet of roadside erosion that are still sources of sediment. These are located in section 17 of Richfield Township.

WATER RESOURCES OBJECTIVES

Mud Lake, Coney River, and the Oconomowoc River

The objectives for the Coney River are to improve the forage fish community, and to reduce the pollutant loads carried by the river to Friess Lake. The water quality objectives for the Oconomowoc River are to improve the forage fish community, to protect the northern pike spawning habitat near the river's entry into Friess Lake, and to reduce the pollutant load carried by the river into Friess Lake. Specific objectives for Mud Lake have not been established.

Friess Lake

The water resource goals for Friess Lake, as stated in A Water Quality Management Plan For Friess Lake, (SEWRPC, 1983), are to provide a level of water quality in the lake suitable for the maintenance of warmwater fish and other aquatic life, and to reduce the severity of existing nuisance conditions caused by excessive algae growth. As a means to achieve this goal, SEWRPC established a criterion of .02 mg/l phosphorus in the lake at spring turn-over (see Table II-1). A secondary criterion of .03 mg/l phosphorus for southeastern Wisconsin Lakes has been suggested as a means of achieving "good" water quality (Lillie and Mason, 1983).

Table IV-4 shows the reduction in phosphorus loading to the lake needed to achieve various concentrations of inlake phosphorus and consequently various

Table IV-4. Estimated Water Quality Impacts On Friess Lake From Different Phosphorus Loading Reduction Levels

Phosphorus Load (lbs.)	Reduction From Present Load	PREDICTED AVERAGE CONDITIONS				
		Total Phosphorus (mg/l)	Chlorophyll-a (ug/l)	Secchi Disc Depth (ft.)	Trophic Status Index	Wisconsin Lakes Water Quality Index(1.)
2360(2.)	0	0.05	17	3.6	59	poor
1650	30%	0.035	12.5	4.3	55	fair
1530	35%	0.033	11.9	4.4	55	fair
1420	40%	0.03 (3.)	10.9	4.7	54	fair to good
1300	45%	0.028	10.2	4.8	53	fair to good
930	60%	0.02 (4.)	7.5	5.6	50	good

1. See Table III-2.
2. This is the estimated existing load based on the Dillon-Rigler Model and an in-lake phosphorus concentration of .05 mg/l.
3. This is the secondary criterion proposed for Friess Lake.
4. This is the primary standard established for Friess Lake by the Regional Planning Commission.

degrees of water quality. In order to achieve the objective proposed by SEWRPC, a 60 percent reduction in the phosphorus loading is needed; in order to achieve the secondary criterion, a 40 percent reduction is needed.

Table IV-5 shows the relative importance of all phosphorus sources in the drainage to Friess Lake. The table also summarizes the percent reduction of the phosphorus load from each of these sources that could be achieved under ideal circumstances, and the overall phosphorus load reduction that might be achieved for Friess Lake. The conclusion from Table IV-5 is that it is probably not feasible to achieve more than a 40 percent reduction in the phosphorus loading to Friess Lake as a result of controlling rural and agricultural nonpoint source pollutant sources. Even this level of control assumes 100 percent participation by landowners and operators whose lands are contributing to these pollution sources. Limitations to achieving a greater level of control include the fact that 69 percent of the soil loss in the area draining to Friess Lake is occurring at a very low rate (see Table III-7), and would be difficult to control. Thus, only a portion of the phosphorus contributed by eroded soil can be controlled. In addition, there will remain a large contribution of soluble phosphorus contained in general runoff waters from agricultural areas. This portion of the phosphorus load is, in general, difficult to control.

Taking all of these factors into account, the objective of the Nonpoint Source Control Program in the area draining to Friess Lake will be to reduce the phosphorus load from agricultural and urban nonpoint sources by 40 percent. If accomplished, this will result in decreasing the total phosphorus concentration in the lake to a more acceptable level, and is an important step in achieving the .02 mg/l phosphorus concentration in the lake established as an ultimate goal by SEWRPC.

Even though Friess Lake has a fairly rapid flushing rate and should respond well to pollution control efforts, water quality improvements in Friess Lake expected to occur as a result of reducing the phosphorus load from these nonpoint source pollution sources may take some time to develop. This is because land management practices will be installed over a number of years, and internal phosphorus cycling within the lake will retard reaching a new equilibrium. In the short term, however, the lake will be protected from further degradation from these rural nonpoint pollutant sources.

RURAL POLLUTION CONTROL STRATEGY

The proposed strategy for controlling major categories of rural nonpoint pollutant sources is presented below. For each category, the desired level of control is listed and management categories are defined. Basic information was discussed in Chapter III (Analytical Methods).

Changes may need to be made in the inventory data as each site is visited by project staff during implementation. Any such changes made must be in accordance with specified procedures consistent with the original data analysis.

Table IV-5. Estimated Feasibility of Reducing The Phosphorus Loading To Freiss Lake

Pollutant Source Category	Portion of the Phosphorus Load Contributed By The Source Category	Portion of Phosphorus Load That Can Reasonably Be Removed From The Source Category	Feasible Phosphorus Load Reduction(1.)
Agricultural Runoff (sediment phosphorus)	35%	31%	11%
Agricultural Runoff (soluable phosphorus)	18%	5%	1%
Barnyard Runoff	15%	90%	14%
Manure Stack Runoff	6%	90%	5%
Runoff of Winterspread Manure	8%	90%	6%
Urban Runoff	5%	10%	1%
Septic Systems(2.)	11%	50%	6%
Atmospheric Deposition (2.)	2%	0%	0%

Total without control of septic systems: 38%

Total with control of septic systems: 44%

1. This figure = (column B)*(column C).
2. Based on information in the Freiss Lake Management Plan, prepared by SEWRPC. Actions needed to reduce phosphorus loading from septic systems are not currently being taken.

1. Upland Sheet and Rill Erosion Sources

Table III-7 shows that 597 acres of sheet and rill erosion control practices will be needed to bring the erosion rate within a range acceptable for purposes of water quality protection. Conservation tillage will be the practice most widely recommended, with an estimated 523 acres needed. Table III-7 shows, however, that other practices will be needed to bring upland sheet and rill erosion down to an acceptable level on all lands in the inventory corridor. These additional practices are needed on 115 acres of cropland, and their application would result in the control of an additional 191 tons of soil loss per year. In addition to these practices on croplands practices are needed to curb erosion occurring on 74 acres of grazed woodlots and poorly managed pastures.

Table III-7 shows that application of soil conservation practices on upland areas will reduce the soil loss on lands that constitute a high pollution hazard by 31 percent.

Pollutant Management Categories for upland sheet and rill erosion are as follows:

- Management Category I. These are the ranked farms which cumulatively contribute the top 85 percent of the portion of the soil loss that is occurring at a rate greater than three tons/acre/year (t/a/y). This includes those farms having at least 50 tons/acre/year soil loss targeted for control. In addition, any single field in the inventory corridor eroding at a rate exceeding seven t/a/y will be placed in this management category.

- Management Category II. The remaining lands in the area draining to Friess Lake that have soil loss exceeding three t/a/y will be placed in this management category.

- Management Category III. Fields that are currently losing less than 3 t/a/y are not eligible for cost sharing, and are placed in management category III.

Since the upland sheet and rill erosion survey did not assess gully erosion, the need for gully controls will be assessed during implementation. Management categories will be assigned to gullies by project staff at the time they are assessed.

2. Barnyard Runoff Sources

- Management Category I. Barnyards in this category include those that cumulatively contribute the top 75 percent of the phosphorus load from this source to surface waters, or any barnyard contributing at least 17 pounds of phosphorus as determined by the ARS Model.

- Management Category II. The remaining barnyards in the area draining to Friess Lake that have at least some loading of phosphorus to the waterways are in this management category.

- Management Category III. Barnyards that are well buffered from the surface channel network, and that produce no loading of phosphorus to the surface waters are not eligible for cost sharing.

3. Runoff of Winterspread Manure

- Management Category I. The ranked landowners who cumulatively account for the top 75 percent of the critical acres winterspread with manure in the area draining to Friess Lake, or anyone spreading at least 10 critical acres during the winter, is placed in this management category for manure spreading.

- Management Category II. The remaining farms in the area draining to Friess Lake that receive winterspread manure on critical acres are placed in this management category.

- Management Category III. Farms that currently receive no winterspread manure on critical acres are placed in this management category for manure spreading.

If a pollution hazard exists due to the improper storage or spreading of manure at other times of the year, local staff will document the problem and assign a management category.

4. Other Agricultural Nonpoint Pollution Sources

Measures designed to protect streambanks are eligible for cost sharing. These sites will be identified during implementation, and management categories will be assigned by project staff at that time.

Drainage from tiled organic soils which are cropped may be locally significant pollutant sources, and will be the covered as part of a special information and education program dealing with proper fertilizer application.

Measures to control gully erosion and roadside erosion are eligible for cost sharing for those sites identified during implementation. Management categories will be assigned to such sites by project staff.

The control strategy for rural pollution sources affecting the Coney River and the Oconomowoc River is the same as that developed for Friess Lake, since the barnyards, eroding uplands, and manure spreading controls proposed for the area draining to Friess Lake will have an effect along both of these rivers. Any new pollution sources identified during plan implementation will be evaluated in terms of their impacts on these rivers, as well as their impacts on Friess Lake.

URBAN POLLUTION CONTROL STRATEGY

The use of information and education programs will be emphasized in order to control nonpoint source pollution associated with the three concentrations of urban land use in the area draining to Friess Lake. Primary emphasis will be placed on developing and distributing educational materials to the urban areas

in the direct drainage area to Friess Lake. Secondary emphasis will be placed on the areas in Polk and Richfield townships. Chapter XIV contains specific details on the information and education program planned for these urban areas.

Practices needed to control the 1900 feet of waterway and roadside erosion in section 17 of Richfield Township (discussed in A Water Quality Management Plan For Friess Lake, from SEWRPC, 1983), may be eligible for cost sharing. Management categories will be assigned by project staff during implementation.

Finally, Washington County, the towns of Erin, Polk, Richfied and Hartford, and the Village of Slinger should review the need to adopt or modify construction erosion and stormwater management provisions in local ordinances and codes. Chapter XIV contains information about the support being offered by the Department of Natural Resources in this effort.

INTEGRATION OF PROGRAMS IN ACHIEVING WATER RESOURCES OBJECTIVES

A Water Quality Management Plan For Friess Lake, prepared by the Southeastern Wisconsin Regional Planning Commission (1983), includes recommendations in several program areas outside the scope of the Nonpoint Source Control Program. These include:

1. modifying local zoning ordinances,

2. conducting an on-site sewage disposal inspection program by the Washington County Land Use and Parks Department, and

3. establishing an approved Department of Natural Resources public boat access.

CHAPTER V

THE AREA DRAINING TO NORTH LAKE:

The Flynn Creek Subwatershed
The Upper Oconomowoc River Subwatershed
The Little Oconomowoc River Subwatershed
The Mason Creek Subwatershed
The North Lake Subwatershed

EXISTING WATER RESOURCE CONDITIONS

The area draining to North Lake includes five subwatersheds and encompasses about 26,900 acres, including the surface of North Lake. The five subwatersheds and their respective areas are: Flynn Creek (3,259 acres), Upper Oconomowoc River (8,722 acres), Little Oconomowoc River (7,604 acres), Mason Creek (5,227 acres) and the North Lake Subwatershed, which is the direct drainage area to North Lake (2,080 acres). Subwatersheds are shown on Map II-1.

Water resources in this part of the watershed include Flynn Creek, the Upper Oconomowoc River from Friess Lake to North Lake, Mason Creek, the Little Oconomowoc River, and North Lake. Each of these water resources is discussed below.

Flynn Creek

Flynn Creek is a major tributary to the Upper Oconomowoc River. The stream is 4.5 miles long, and has a steep gradient (23 feet per mile). The upper two-thirds of the stream is extensively ditched.

In general, low flows limit portions of this stream to a forage type of fish community. A fish collection made during 1975 in the upper areas of the creek showed only nine species of forage and pan fishes. All forage fish species were types tolerant of pollution. The lower third of the stream is spring-fed and has a sand and gravel substrate. A fish collection conducted during 1975 in this part of the stream showed increased diversity, with 14 species of forage and panfish being collected. The forage fish community was dominated by species tolerant of pollution, although three species needing clean water were present. These were the central stoneroller, the blacknose dace, and the Iowa darter.

The high gradient, good substrate, and springs that characterize portions of Flynn Creek indicate a potential for the stream to support trout. More assessment work is needed to confirm this (Personal communication, DNR Fish Manager, August, 1985).

The Upper Oconomowoc River

The Upper Oconomowoc River is 9.5 miles long, stretching from Friess Lake to North Lake. Little Friess Lake (14 acres) and Lowes Lake (25 acres) are shallow, natural kettle lakes through which the river flows. Monches Millpond (16 acres) and Funk's Millpond (31 acres) are very shallow impoundments

located on the lower half of this river. Funk's Millpond has a severely fluctuating water level, caused by a deteriorating dam and outlet flume that is alternately opened and closed by unauthorized persons. The millpond is filled with sediment and supports extensive growths of aquatic weeds. Weed decomposition and release of nutrients from bottom sediments, along with scouring of bottom sediments when the pond is drawn down, are suspected to affect the Oconomowoc River and North Lake. Although water quality data to confirm these impacts are unavailable, residents on North Lake have reported that the Oconomowoc River has been excessively turbid on some days as it flows into North Lake.

The owner of the dam has been cited for failing to maintain the dam which impounds Funk's Millpond, and the Department of Natural Resources is working with Waukesha County in exploring ways to have the dam removed so that the wetland in this area can be restored.

The river is navigable by canoe from Little Friess Lake to North Lake (Poff and Threinen, 1963a, 1963b), although the stretch above Lowes Lake is often obstructed by fallen trees.

Chemical, bacteriological, and biological information was collected for this river during the years 1968-1979. Three sections of the river are represented by these collections: the upper section, from Friess to Lowes Lake; the middle section, near the Monches Millpond; and the lower section, between Funk's Millpond and North Lake (DNR Files; Fago, 1982; SEWRPC, 1978).

Daytime dissolved oxygen concentrations were adequate to support a healthy forage fish community, as well as warmwater sport fish, in all three sections of the river. Concentrations exceeded five mg/l for all but two of the 80 measurements made. These violations of the state water quality standards, which occurred at the State Highway 83 bridge above North Lake, were 4.5 and 4.9 mg/l and were therefore only minor.

Total phosphorus concentrations averaged .033 mg/l in the upper section and .08 mg/l in the lower section. These concentrations are below the .1 mg/l criterion recommended for streams, but could still represent significant nutrient enrichment if the phosphate phosphorus portion exceeds .025 mg/l. Occasionally, high total phosphorus concentrations were measured in the lower section of the river. Of the 31 samples collected in the lower section, eight samples exceeded .1 mg/l total phosphorus, and the highest concentration noted was .23 mg/l.

Nitrate nitrogen concentrations were excessive throughout the sampling period. Concentrations ranged from .1 mg/l to 1.7 mg/l, averaging .6 mg/l in the upper section and .7 mg/l in the lower section.

Bacteriological sampling indicated a relatively clean river in all three sections. The MFFC count per 100 ml sample was less than 400 in the upper two sections on all dates sampled. The counts were generally low in samples collected at the highway 83 bridge. However, counts ranged as high as 4,300 MFFC/ 100 ml sample, and 25 percent of the samples exceeded 400 MFFC/100 ml sample.

Biological sampling included fish collections, plus the collection of aquatic macroinvertebrates for the purpose of calculating a biotic index.

Fish were collected at four stations, two in the upper section and two in the lower section. In the upper section, just below Friess Lake, 13 species of fish were collected including eight forage fish species and five species of pan/sport fish. Largemouth bass were present in the collection. Species tolerant of pollution dominated the forage fish community, although one species intolerant of pollution, the hornyhead chub, was present. Just south of Little Friess Lake the fish community was more diverse, with 19 species present including 14 forage fish species and five panfish species. Although forage species tolerant of pollution again dominated the sample, the hornyhead chub was collected in relatively large numbers. Most importantly, the slender madtom, an endangered species, was present at this site.

Two sites were sampled for fish near State Highway 83 in the lower section of the river. For the two sites combined, 27 species were collected. Eighteen were forage fish species, five were panfish species, and three other species included pickerel, smallmouth bass, and northern pike. The slender madtom, an endangered species, was also present at this site. The forage fish population contained a more diverse group of species intolerant of water pollution. These included the hornyhead chub, spot-tail shiner, stonecat, rainbow darter, and logperch.

The biotic index was calculated for samples collected at the State Highway 83 bridge. The index was 2.52 for the spring 1979 sample, and 2.48 for the fall 1979 sample. Both samples indicate good water quality.

Mason Creek

Mason Creek originates in section 6 of Merton Township, at the confluence of its east and west branches. The east and west branches, which originate in Erin Township (Washington County), are extensively ditched for agricultural drainage. The east branch is approximately one mile long, and the west branch is approximately two miles long. The mainstem of Mason Creek is 5.2 miles long, has a relatively shallow gradient (6-7 feet/mile), and empties directly into North Lake (Poff and Threinen, 1963a, 1963b). Historically, Mason Creek supported a brook trout fishery over its entire length. Brook trout are found in Mason Creek today, but their distribution fluctuates (DNR Files).

Water resources information was collected on Mason Creek during the period from 1973-1983 (DNR Files; Fago, 1982; Szewczykowski, 1983). This information indicates that Mason Creek can be divided into four sections for purposes of resource evaluation. These sections are: 1) the east branch; 2) the west branch; 3) the upper mainstem, from the confluence of the east and west branches to County Trunk CW; and 4) the lower mainstem, from County Trunk CW to the creek's mouth at North Lake.

The west branch was sampled during 1983 (Szewczykowski, 1983). Dissolved oxygen concentrations were not conducive to supporting a healthy trout population. Although concentrations did not fall below five mg/l, they were never as high as the six mg/l recommended for trout, and dissolved oxygen saturations were low (54-67 percent). Temperatures reached 75 degrees

Fahrenheit, near the lethal limit for brook trout. The biotic index was 3.99, also indicating that the water quality in the west branch is poor. Siltation of the stream substrate, and turbid water were also noted. The water quality of the west branch is expected to have a negative impact on some of the downstream portions of Mason Creek.

The east branch was also sampled during 1983 as part of the same survey. The water temperature and dissolved oxygen concentrations were found to be excellent for trout. The biotic index was 2.06, also indicating very good water quality. Flows during July were adequate for trout. A good gravel substrate was present although the extent to which it is used for reproduction was not assessed.

The upper mainstem of Mason Creek was also sampled during the 1983 survey, both at the confluence of the east and west branches and at County Trunk CW. The beneficial impact of flow from the east branch is evident from sampling conducted at the confluence of the east and west branches. Dissolved oxygen concentrations and saturations, as well as water temperatures and flows, were excellent for brook trout. A fish collection included 52 brook trout. Forage fishes however, were dominated by species tolerant of water pollution.

Upstream of County Trunk CW, many water quality and habitat factors indicate a good environment for trout. Dissolved oxygen concentrations were excellent, ranging from 8.9 to 9.8 mg/l. Streamflows were adequate to support trout. Cover was found to be excellent, and the trout food supply adequate. However, significant siltation of the substrate was noted, and temperatures reached 74 degrees Fahrenheit. The biotic index of 2.37-2.53 indicated a slightly degraded water quality when compared to the index calculated for the east branch. A fish collection showed only 12 brook trout. The forage fish population was dominated by types tolerant of pollution, however one forage fish species intolerant of pollution, the pearl dace, was noted. This information indicates that the east branch of Mason Creek is vital in sustaining the brook trout population in the upper mainstem of Mason Creek.

The lower mainstem of Mason Creek was extensively monitored between 1973 and 1983 at several locations. These locations included Shore Drive, located just below County Trunk CW; and Krebster Road and County Trunk EC, both located just above North Lake (DNR Files; DNR, 1976; Fago, 1982; Szewczykowski, 1983). Dissolved oxygen concentrations can be considered excellent for trout at all three stations, generally ranging from seven mg/l to 10 mg/l. Water temperatures, however, were found to be marginal for good trout habitat. Flows were generally adequate to support trout. Phosphorus concentrations averaged .06 mg/l, ranging from .02-.99 mg/l. Only 25 percent of the samples exceeded the .1 mg/l criterion for total phosphorus. These concentrations could represent significant nutrient enrichment if the phosphate phosphorus portion of the total phosphorus concentration exceeds .025 mg/l. The biotic index calculated at County Trunk EC showed 1.83 for the spring, 1979 sample. This indicates excellent water quality. Another sample collected during the summer of 1983 gave an index value of 2.35, indicating good water quality. Although there was some gravel stream substrate noted at all three stations, siltation of the substrate was significant.

Fish collections in the lower mainstem of Mason Creek were made during 1975, 1981, and 1983 (DNR Files; Fago, 1982; Szewczykowski, 1983). The 1975 sample, collected at County Trunk EC, showed a diverse fish community. Fourteen species were collected, including 11 forage and three panfish species. The forage community contained five species which need clean water to survive, including darters, stonerollers, the hornyhead chub, and the stonecat. These cleanwater species dominated the forage fish community. In addition, the slender madtom, an endangered species, was collected at this site. Although no brook trout were sampled at this station in 1975, three were found on the same date at a sampling station located closer to the mouth of North Lake. During 1981, the entire lower section of the mainstem was surveyed. No brook trout were found, although the sampling produced juvenile smallmouth and largemouth bass, and several forage species which need clean water to survive (hornyhead chub, rainbow darter, and central stoneroller). The 1983 sampling was conducted at County Trunk EC, where no brook trout were noted. The fish community consisted of 13 forage fish species. Nine species were types tolerant of water pollution, and dominated the community. Fair numbers of hornyhead chubs and rainbow darters, both clean water forage species, were noted, however.

Bacteriological sampling conducted during 1976-77 at the County Trunk EC bridge showed counts ranging from below 10 to 11,000 MFFC/100 ml sample. Counts were excessive on three of 13 dates, and about 40 percent of the samples exceeded 400 counts MFFC/100 ml sample. Residents on North Lake are aware of these sampling results, and have expressed their concern.

Little Oconomowoc River

The Little Oconomowoc River is 5.6 miles long, with its headwaters consisting of four wilderness lakes formed in a large wetland complex. These lakes are small, ranging in size from five to 16 acres, and have maximum depths ranging from eight to 37 feet. Murphy Lake and Malloy Lake receive flow from an intermittent stream that drains about four square miles. McConville Lake and Beck Lake are seepage-fed bog lakes. These four lakes support bass, panfish, and northern pike, and are important waterfowl lakes (Poff and Threinen, 1963a, 1963b). There is no public access to these lakes (Threinen, 1982).

The Little Oconomowoc River is naturally divided into three sections as a result of gradient changes and associated shoreline wetlands. The upper section reaches from Malloy Lake to the Washington-Waukesha County line. It is characterized by low gradient (seven feet/mile) and extensive shoreline wetlands. The middle section reaches from the county line to State Highway 83. It is characterized by a steeper gradient (19 feet/mile) and few shoreline wetlands. The lower section, between State Highway 83 and North Lake, has a low gradient and extensive shoreline wetlands. Chemical, physical, biological, and bacteriological data were collected for these three sections of the Little Oconomowoc River during the period 1976-1983 (DNR Files; Fago, 1982).

In the upper section, data was collected during 1983 at the County Trunk Q bridge (DNR Files). Several factors were found that severely limit the stream's recreational and fishery potential. These limitations included heavy

siltation, extensive aquatic weed growths, poor configuration of riffles and pools, and inadequate average stream depth. Some of these limitations are naturally occurring.

In the middle section, data was collected during 1983 at the Hoff Road bridge crossing, located just below the county line, and data was collected during 1979 and 1983 at the Kilbourne Road bridge crossing, located just upstream of State Highway 83. Physical habitat characteristics are good to excellent in this section, although average flow depths were only fair. Daytime summer water temperature was fairly low, at 64 degrees Fahrenheit. The biotic index was 1.16 for the spring sample and 1.46 for the fall sample, both indicating excellent water quality. Fish sampling, however, indicates that something is occurring that limits development of a healthy forage or warmwater fish population. Only four species were collected. All were forage species, and these were dominated by types tolerant of pollution.

In the lower section, data was collected at the County Trunk EC bridge during 1975-1977 and in 1983 (DNR Files). Dissolved oxygen concentrations ranged from 3.7 mg/l to 12 mg/l, averaging 8.2 mg/l. Few samples violated either the five mg/l standard for warmwater fish or the six mg/l standard for coldwater fish. Nutrient information showed an enriched stream. Total phosphorus concentrations averaged .14 mg/l, ranging from .04 mg/l to .45 mg/l. Nitrate-nitrogen concentrations were high, averaging .27 mg/l, and ranging from .11 mg/l to 4.5 mg/l. Growths of aquatic weeds were noted to be excessive. Habitat limitations included significant siltation of the streambed, low average stream depth, and only a fair configuration of pools and riffles. Fish sampling found a low diversity of forage fish types tolerant of pollution, and little else.

Bacteriological sampling showed occasionally excessive counts of coliform bacteria. Counts ranged from 30-30,000 MFFC/100 ml sample. Sixty percent of the samples had counts exceeding 400 counts/ 100 ml sample.

North Lake

North Lake is the second of six major lakes in a chain connected by the Oconomowoc River. The lake has a surface area of 439 acres, and is relatively deep. The maximum depth is 73 feet, the average depth is 37 feet, and over half of the lake is more than 40 feet deep. During 1976-1977, a hydrologic budget was determined for North Lake by SEWRPC. The major inlet to the lake is the Oconomowoc River, which receives flow from Friess Lake, Flynn Creek, and the Little Oconomowoc River before entering North Lake. Seventy percent of the inflow comes from this source. Mason Creek provides seven percent of the inflow, and the intermittent outlet from Cornell Lake provides five percent of the inflow. The remaining surface water inflow provides eight percent of the hydrologic load to North Lake, and comes from overland flow and precipitation. Groundwater accounts for 10 percent of the inflow to the lake, and occurs primarily along the northern portion of the west shore. The eastern shore is a groundwater flow transition zone, where flows into and out of the lake alternate, and the south and southwest shores are areas where the groundwater is recharged from the lake. The residence time of water in the lake is approximately 9.5 months during a year of normal precipitation, meaning the lake is flushed about 1.3 times per year (SEWRPC, 1982).

There are two privately owned and three town-owned access sites on North Lake. The two privately owned sites have boat ramps, but one is a owned by a private club and is for members only. The other charges a launch fee. The three town access sites are walk-in trails off of town roads, but parking at the trail heads is not allowed. These sites were evaluated during 1976 by the Department of Natural Resources to determine their adequacy for boat access. None of the sites were deemed adequate, two were judged to be marginal, and three were judged to be inadequate (SEWRPC, 1982).

Water resources information collected from 1973-1979 has been summarized and interpreted in the lake management report for North Lake (SEWRPC, 1982). This information indicates that the lake is moderately fertile, or mesotrophic.

Aquatic weed growths in North Lake are generally sparse. The growths do not generally affect recreational uses of North Lake, and are probably important in providing cover for fish. There is no record of activities to control aquatic weeds in North Lake since 1954. A 1976 aquatic weed survey found sparse to moderate growth in 80 percent of the lakeshore areas. There were abundant stands of aquatic weeds, however, in the shallow waters at the north end of the lake. Weed growths in this area may occasionally reach nuisance conditions. These growths correspond to areas of silty substrate, located at the mouths of Mason Creek and the Oconomowoc River. Since the general lack of suitable substrate is expected to be the cause of low weed growths in the lake, the areas of densest growth may be attributed to deposition of sediment carried into the lake by the river and Mason Creek.

Algae populations were surveyed in North Lake during 1976-77. Blue-green algae formed the most abundant algae group found in the lake during the sampling period. These algae are common during late spring to early fall in lakes which are rich in nutrients. These algae are not favored food for fish or zooplankton, and their dominance can affect the diversity and health of these animal communities. In addition, decomposing algae can result in the depression of oxygen in the bottom waters of a lake.

Algae growths are not considered a major problem in North Lake, and chemical control measures have not been recorded since 1952. However, concentrations of chlorophyll-a as high as 11 micrograms per liter (ug/l) have been measured in the lake. This concentration is generally associated with visible water quality impairment, and algae blooms could occasionally be affecting some recreational uses, such as swimming, and the lake's aesthetic qualities.

Dissolved oxygen measurements taken in the lake during the sampling period indicate that total oxygen depletion occurs in the bottom waters during the period of summer (June-August) stratification. This condition was also recorded in the lake during the early 1900s, and there appears to have been little change in the dissolved oxygen characteristics of North Lake over the 70-year period of record. During winter, oxygen concentrations are adequate at most depths to support fish and other aquatic life.

The benthic, or bottom dwelling, macroinvertebrates were also sampled to determine if low dissolved oxygen levels in the bottom waters were adversely affecting the benthic community. The number and type of organisms found were indicative of a mesotrophic lake where the oxygen concentrations are not critical for long periods of time.

North Lake appears to have healthy populations of several sport fish species including walleye, northern pike, and largemouth bass. The lake also supports populations of panfish and cisco, a coldwater fish species.

Table V-1 summarizes phosphorus, chlorophyll, and secchi depth measurements made during 1976-1977. These three parameters are commonly used to assess the trophic status of lakes (see Chapter III). Based on the phosphorus concentrations, the lake is considered to be excessively fertile, or eutrophic. These concentrations normally result in poor water quality. However, the chlorophyll measurements, which quantify the presence of algae, were not as high as normally expected given these phosphorus concentrations. Based on chlorophyll concentrations, the lake was considered to be meso-eutrophic during the study period.

Table V-2 shows the chlorophyll and water clarity conditions which would be expected in North Lake as a result of the high phosphorus concentrations. This table shows the potential of the lake to develop increasingly poor water quality given the existing levels of nutrient enrichment. The reason the lake has not shown as much water quality degradation as expected is unclear, although this phenomenon is typical of lakes in southeastern Wisconsin (Lillie and Mason, 1983).

Overall, North Lake is a high quality recreation resource that lacks the access needed for the public to make full use of its natural sport fishery, its good water quality and natural sand beaches, and its open waters ideal for sailing and power boating.

LAND USE AND NONPOINT POLLUTANT SOURCES

The following discussion is presented in three sections, based on the importance of the water resources in this area. These sections include: the Mason Creek Subwatershed, because Mason Creek has a brook trout fishery needing protection and improvement; the Little Oconomowoc River Subwatershed, because the Little Oconomowoc River has good water quality with fishery improvement potential; and the entire area draining to North Lake, because North Lake is a high quality lake resource which needs protection.

The Mason Creek Subwatershed

The Mason Creek Subwatershed encompasses 5,227 acres. Table III-4 shows that 34 percent of the subwatershed was inventoried for nonpoint pollutant sources. Rural land uses dominate the inventory corridor in this area, comprising 1,690 acres or 95 percent of the subwatershed. Urban land uses cover 87 acres, or five percent of the subwatershed.

Table III-5 shows the composition of rural lands inventoried in the subwatershed. Most of the acreage is in continuous row crops or crop rotations, covering 49 percent of the area. Of this cropland, three-fourths is cropped in rotation and one-fourth is continuously row cropped. Little of this cropland has erosion control practices applied at this time. Wetlands are also an important landcover, encompassing 41 percent of the inventoried area. The remaining acreage covers 10 percent of inventoried rural area, and is comprised of pastures, grasslands, woodlots, and farmsteads.

Table V-1. Existing Water Quality Conditions For North Lake(1.)

Water Quality Parameter	Range	Average	Trophic Status Index	Wisconsin Lakes Water Quality Index (2.)
Total Phosphorus(3.) (mg/l)	.04 to .07	0.06	63 (eutrophic)	fair to poor
Chlorophyll-a(4.) (ug/l)	2.3 to 11.0	7.1	50 (meso-eutrophic)	very good to good
Secchi Disc Depth(4.) (feet)	3.3 to 8.3	4.4	56 (eutrophic)	fair to poor

1. Water quality data from the North Lake Management Plan prepared by the Southeastern Wisconsin Regional Planning Commission.
2. See Table III-2.
3.Concentration during spring turn-over.
4.Average summer values.

Table V-2. Expected Algae and Water Clarity Conditions In North Lake Resulting From Total Phosphorus Concentrations Measured In The Lake

Parameter	Measured Value	Calculated Value	Trophic Status Index	Wisconsin Lakes Water Quality Index(1.)
Total Phosphorus (mg/l)	0.06			
Chlorophyll-a (ug/l)		21	60 (eutrophic)	poor
Secchi Disc Depth (feet)		3.3	60 (eutrophic)	poor

1. See Table III-2.

Table III-6 shows that 61 percent of the sheet and rill erosion in this subwatershed occurs at a rate less than three tons/acre/year, and is not specifically targeted for erosion control practices. Most of the remaining erosion occurs at moderate rates of three to five tons per acre per year. Table III-7 shows that 2,134 tons of soil are eroded in the Mason Creek Subwatershed each year as a result of upland sheet and rill erosion.

A detailed assessment of gully erosion could not be made during the upland erosion inventory, although gullies are expected to occur and will be identified by local staff during project implementation.

A determination was made during the initial phases of the inventory that roadside erosion was not widespread enough to warrant a detailed survey. When found during plan implementation, problem sites will be documented by local staff.

Streambank erosion on Mason Cre k was inventoried, because of the stream's high resource value. Approximately 7,000 feet of eroding bank were identified at five sites. Erosion at these sites is being caused by cattle and machinery crossings, cattle access, and at one site, by the road shoulder slumping.

There are estimated to be 29 acres of cropped organic soils in the subwatershed. Some of this area may have been been ditched or tiled for drainage purposes, and as such could have a significant potential to contribute soluble phosphorus to surface waters if fertilizer applications are not properly managed.

Tables III-8 and III-9 show the pollution potential from animal waste in the Mason Creek Subwatershed. Table III-8 shows that of the 12 livestock operations in this area, only eight have a connection with surface waters. The significance of barnyards as a pollution source is further reduced, since three of these eight barnyards are so well buffered from the surface waters that phosphorus is expected to be completely filtered from the runoff water before it reaches a surface channel. Therefore, only five of the 12 livestock operations in the Mason Creek Subwatershed were shown to contribute phosphorus to surface waters as a result of barnyard runoff.

Table III-9 shows the predicted distribution of critical lands where manure may be spread during winter. It is estimated that less than 40 critical acres per year are winterspread with manure. These acres are critical because they are within 200 feet of a channel and pose a hazard for winterspreading, even at slopes less than six percent. Land Conservation Committee staff indicate there may hazards posed by improper storage or disposal of manure at other times of the year, such problems will be assessed by local staff during project implementation.

There are only 61 acres of typically urban lands in this subwatershed. These are almost exclusively low-density residential development, concentrated in section 8 of Merton Township along the lower reaches of Mason Creek. Table III-11 shows that pollutant generation from these areas is minimal, with less than two tons/year of suspended sediment and under 10 pounds/year of phosphorus produced. These figures do not include the estimated contribution from septic systems located on soils having limitations for domestic waste disposal. No assessment of this contribution has been made.

The impact of urban pollutant sources on Mason Creek are probably minimal, since they would only affect a short portion of the creek's lower reaches.

The Little Oconomowoc River Subwatershed

The Little Oconomowoc River Subwatershed encompasses 7,604 acres. Table III-4 shows that 58 percent of the subwatershed was inventoried for nonpoint pollution sources. Rural land uses dominate the inventory corridor in this area, comprising 4,025 acres or 91 percent of the subwatershed. Urban land uses cover 394 acres, or nine percent of the subwatershed.

Table III-5 shows the composition of rural lands inventoried in the subwatershed. Wetlands are the most prevalent landcover, encompassing 39 percent of the inventoried area. Woodlots are also an important landcover, encompassing 23 percent of the inventoried area. These woodlots are, in general, well managed and pose little threat to water quality due to soil erosion. Croplands cover 27 percent of the inventoried area. Three-quarters of the cropland is in rotation, with one-quarter planted to row crops year after year. In general, there are few conservation practices applied to these croplands. The remaining acreage covers 11 percent of inventoried rural area, and is comprised of pastures, grasslands, and farmsteads.

Table III-6 shows that 32 percent of the sheet and rill erosion in this subwatershed occurs at a rate less than three t/a/y, and is not specifically targeted for erosion control practices. The remaining sheet and rill erosion is occurring at moderate to very high rates. Nineteen percent of the sheet and rill erosion occurs at three to five tons per acre per year, 30 percent occurs at rates of five to 10 t/a/y, and 19 percent occurs at rates exceeding 10 t/a/y. Table III-7 shows that 4873 tons of soil are eroded in this subwatershed each year as a result of upland sheet and rill erosion.

A detailed assessment of gully erosion could not be made during the upland erosion inventory. However, some sites may occur, and will be identified by local staff during project implementation. Roadside and streambank erosion was not inventoried because it was felt that these sources of erosion were not widespread enough to warrant a detailed survey. If problem sites are found during implementation, they will be documented by local project staff.

There are estimated to be 130 acres of cropped organic soils in the subwatershed. Some of this area may have been been ditched or tiled for drainage purposes, and as such could have a significant potential to contribute soluble phosphorus to surface waters if fertilizer applications are not properly managed.

Tables III-8 and III-9 show the pollution potential from animal waste in the Little Oconomowoc River Subwatershed. Table III-8 shows that of the 11 livestock operations in this area, only seven have a connection with surface waters. The significance of barnyards as a pollution source is further reduced, since three of these seven barnyards are so well buffered from the surface waters that phosphorus is expected to be completely filtered from the runoff water before it reaches a surface channel. Therefore, only four of the 11 livestock operations in the Little Oconomowoc River Subwatershed contribute phosphorus to surface waters as a result of barnyard runoff.

Table III-9 shows the predicted distribution of critical lands where manure may be spread during winter. It is estimated that 45 critical acres per year are winterspread with manure. About half of these acres are critical because they are within 200 feet of a channel and pose a hazard for winterspreading, even at slopes less than six percent. The other half are critical because they have slopes greater than, or equal to, six percent. The LCC staff indicate that there may be a pollution hazard posed by manure improperly stored or spread during other times of the year. These problems will be documented by project staff during implementation.

There are only 141 acres of typically urban lands in this subwatershed. These are almost exclusively low-density residential development, concentrated in sections 22 and 27 of Erin Township, just to the east of Beck and McConville Lakes. In addition, there is some low-density residential development in section 9 of Merton Township, along the lower reaches of the river. Table III-11 shows that pollutant generation from the urban land uses in this subwatershed is minimal. These figures do not include the estimated contribution from septic systems located on soils having limitations for domestic waste disposal. No assessment of this contribution has been made.

The impacts of urban pollutant sources on the Little Oconomowoc River are probably minimal, since pollutants generated from low-density urban areas, which predominate here, are normally well buffered from the stream channel system.

The Area Draining To North Lake

All five subwatersheds contained in the area draining to North Lake were considered in preparing this summary. They include the Little Oconomowoc River, Mason Creek, Flynn Creek, Upper Oconomowoc River, and North Lake subwatersheds.

Table III-4 shows the portion of each contributing subwatershed inventoried for land use and nonpoint pollutant sources. Combining the information for the whole area, a total of 12,407 acres or 46 percent of the area was inventoried. Rural land uses dominate the inventory corridor, encompassing 11,083 acres or 89 percent of the area. Urban land uses cover 1,324 acres, or 11 percent of the subwatershed.

Table III-5 shows the composition of rural lands inventoried in each of the five contributing subwatersheds. Combining the information for the whole area, it can be seen that wetlands form the most significant landcover, encompassing 3,995 acres or 37 percent of the area. Croplands cover 3730 acres or one-third of the area. Three-fourths of this cropland, or 2,810 acres, are in rotation. One-fourth of this cropland, or 920 acres is planted to row crops year after year. Little of this cropland has conservation practices applied at this time. Woodlots also form a significant portion of the landcover in the rural inventory corridor, encompassing 2,299 acres or 21 percent of the area. These woodlots are generally well managed and do not pose a water pollution potential. The remaining acreage covers 1,059 acres or nine percent of the rural inventory corridor, and includes pasture, grassland, and farmsteads.

Table III-6 summarizes rural sheet and rill erosion characteristics for the five subwatersheds in this area. Combining the information for the whole area, 42 percent of the sheet and rill erosion in the area draining to North Lake is coming from lands eroding soil at a rate less than three t/a/y. These lands are not targeted for control practices. Seventeen percent of the soil erosion occurs at three to five tons per acre per year, 26 percent occurs at five to 10 t/a/y, and 14 percent occurs at a rate exceeding 10 t/a/y. Table III-7 shows that 14,145 tons of soil are eroded in this area each year as a result of upland sheet and rill erosion.

Gully erosion could not be inventoried as part of this assessment. Problem sites will be identified by local staff during project implementation. A determination was made during the initial phases of the inventory that roadside erosion and streambank erosion were not widespread enough to warrant a detailed survey. Any problem sites will be identified during project implementation.

There are approximately 185 acres of cropped organic soils in the watershed. Almost three-fourths of this acreage is in the Little Oconomowoc River Subwatershed, with the rest split evenly between the Flynn Creek and Mason Creek subwatersheds. Some of this area may have been ditched or tiled for drainage purposes, and has a significant potential to contribute soluble phosphorus to surface waters if fertilizer applications are not properly managed.

Tables III-8 and III-9 show the pollution potential from animal waste in the area draining to North Lake. Table III-8 shows that of the 33 livestock operations in this area, only 23 have a connection with surface waters. The significance of barnyards as a pollution source is further reduced, since 10 of these 23 barnyards are so well buffered from the surface waters that phosphorus is expected to be completely filtered from the runoff water before it reaches a surface channel. Therefore, only 13 of the 33 livestock operations in the area draining to North Lake contribute phosphorus to surface waters as a result of barnyard runoff.

Table III-9 shows the predicted distribution of critical lands where manure may be spread during winter. It is estimated that 102 critical acres per year are winterspread with manure in the area draining to North Lake. This acreage is limited to the Flynn Creek, Little Oconomowoc River, and Mason Creek subwatersheds. About 60 percent of these acres are critical because they are located within 200 feet of a channel, whereas 40 percent are critical because their slopes are equal to or greater than six percent. As mentioned in the discussions concerning manure spreading in the Mason Creek and Little Oconomowoc River subwatersheds, LCC staff indicate there may be a problem caused by improper manure storage or spreading at other times of the year. This problem will be assessed in more detail during implementation by project staff.

Table III-11 shows the pollutant generation from lands within the urban inventory corridor for each of the contributing subwatersheds in the area draining to North Lake. In general, pollutant generation from these areas is relatively low, with only 40 tons of sediment per year and 172 pounds of phosphorus per year generated.

Table V-3 shows the composition and pollution potential of urban land uses in the area draining to North Lake. This table shows that traditional urban land uses, such as residential and commercial, encompass about 50 percent of the land uses inventoried in the urban corridor. These specific urban land uses generated 82 percent of the suspended solids, 83 percent of the phosphorus, and 94 percent of the lead loads referenced in Table III-11.

Table V-3 shows that the major urban land use in the area draining to North Lake is residential, with low density residential areas predominating. These residential areas account for 92 percent of the traditional urban land use, and account for 45 percent of the suspended solids, 48 percent of the phosphorus, and 28 percent of the lead generated from these areas. Although the low density residential areas cover significantly more area than the medium density residential areas, the medium density residential areas generate most of the pollutants from the residential areas.

Commercial areas cover only 33 acres, or five percent of the traditional urban land uses. However, these areas generate 34 percent of the suspended solids, 36 percent of the phosphorus, and 56 percent of the lead from these areas. Industrial and construction areas together cover only three percent of the traditional urban areas, but generate significant proportions of the suspended solids (20 percent), phosphorus (16 percent) and lead (16 percent) coming from the traditional urban areas.

These urban land uses are concentrated in several portions of the area draining to North Lake. The low density residential development is concentrated in four areas. These are just south of Friess Lake in sections 17 and 20 of Richfield Township, just east of Beck and McConville lakes in sections 22 and 27 of Erin Township, along the mouths of Mason Creek and the Little Oconomowoc River in sections 8 and 9 of Merton Township, and along the shores of North Lake in sections 15,16,17, 20 and 21 of Merton Township. The medium density residential areas are concentrated near North Lake, in sections 16, 17, and 20 of Merton Township. The commercial and industrial development is concentrated in this same area. Pollutant transport from these areas will vary greatly. It is characteristically low from low and medium density residential areas, although these areas may be of concern where located along the shores of North Lake. Excessive application of lawn chemicals, improper disposal of leaves and grass clippings, and negligent use and disposal of hazardous household materials are all potential contaminants from these areas.

In preparing A Water Quality Management Plan For North Lake, SEWRPC documented several site specific erosion problems occurring in the urban portion of the direct drainage area to the lake (SEWRPC, 1982). These included the following:

1. Three roadside erosion sites, totalling 900 lineal feet,

2. One waterway erosion site, totalling 2,000 lineal feet,

3. Two dump spoil erosion sites, covering a total of 1.2 acres,

4. Two eroding construction sites, covering 2.5 acres.

Table V-3. Estimated Pollutant Generation From Urban Land Uses In The Area Draining To North Lake(1.)

Land Use	Area(acres)	Pollutant Generation(Lbs./Year)		
		Suspended Solids	Phosphorus	Lead
Low Density Residential	474	10646	19	4
Medium Density Residential	123	19333	50	22
High Density Residential	0	0	0	0
Commercial	33	22639	51	52
Industrial	11	6290	10	14
Construction	5	7064	13	1
SUBTOTAL	646	65972	143	93
Other(2.)	677	14857	29	6
TOTAL	1323	80829	172	99

1. Data compiled by the Southeastern Wisconsin Regional Planning Commission.
2. These lands include rural land uses contained within the urban area. Wetlands, woodlands, recreation lands, and open lands are included.

These sites were all in sections 16, 17, 20, and 21 of Merton Township.

WATER RESOURCES OBJECTIVES

Flynn Creek and the Upper Oconomowoc River

The water quality objectives for Flynn Creek include: 1) reducing the transport of pollutants to the Oconomowoc River, and 2) improving the potential of the stream forage fish, and possibly trout, by generally reducing pollutant loads from nonpoint sources.

The water quality objectives for the Upper Oconomowoc River include: 1) protecting the high quality of water for recreational purposes by maintaining low levels of bacterial contamination, and 2) protecting the forage fish community, and the slender madtom, by maintaining high dissolved oxygen concentrations and low phosphorus concentrations.

Mason Creek

Historically, Mason Creek supported brook trout over its entire length. Today, that distribution is limited. Further assessment is needed to determine exactly why brook trout are not colonizing the stream reach below County Trunk CW, although it appears that elevated water temperatures and substrate siltation may be possible reasons.

The water quality objectives for Mason Creek include: 1) protecting and improving the brook trout population above County Trunk CW, 2) expansion of the brook trout population to sections below County Trunk CW if it is deemed feasible, 3) protecting and improving the forage fish population in all reaches of Mason Creek, and protecting the slender madtom in its present range, and 4) reducing pollutants carried to North Lake.

The attainment of these objectives will require instream and bank rehabilitation work to increase trout habitat, as well as controlling nonpoint pollutant sources identified in the subwatershed. This habitat rehabilitation work will require coordination with other Department of Natural Resources programs.

Little Oconomowoc River

The water quality objectives for the Little Oconomowoc River include: 1) reducing sediment, coliform bacteria, and nutrients carried to North Lake, and 2) improving the forage fish community, particularly in the stream section between the county line and State Highway 83.

North Lake

A Water Quality Management Plan For North Lake (SEWRPC, 1982) states that the management goal for the lake is to provide for a level of water quality suitable for recreation and the maintenance of warmwater fish and other aquatic life. Although a high level of water quality already exists in North Lake, the existing concentrations of phosphorus in the lake are high. In the long term, the water quality in the lake could become worse if these concentrations are not lowered.

The Southeastern Wisconsin Regional Planning Commission has established a criterion of .02 mg/l phosphorus in the lake at spring turn-over as a means to maintain long-term, consistently high water quality (See Table II-2). A secondary criterion of .03 mg/l phosphorus for southeastern Wisconsin lakes has been suggested as a means of achieving "good" water quality (Lillie and Mason, 1983).

Table V-4 shows the reduction in phosphorus loading to North Lake needed to achieve various concentrations of inlake phosphorus, and consequently, to achieve various degrees of water quality. In order to achieve the .02 mg/l phosphorus objective proposed by SEWRPC, a 65 percent reduction in the phosphorus loading to the lake is needed. In order to achieve the secondary objective of .03 mg/l phosphorus in the lake, a 50 percent reduction in the phosphorus load is needed.

Table V-5 shows the relative importance of all phosphorus sources in the drainage area to North Lake. The table also summarizes the percent reduction of the phosphorus load from each of these sources that can be expected under ideal circumstances, and the overall phosphorus load reduction that might be achieved. The conclusion from Table V-5 is that it is probably not feasible to attain greater than a 28 percent reduction in the phosphorus loading to North Lake as a result of controlling urban and agricultural nonpoint pollution sources. Even this level of control assumes 100 percent participation by landowners and operators contributing to the existing pollutant loadings.

The objective of the Nonpoint Source Control Program for North Lake is to improve the aesthetic quality of the lake, and reduce its trophic potential. To do this, the watershed project will attempt to reduce the phosphorus loading to the lake by 28 percent. This will result in decreasing the concentration of phosphorus in the lake. Although the concentration established by the SEWRPC will not be met through this program alone, the reduction in the phosphorus concentration will serve as an important first step in attaining the .02 mg/l objective stated in A Water Quality Management Plan For North Lake, prepared by SEWRPC.

RURAL POLLUTION CONTROL STRATEGY

The proposed strategies for controlling rural nonpoint pollutant sources are presented below. These control strategies will be sufficient to meet the water resources objectives for North Lake, Mason Creek, and the Little Oconomowoc River. The Upper Oconomowoc River and Flynn Creek will be protected as a result of reducing the pollutant loads to North Lake from these subwatersheds.

Changes in the inventory may be needed as each site is visited by project staff during implementation. Any changes made will be done in accordance with specified procedures consistent with the criteria used to develop the original strategy.

For purposes of site re-evaluation, or for purposes of evaluating newly discovered sites, the following steps should be taken. For sites in the Mason Creek or Little Oconomowoc River subwatersheds, both the appropriate

Table V-4. Estimated Water Quality Impacts On North Lake From Different Phosphorus Loading Reduction Levels

		PREDICTED AVERAGE CONDITIONS				
Phosphorus Load (lbs.)	Reduction From Present Load	Total Phosphorus (mg/l)	Chlorophyll-a (ug/l)	Secchi Disc Depth (ft.)	Trophic Status Index	Wisconsin Lakes Water Quality Index(1.)
6800(2.)	0	0.06	21	3.3	60	poor
5100	25%	0.045	15.8	3.8	58	fair
4760	30%	0.042	14.8	4	57	fair
3390	50%	0.03 (3.)	10.9	4.7	54	fair to good
2260	65%	0.02 (4.)	7.5	5.6	50	good

1. See Table III-2.
2. This is the estimated existing load based on the Dillon-Rigler Model and an in-lake phosphorus concentration of .06 mg/l.
3. This is the secondary criterion proposed for North Lake.
4. This is the primary standard established for North Lake by the Regional Planning Commission.

subwatershed criteria and the criteria for the area draining to North Lake should be consulted. For the North Lake, Flynn Creek and Upper Oconomowoc River subwatersheds, the sites will be evaluated using the criteria established below for the area draining to North Lake.

The magnitude of control practices needed and the pollutant management categories for each major type of source are as follows:

1. Upland Sheet and Rill Erosion Sources

Table III-7 shows that 193 acres of sheet and rill erosion control practices will be needed in the Mason Creek Subwatershed to bring the erosion rate within a range acceptable for purposes of water quality protection. Conservation tillage will be the practice most widely recommended, with an estimated 182 acres needed. In addition, a small number of acres of pasture will need stabilization. Table III-7 shows that these practices will be adequate to bring upland sheet and rill erosion down to the tolerable level of soil loss on all but nine acres of cropland in the agricultural inventory corridor. Table III-7 shows that application of these soil conservation practices on upland areas will reduce the soil erosion on lands constituting a high pollution hazard by 28 percent.

Table III-7 shows that 540 acres of sheet and rill erosion control practices will be needed to bring the erosion rate within the Little Oconomowoc River Subwatershed down to a range acceptable for purposes of water quality protection. Conservation tillage will be the practice most widely recommended, with an estimated 450 acres needed. In addition, 90 acres will need pasture stabilization. Table III-7 shows that these practices, however, will not be adequate to bring upland sheet and rill erosion down to the tolerable level of soil loss on all lands in the inventory corridor. Additional practices will be needed on 150 acres of land, and can further decrease the existing sheet and rill erosion by 179 tons per year. The application of conservation tillage and pasture management practices on upland areas will reduce the soil loss on lands constituting a high pollution hazard by 44 percent. If the additional 179 tons per year soil erosion is taken into account, the level of control could reach almost 50 percent.

Table III-7 also shows that 1292 acres of sheet and rill erosion control practices will be needed in the area draining to North Lake to bring the erosion rate within a range acceptable for purposes of water quality protection. Conservation tillage will again be the practice most widely recommended, with an estimated 1191 acres needed. In addition, 101 acres of pasture management will be needed. Table III-7 shows, however, that other practices will be needed to bring upland sheet and rill erosion down to an acceptable level on all lands in the inventory corridor. Additional practices will be needed on 372 acres of cropland. Their application would result in an additional 727 tons soil saved per year, thus reducing the potential for delivery of sediment to surface waters. Application of conservation tillage and pasture management practices on upland areas will reduce the soil erosion on lands constituting a high pollution hazard by 35 percent. With the addition of other practices, the soil erosion can be reduced by 40 percent.

Table V-5. Feasibility of Reducing The Phosphorus Loading To North Lake

Pollutant Source Category	Portion of the Phosphorus Load Contributed By The Source Category	Portion of Phosphorus Load That Can Reasonably Be Removed From The Source Category	Feasible Phosphorus Load Reduction(1.)
Agricultural Runoff (sediment phosphorus)	35%	35%	12%
Agricultural Runoff (soluable phosphorus)	15%	5%	1%
Barnyard Runoff	3%	90%	3%
Manure Stack Runoff	3%	90%	3%
Runoff of Winterspread Manure	4%	90%	4%
Urban Runoff	4%	10%	1%
Septic Systems(2.)	6%	75%	5%
Atmospheric Deposition (2.)	10%	0%	0%
Load From Friess Lake	11%	38%	4%
Load From Cornell Lake (2.)	11%		
			With Septic System Controls: 33%
			Without Septic System Controls: 28%

1. This figure = (column B)*(column C).
2. Based on information in the North Lake Management Plan, prepared by SEWRPC.. Actions needed to reduce phosphorus loading from septic systems are not currently being taken.

Management Category I. Mason Creek Subwatershed: These are the ranked farms that cumulatively contribute the top 75 percent of that portion of the soil erosion occurring at a rate exceeding three t/a/y. This includes those farms with at least 20 tons/ year soil loss targeted for control. In addition, any fields eroding soil at a rate exceeding seven t/a/y are in this management category.

Management Category I. Little Oconomowoc River Subwatershed: These are the ranked farms that cumulatively contribute the top 75 percent of that portion of the soil erosion occurring at a rate exceeding three t/a/y. This includes those farms with at least 55 tons/ year soil loss targeted for control. In addition, any fields eroding soil at a rate exceeding seven t/a/y are in this management category.

Management Category I. Area draining To North Lake: These are the ranked farms that cumulatively contribute the top 75 percent of that portion of the soil erosion occurring at a rate exceeding three t/a/y. This includes those farms with at least 60 tons/year soil loss targeted for control. In addition, any fields eroding at a rate exceeding seven t/a/y are in this management category.

Management Category II. The remaining lands in the area draining to North Lake that have soil eroding exceeding three t/a/y are placed in this management category.

Management Category III. Fields that are currently eroding less than three t/a/y are not eligible for cost sharing, and as such are placed in this management category.

Since the upland sheet and rill erosion survey did not assess gully erosion, the need for gully controls will be assessed during implementation. Management categories will be assigned to gullies by project staff at the time they are assessed.

2. Barnyard Runoff Sources

Management Category I. Mason Creek Subwatershed: Barnyards in this category include those that cumulatively contribute the top 75 percent of the phosphorus load from this source to surface waters, or any barnyard contributing at least 11 pounds of phosphorus as determined by the ARS Model.

Management Category I. Little Oconomowoc River Subwatershed: Barnyards in this category include those that cumulatively contribute the top 75 percent of the phosphorus load from this source to surface waters, or any barnyard contributing at least 11 pounds of phosphorus.

Management Category I. Area draining to North Lake: Barnyards in this category include those that cumulatively contribute the top 50 percent of the phosphorus load from this source to North Lake, or any barnyard contributing at least 12 pounds of phosphorus.

Management Category II. The remaining barnyards in the area draining to North Lake that have at least some loading of phosphorus to waterways are in this management category.

Management Category III. Barnyards that are well buffered from the surface channel network, and that produce no loading of phosphorus to surface waters are not eligible for cost sharing.

3. Runoff of Winterspread Manure

The needs analysis performed to date is based on potential problems caused by winterspreading of manure on critical lands. There may also be cases where improper storage and spreading of manure during other times of the year is posing a water pollution hazard. Any such hazards will be assessed by local staff during project implementation, and management categories will be assigned.

Management Category I. Mason Creek Subwatershed: Ranked landowners that cumulatively account for the top 75 percent of the critical acres winterspread with manure in the Mason Creek Subwatershed, or anyone spreading at least four critical acres per year during the winter, is placed in this management category.

Management Category I. Little Oconomowoc River Subwatershed: Ranked landowners that cumulatively account for the top 75 percent of the critical acres winterspread with manure in this subwatershed, or anyone spreading at least five critical acres per year during the winter, is placed in this management category.

Management Category I. Area draining to North Lake: Ranked landowners that cumulatively account for the top 50 percent of the critical acres winterspread with manure in the area draining to North Lake, or anyone spreading at least six critical acres during the winter per year, is placed in this management category.

Management Category II. The remaining farms in the area draining to North Lake that winterspread manure on critical lands during the winter are placed in this management category.

Management Category III. Farms that do not currently spread manure on critical lands are placed in this management category.

4. Streambank Erosion

Management Category I. Mason Creek Subwatershed: The sites identified during the inventory to be eroding as a result of roadside failure and agricultural practices will be placed in this management category.

5. Other Agricultural Nonpoint Pollution Sources

Streambank protection measures to correct erosion problems found at other sites during project implementation are eligible for cost sharing. This includes any streambank stabilization needed along a future channel bank that would be created by the permanent removal of the Funk's Millpond dam, but does not include stabilization of the dam site itself. It is expected that such stabilization would be required as a condition of any contract let to remove the dam.

Tile drainage from cropped organic soils may be locally significant, and will be covered as part of a special information and education program dealing with proper fertilizer application.

Measures to control gully and roadside erosion are eligible for cost sharing. Sites will be identified and management categories assigned during implementation.

URBAN POLLUTION CONTROL STRATEGY

The use of information and education programs will be emphasized to control pollution associated with the urban areas in the area draining to North Lake. Primary emphasis will be placed on developing and distributing educational materials in the urban areas located in Merton Township along the shores of North Lake. Secondary emphasis will be placed on other urban areas identified earlier in this chapter. Chapter XIV presents an information and education strategy that will include these urban areas.

Practices needed to control the waterway, roadside, and dump site erosion identified by SEWRPC in the urban part of the North Lake Subwatershed will be eligible for cost sharing provided a need still exists. These sites will be reviewed, and management categories assigned during implementation.

A review and modification of provisions in local codes and ordinances to control construction erosion and urban stormwater runoff should be done by Waukesha County, the Town of Merton, and the villages of Chenequa and Merton. Assistance in this effort will be provided by the Department of Natural Resources through the Nonpoint Source Control Program, as explained in Chapter XIV.

INTEGRATION OF PROGRAMS IN ACHIEVING WATER RESOURCES OBJECTIVES

A Water Quality Management Plan For North Lake, prepared by SEWRPC (1982) includes recommendations in several program areas outside the scope of the Nonpoint Source Control Program.

These recommendations include:

1. modification of local zoning ordinances,

2. provision of sanitary sewer service to portions of the North Lake Subwatershed,

3. revision of the Waukesha County sanitary ordinance to address the operation, maintenance, and inspection of privately owned on-site sewage disposal systems, and

4. establishment of an approved Department of Natural Resources public boat access at North Lake.

The completion of these activities will help realize the water quality goals for North Lake.

CHAPTER VI

THE OKAUCHEE LAKE SUBWATERSHED

EXISTING WATER RESOURCE CONDITIONS

The Okauchee Lake Subwatershed, including the surface areas of its major lakes, encompasses 6,868 acres. Water resources in this subwatershed include: the segment of the Oconomowoc River stretching from North Lake to Okauchee Lake, Okauchee Lake, Lower Okauchee Lake, and Upper Oconomowoc Lake. The location of this subwatershed is shown on Map II-1.

The Oconomowoc River

The portion of the Oconomowoc River located in the Okauchee Lake Subwatershed is approximately two miles long. Chemical, bacteriological, and biological information was collected for this river reach during the years 1973-1979. Sampling points were located as follows: at the outlet to North Lake; at the West Shore Drive bridge crossing, situated midway between the two lakes; and at the County Trunk K bridge crossing, situated just above Okauchee Lake.

Chemical and bacteriological sampling conducted between 1973 and 1977 showed good water quality throughout the entire stream segment (DNR, 1976; SEWRPC, 1982). Dissolved oxygen concentrations and saturations were excellent. Concentrations ranged from eight mg/l to 15 mg/l, with saturations ranging from 85 percent to 120 percent. Although occasionally excessive, phosphorus concentrations averaged .05 mg/l to .08 mg/l at the three sites. Fecal coliform counts were occasionally excessive, but on the average were low. The only problem noted by sampling was excessive inorganic nitrogen concentrations found at all three locations. The nitrate-nitrogen concentrations ranged from .06 mg/l to 1.0 mg/l, and averaged from .43 mg/l to .58 mg/l at the three locations.

Results of fish and aquatic macroinvertebrate sampling conducted at County Trunk K confirm that the water quality in this portion of the Oconomowoc River is good. Two fish samples, collected in 1973 and 1975, had similar characteristics (Fago, 1982). Combined, the samples included 20 species of fish. Forage and panfish dominated the community. The forage fish community was dominated by types needing clean water to thrive, including stonerollers, hornyhead chubs, rainbow darters, and fantail darters. In addition, the slender madtom, an endangered species, was found at this sampling site during 1973 and 1975. The biotic index was calculated for samples collected during the spring and fall of 1979. The spring index was 2.51 and the fall index was 2.74 (DNR Files). Both index values indicate good water quality.

In general, this stretch of the Oconomowoc River has good water quality, as indicated by chemical, bacteriological, and biological sampling. In addition, the physical habitat is excellent for northern pike and walleye spawning (SEWRPC, 1981). Habitat features include gravel and rubble riffle areas, shallow pools, and shallow marsh areas that border parts of the lower river. Portions of the Oconomowoc River between North and Okauchee Lake are posted as a fish refuge during the spring to protect spawning fish.

Okauchee Lake

Okauchee Lake lies in a chain of lakes that also includes Lower Okauchee Lake and Upper Oconomowoc Lake. Okauchee Lake is a natural glacial lake, although its level is artificially maintained nine feet above its natural level by the dam creating Lower Okauchee and Upper Oconomowoc Lakes. Water resources information for these lakes is presented in A Water Quality Management Plan for Okauchee Lake (SEWRPC, 1981), and is summarized below.

Okauchee Lake has a surface area of 1,198 acres, making it the largest of the three lakes. The lake contains a central basin, that underlies 30 percent of the lake's surface. Here waters range in depth from 40 feet to 115 feet. The lake also contains an extensive area of shallows, where waters less than five feet deep underlie seven percent of the lake surface, and waters less than 10 feet underlie almost 50 percent of the lake surface. This extensive shallow area is due, in part, to the dam on Upper Oconomowoc Lake, which raises the water level on Okauchee Lake approximately nine feet above its natural level.

A hydrologic budget was estimated for the 1976-77 period by the Southeastern Wisconsin Regional Planning Commission. The hydrologic budget indicated that 68 percent of the inflow was via the Oconomowoc River, 18 percent was from groundwater, 10 percent was from precipitation, and four percent was from surface runoff in the direct drainage area. Both the Oconomowoc River and groundwater were important as outflow from the lake. The river accounted for 59 percent of the outflow, and groundwater accounted for 30 percent of the outflow. The residence time of water in Okauchee Lake during a year of average precipitation is about 10 months.

The groundwater flow direction was monitored in order to prepare the hydrologic budget for Okauchee Lake. Only the northeast area of the lakeshore was strictly a groundwater inflow zone. The northern and eastern shores of the lake were transition zones, where groundwater flow directions were determined to vary. The southern and western shores were zones of groundwater outflow.

Public boat access to Okauchee Lake is adequate. There are two publicly owned access sites, one owned and operated by the DNR and one by the Town of Oconomowoc. In addition, there are eight privately owned boat access sites. There are no public beaches along the lakeshore.

Water resources information collected for Okauchee Lake indicates that the deeper portions of the lake exhibit characteristics of a meso-eutrophic, or moderately fertile lake, while the shallower portions of the lake exhibit the nuisance characteristics of more eutrophic waters. Aquatic weed growths in Okauchee Lake during 1976-77 were moderate to high over nearly half of the lake bottom where waters are shallow. These weeds reached the water surface over nearly 20 percent of the lake. These weeds included heavy growths of coontail and water milfoil, which are often indicative of fertile lakes. Aquatic weeds are harvested from the entire shoreline of Okauchee Lake within 20 to 30 feet of the shore, three to five times per year, in order to improve the lake for recreational use. In addition there is an active program of chemical weed control. These programs are maintained by the Okauchee Lake Management District.

Algae populations were surveyed in Okauchee Lake during 1976-77. Although algae concentrations were relatively low during the summer, chlorophyll concentrations sufficient to cause visual impairment of lake water clarity have been noted in the 1973-1978 period of record. Algae bloom conditions are common in the many bays of Okauchee Lake, where an active program of chemical algae control is pursued by the Lake District.

Dissolved oxygen measurements taken in the lake from 1973-1977 indicate that total oxygen depletion occurs in portions of the bottom waters during the period of summer stratification. This condition was also recorded in the lake during the early 1900s, when oxygen depletion contributed to a major summer kill of cisco, a coldwater fish species. There appears to have been little change in the summer dissolved oxygen characteristics of Okauchee Lake over the 70-year period of record. During winter, oxygen concentrations appear adequate in most waters of the open lake to support fish and other aquatic life. Winterkill of fish has been a problem, however, in some of the shallow, localized bays.

Okauchee Lake supports a large and relatively diverse community of warm water fish, including a variety of forage fish, panfish, and larger sportfish including walleye, smallmouth bass, largemouth bass, and northern pike. The DNR stocked many of these species in Okauchee Lake between 1933 and 1957. In 1978, walleye fingerlings were stocked in the lake.

Table VI-1 summarizes phosphorus, chlorophyll, and secchi depth measurements made between 1973 and 1978 on Okauchee Lake. These measurements should be considered representative only of the deeper lake waters, and not of the many shallow bays. This table shows that the water quality was generally good. However, the potential exists for some deterioration of the water quality, based on the amount of phosphorus present in the lake. Table VI-2 shows the chlorophyll and water clarity conditions which might be expected in Okauchee Lake as a result of the existing phosphorus concentrations. This table shows that, on the average, less clear water might be expected than what was measured during the 1973-1978 period. The reason why the lake clarity is not as degraded as expected, based on the phosphorus concentrations, is not clear, although this phenomenon has been noted to be common for lakes in southeastern Wisconsin (Lillie and Mason, 1983).

Finally, periodic dredging has been required to maintain a suitable depth in the navigation channel connecting Tierney Bay and Okauchee Lake. Although the channel was dredged in the summer of 1985, upland erosion and channel bank slumping will eventually fill the channel with sediment, making it nonnavigable by power boats or aquatic weed harvesting equipment needed for the bay. In addition, sedimentation of Icehouse Bay, caused by the reconstruction of State Highway 16, has resulted in decreased water depths and more substrate for aquatic weed growth.

Lower Okauchee and Upper Oconomowoc Lakes

Lower Okauchee and Upper Oconomowoc lakes were formed in 1911 and 1961 respectively by damming the Oconomowoc River below Okauchee Lake. Both lakes are small and shallow. Lower Okauchee Lake is 47 acres, has a maximum depth of 14 feet and an average depth of 7.6 feet. Upper Oconomowoc Lake is

Table VI-1. Existing Water Quality Conditions For Okauchee Lake(1.)

Water Quality Parameter	Range	Average	Trophic Status Index	Wisconsin Lakes Water Quality Index (2.)
Total Phosphorus(3.) (mg/l)	.01 to .05	0.03(4.)	53 (mesotrophic)	good
Chlorophyll-a(5.) (ug/l)	4.0 to 14.9	8.9	52 (mesotrophic)	good
Secchi Disc Depth(5.) (feet)	4.7 to 8.5	7.3	48 (mesotrophic)	good

1. Water quality data from the Okauchee Lake Management Plan prepared by the Southeastern Wisconsin Regional Planning Commission.
These data are for the main lake basin only, and do not reflect water quality conditions in the many bays that occur along the shoreline of the lake.
2. See Table III-2.
3. Concentration during spring turn-over.
4. Concentration may be slighltly elevated due to arsenic interference with test.
5. Average summer values.

Table VI-2. Expected Algae and Water Clarity Conditions In Okauchee Lake Resulting From Total Phosphorus Concentrations Measured In The Lake(1.)

Parameter	Measured Value	Calculated Value	Trophic Status Index	Wisconsin Lakes Water Quality Index(2.)
Total Phosphorus (mg/l)	0.03(3.)			
Chlorophyll-a (ug/l)		11	54 (meso-eutrophic)	fair
Secchi Disc Depth (feet)		4.6	55 (meso-eutrophic)	poor

1. These conditions describe the long-term potential water quality for the main lake basin only, and not for bays along the shoreline.
2. See Table III-2.
3. This concentration may be slightly elevated due to arsenic interference.

36 acres, has a maximum depth of 14 feet and an average depth of 7.4 feet. Both lakes were formed over what was primarily marshland, and as a result have mucky, nutrient-rich bottoms.

The hydrology of these lakes is dominated by the Oconomowoc River, which accounts for 97 percent of the inflow and outflow. Groundwater flow during 1976-77 moved in a southerly direction, away from these two lakes. The residence times for water in each of these two lakes during a year of normal precipitation is less than one week.

Water quality information for these two lakes is limited, but enough information exists to indicate these lakes are fertile. Water clarity was measured in these lakes during the summer of 1977. In Lower Okauchee Lake, the summer secchi depth ranged from five to 7.7 feet, averaging 6.7 feet. Upper Oconomowoc Lake had secchi depths ranging from 4.7 to 7.1 feet, with an average of 5.5 feet. These average water clarity measurements are indicative of meso-eutrophic lakes.

The most serious use problem in these lakes is weed growth, which covers 75 to 80 percent of the lake bottoms. Weed species present include milfoil and coontail, generally considered indicative of enriched waters. The same aquatic weed control program used on Okauchee Lake, including mechanical harvesting and chemical control, is used on these two lakes.

Because these lakes are shallow and their water volumes are replaced in such a short time, the lakes do not stratify during the summer. As a result, there is no depletion of dissolved oxygen, and the oxygen concentrations are high enough at all depths throughout the year to support fish and other aquatic life.

LAND USE AND NONPOINT POLLUTANT SOURCES

Table III-4 shows the portion of the Okauchee Lake Subwatershed inventoried for land use and nonpoint pollutant sources. The inventory corridor included 3,361 acres, or 48.9 percent of the subwatershed. The lands inventoried were almost equally divided between urban and rural land uses. Rural lands in the inventory corridor covered 1,823 acres while urban lands in the inventory corridor covered 1,538 acres.

Table III-5 shows the composition of rural lands inventoried in the subwatershed. Row crops comprise the most significant part of the rural land use. These croplands cover 1,006 acres, or slightly over half of the rural inventory area. Two-thirds of the acres in row crops, or 640 acres, are planted in rotation. The remaining one-third of the cropland acres, or 346 acres, are planted to row crops year after year. Little of this cropland has conservation practices applied at this time.

The remaining acreage has little potential for generating pollutants. Grasslands and wetlands cover 519 acres, or 28 percent of the rural inventory corridor, while generally well-managed pastures and woodlots cover 308 acres, or 16 percent of the rural inventory corridor.

Much of the agricultural land in the inventory corridor is internally drained, and does not pose a threat to surface waters. Tables III-6 and III-7 present the characteristics of the soil erosion problem on only those inventoried lands in the Okauchee Lake Subwatershed having a potential to contribute sediment and associated pollutants to the surface water system.

Table III-6 shows that an estimated 2,030 tons of soil are eroded in the Okauchee Lake Subwatershed each year as a result of upland sheet and rill erosion. Thirty-one per cent of the sheet and rill erosion in the subwatershed is coming from lands losing soil at a rate less than three tons per acre per year (t/a/y). These lands are not targeted for control practices. The remaining 69 percent of the sheet and rill erosion is coming from lands targeted to receive control practices. Two percent of the sheet and rill erosion is coming from lands losing soil at a rate of three to five tons/acre/year, 54 percent is coming from lands losing soil at a rate of five to 10 t/a/y, and 13 percent of the sheet and rill erosion occurs on lands losing soil at a rate exceeding 10 t/a/y.

A determination was made during the initial phases of the inventory that streambank erosion along the Oconomowoc River, and roadside erosion were not widespread enough to warrant a detailed survey. A detailed assessment of gully erosion in rural portions of the inventory corridor was not made during this nonpoint source inventory, either. It is expected, however, that streambank, roadside and gully stabilization needs will be found in some areas by LCC staff during project implementation. This is indicated by a preliminary inventory of nonpoint sources in the Okauchee Lake Subwatershed made during preparation of A Water Quality Management Plan For Okauchee Lake (SEWRPC, 1981). This inventory, summarized in a SEWRPC staff memorandum concerning urban and rural nonpoint sources of water pollution in the Okauchee Lake Subwatershed (SEWRPC, 1981) found 38 sites where soil erosion was a concern.

Seven of these sites (site numbers 13, 20, 21, 30, 31, 36 and 38) included gully erosion, roadside erosion, and streambank erosion sites in the inventory corridor established for this priority watershed project. Specifically, sites identified that are in the rural inventory corridor include five sites of waterway erosion covering 2.5 acres, one site of roadside erosion covering .1 acre, and one site of streambank erosion stretching 2,000 feet. The LCC staff will use these preliminary inventory results as a start in identifying gully erosion, streambank erosion, and roadside erosion needs in the subwatershed. These needs will be identified, and management categories assigned during implementation of this priority watershed plan.

A detailed lakeshore erosion survey was conducted using a boat to scan the shoreline of Okauchee Lake. Although shoreline erosion is a common concern of many lakeshore property owners who may be losing property, only those areas judged to be having a significant impact on the public use of the lake were considered critical areas for purposes of the Wisconsin Nonpoint Source Water Pollution Abatement Program. One critical site was identified. This is the shoreline of the Tierney Bay navigation channel, which connects the bay to Lake Okauchee. Eroding uplands and slumping channel banks resulted in the channel becoming nonnavigable for power boats and weed cutting equipment.

The channel was dredged in the summer of 1985, and use of the channel is now very heavy. The uplands and channel banks need stabilization to maintain the navigation channel and provide greater public use of both the lake and Tierney Bay.

Tables III-8 and III-9 show the pollution potential from animal waste in the Okauchee Lake Subwatershed. These tables show that animal waste is of little concern as a pollution source in this subwatershed. Table III-8 shows that of the five livestock operations in the subwatershed, four are either hydrologically disconnected from the Oconomowoc River and Okauchee Lake, or are so well buffered from these waters that the phosphorus is filtered from the runoff water before entering the surface channel network. The sole barnyard that contributes phosphorus to the surface channel network constitutes a small portion of the phosphorus load to the lake.

Table III-9 shows that there are no critical lands predicted to be spread with manure during the winter in the Okauchee Lake Subwatershed. However, manure spread or stored on unsuitable lands during other times of the year may pose a pollution hazard. Where these problems occur, they will be identified by project staff during implementation.

Table III-11 shows the pollutant generation from lands within the urban inventory corridor of the Okauchee Lake Subwatershed. This table shows that about 156 tons of suspended solids, 655 pounds of phosphorus, and 254 pounds of lead are generated annually by all lands within the urban inventory corridor. The urban area thus contributes 12 percent of the phosphorus load (see Table VI-6), and virtually all of the lead load, to Okauchee Lake.

Table VI-3 shows the composition and pollution potential of the different urban land uses in the Okauchee Lake Subwatershed. This table shows that traditional urban land uses, such as residential, commercial, industrial, and construction areas, encompass about 75 percent of the land uses inventoried in the urban corridor. The remaining areas are actually rural land uses contained within the urban inventory corridor. These residential, commercial, industrial, and construction areas generated 97 percent of the suspended solids, 98 percent of the phosphorus, and 99 percent of the lead loads coming from within the urban inventory corridor.

Table VI-3 shows that the major urban land use in the Okauchee Lake Subwatershed is residential. The 1075 acres of residential land use account for 92 percent of the urban land area, 69 percent of the suspended solids generation, 72 percent of the phosphorus generation, and 50 percent of the lead generation from the urban area. These residential areas do not have curb and gutter drainage. In many areas, there is grassed swale drainage, which provides excellent infiltration and pollutant filtering. In some areas, however, the grassed swales have been destroyed by homeowners to facilitate lawn maintenance, and runoff waters are channeled along the gravel road shoulders. Residences along most of the shoreline have lawns established between the driveways or roads and the lake. This provides additional buffering.

Although these residential areas already have, for the most part, characteristics that limit the generation and transport of pollutants to these

Table VI-3.Estimated Pollutant Generation From Urban Land Uses In The Okauchee Lake Subwatershed(1.)

		Pollutant Generation(Lbs./Year)		
Land Use	Area(acres)	Suspended Solids	Phosphorus	Lead
Low Density Residential	445	9980	18	4
Medium Density Residential(2.)	249	39202	102	45
Medium/High Density Residential(2.)	381	159722	343	76
Commercial(2.)	78	64743	120	123
Industrial(2.)	1	396	1	1
Construction	19	29826	56	2
SUBTOTAL	1173	303919	640	251
Other(3.)	365	8149	15	3
TOTAL	1538	312068	655	254

1. Data compiled by the Southeastern Wisconsin Regional Planning Commission.
2. Pollutant loads from these land uses will affect mainly the extreme southwestern bay of Okauchee Lake, Lower Okauchee Lake, and Upper Oconomowoc Lake. This is because these pollutant loads enter near the outlet of Okauckee Lake.
3. These lands include rural land uses contained within the urban area. Wetlands, woodlands, recreation lands, and open lands are included.

lakes, they can pose a water pollution threat where housekeeping practices are poor. Lawn fertilizers and pesticides, leaves, leaf ashes from burning, grass clippings, and improperly disposed waste oil or household chemicals can all contaminate the lakeshore waters.

The distribution of these residential areas around Okauchee Lake is significant. In general, the low density residential areas, which produce low unit area loads of pollutants, occur along the northern, eastern, and western shores of the lake. There are four storm sewers or drainage ditches draining to the lake from these areas. The medium and medium/high density residential areas are mainly confined to the southern end of Okauchee Lake, and to Lower Okauchee Lake. Since these are the areas producing most of the urban pollutant load to the lake, the urban impact can be expected in the lower part of Okauchee Lake, Lower Okauchee Lake, and Upper Oconomowoc Lake, other than in the main lake basin. There are two storm sewer outfalls or drainage ditches draining to Lower Okauchee Lake from this area, and four draining to Upper Oconomowoc Lake.

The commercial land use comprises 78 acres, or only six percent of the urban area in the subwatershed. This commercial area generates 21 percent of the suspended solids, 19 percent of the phosphorus, and 49 percent of the lead from the urban lands. These commercial areas are located at the southern end of Okauchee Lake, near the lake outlet to Lower Okauchee and Upper Oconomowoc Lake. A small portion of the street surface in the commercial area is provided with curb and gutter drainage. There are two storm sewer outfalls that drain this commercial area. These outfalls drain to Lower Okauchee Lake. These street areas, located in the Village of Okauchee, are currently swept about once per year by Waukesha County.

Industrial and construction land uses are not significant in area, although construction areas are estimated to be producing about 10 percent of the suspended sediment and phosphorus coming from the urban lands.

Roadside erosion sites, gully erosion sites, and other sites where erosion requires stabilization were not specifically identified as part of this priority watershed project. However, needs in these areas can be expected to occur. This is indicated by a preliminary inventory of nonpoint sources in the Okauchee Lake Subwatershed made during preparation of A Water Quality Management Plan For Okauchee Lake (SEWRPC, 1981). This inventory, summarized in a SEWRPC staff memorandum concerning urban and rural nonpoint sources of water pollution in the Okauchee Lake Subwatershed, revealed 27 erosion sites in the urban portions of the subwatershed. Of these 27 sites, eight were eroding construction sites, and six were shoreline erosion sites. The eroding construction sites were re-inventoried for this priority watershed plan, and no significant problems were found. Similarly, the lakeshore erosion survey found no significant sites other than the Tierney Bay Channel site discussed earlier in this chapter.

The remaining 14 sites include waterway erosion, roadside erosion, and other areas needing stabilization. These site numbers are 40, 42, 43, 44, 45, 46, 48, 51, 52, 54, 55, 57, 59 and 61.

Specifically, the preliminary inventory revealed three sites of waterway erosion covering 1.6 acres, four sites of roadside erosion covering 2.7 acres, and seven sites of general erosion covering 2.5 acres. The LCC staff will use these preliminary inventory results as a basis in identifying gully, roadside, or other erosion needs in the urban area of the subwatershed. These needs will be identified, and management categories assigned during implementation of this priority watershed plan.

Construction erosion associated with the reconstruction of State Highway 16 has been a concern. The State Highway 16 project involves a total of about 12 miles between Pewaukee and Oconomowoc. During 1978-79, 8.6 miles of the reconstruction was completed before the project was suspended due to lack of funding. The suspension of work resulted in some unstabilized roadcuts along the highway right-of-way in the direct drainage to Okauchee Lake. These unprotected roadcuts resulted in sedimentation in Icehouse Bay. The roadcuts were eventually stabilized, but renewed construction of the highway, scheduled for 1987-89, could pose a threat to Icehouse Bay if construction erosion controls are not used. Stormwater runoff from the completed highway could also pose a water quality threat to the bay if appropriate control measures are not incorporated into the highway designs. The Wisconsin Department of Transportation is currently investigating alternative stormwater discharge locations in in order to minimize the impact on Icehouse Bay.

WATER RESOURCES OBJECTIVES

The Oconomowoc River

The water resources objectives for the portion of the Oconomowoc River between North Lake and Okauchee Lake include: 1) protecting the game fish spawning areas and the resident forage fish community by maintaining the adequate dissolved oxygen, low phosphorus, and good physical habitat conditions that currently exist on this part of the river, and 2) protecting the existing recreational quality of the river by maintaining the high bacteriological quality of the water currently existing in this part of the river.

Okauchee Lake, Lower Okauchee Lake and Upper Oconomowoc Lake

The water resource goal for these lakes is stated in A Water Quality Management Plan For Okauchee Lake (SEWRPC, 1981). The stated goal is to provide a level of water quality in the lakes suitable for full recreational use and support of a healthy warmwater fishery. Five specific problems identified earlier in this chapter need to be discussed with respect to this goal. These are:

1. the moderately high phosphorus concentrations in the central basin of Okauchee Lake, which increases the potential of the lake to develop more frequent and severe water quality problems associated with algae growth,

2. the extensive nuisance growths of aquatic weeds in these lakes,

3. the depletion of dissolved oxygen in the bottom waters of Okauchee Lake during the summer,

4. occasional winterkill of fish in isolated bays of Okauchee Lake, and

5. impaired navigation in the Tierney Bay Channel.

As discussed below, the Nonpoint Source Control Program alone will have little impact on most of these problems, but can serve to protect the lakes from further degradation.

The Southeastern Wisconsin Regional Planning Commission has established a criterion of .02 mg/l phosphorus in these lakes at spring turn-over as a means to reduce their eutrophic potential to a level consistent with meeting water quality goals. A secondary criterion of .03 mg/l phosphorus for southeastern Wisconsin lakes has been suggested in the literature as a means of achieving "good" water quality (Lillie and Mason, 1983).

Table VI-4 shows the reduction in the existing phosphorus loading to Okauchee Lake that is needed to achieve various concentrations of inlake phosphorus, and consequently various degrees of water quality. Although the secondary criterion is already being met in Okauchee Lake, a 33 percent reduction in the phosphorus loading is needed in order to achieve the .02 mg/l phosphorus criterion recommended by SEWRPC. It is important to note that these estimates apply only to the central basin of the lake, and not to the many shallow bays or the other two lakes.

Table VI-5 shows the relative importance of all phosphorus sources in the drainage to Okauchee Lake, summarizes the percent reduction of the phosphorus load from each of these sources that we can expect to achieve under ideal circumstances, and estimates the phosphorus load reduction that might be achieved for Okauchee Lake.

Several important conclusions can be drawn from Table VI-5. The feasible reduction in the phosphorus load to Okauchee Lake is only 20 percent from control of rural and urban nonpoint sources. The control of septic systems would be required to bring about a 33 percent reduction in the phosphorus load.

Also important is the distribution of these sources around Okauchee Lake. Since much of the potential for pollution from septic systems and the urban areas occurs near the southern end of the lake, reduction of phosphorus loads from these sources will have a limited impact on the main lake basin of Okauchee Lake. The impact on Lower Okauchee Lake and Upper Oconomowoc Lake is more difficult to assess. There could be some impact on shallow bays in these lakes, but the water quality of Okauchee Lake will continue to determine the trophic status of these two lakes since it provides most of the nutrient loading. Control of septic systems may not be a factor for Lower Okauchee Lake and Upper Oconomowoc Lake, since previous mapping of the groundwater flow network indicated that the groundwater flow is away from these lakes.

The objectives of the Nonpoint Source Control Program for the Okauchee Lake Subwatershed are:

1. to maintain the aesthetic qualities of Okauchee, Lower Okauchee, and Upper Oconomowoc lakes. This will be done by reducing the phosphorus load to

Table VI-4. Estimated Water Quality Impacts On Okauchee Lake From Different Phosphorus Loading Reduction Levels

		PREDICTED AVERAGE CONDITIONS				
Phosphorus Load (lbs.)	Reduction From Present Load	Total Phosphorus (mg/l)	Chlorophyll-a (ug/l)	Secchi Disc Depth (ft.)	Trophic Status Index	Wisconsin Lakes Water Quality Index(1.)
6720(2.)	0	.03(3.)	10.9	4.6	55	fair to good
5846	13%	0.026	9.5	5	53	good
4973	26%	0.022	8.2	5.4	51	good
4480	33%	0.02 (4.)	7.5	5.6	50	good

1. See Table III-2.
2. This is the estimated existing load based on the Dillon-Rigler Model and an in-lake phosphorus concentration of .03 mg/l.
3. This is the secondary criterion proposed for Okauchee Lake.
4. This is the primary standard established for Okauchee Lake by the Regional Planning Commission.

these lakes through urban and rural nonpoint source practices. Although the inlake phosphorus concentrations are not expected to decrease significantly as a result of these practices, the load reduction will comprise an important first step towards the .02 mg/l phosphorus concentration established by SEWRPC as desirable for these lakes.

2. to protect these waterbodies from developing water quality problems associated with lead and other toxic materials present in urban runoff.

3. to improve the long term navigability of the Tierney Bay Channel, by decreasing sedimentation from eroding channel banks and uplands.

4. to protect the lakes from construction erosion and stormwater runoff, by encouraging development of necessary ordinances.

The Nonpoint Source Control Program will not have a noticeable impact on the nuisance growths of aquatic weeds in these lakes, for two reasons. First, the predicted reduction in the phosphorus load is anticipated to be small. Secondly, the rooted weeds can also use the bottom sediments as a phosphorus source. A combination of mechanical or chemical weed control, and selective dredging, as outlined in A Water Quality Management Plan For Okauchee Lake, will be needed to alleviate problems caused by weed growths in the extensive shallow areas of these lakes.

The Nonpoint Source Control Program will not have a noticeable impact on low dissolved oxygen concentrations in the bottom waters of Okauchee Lake during periods of summer stratification, or on winterkill conditions that occur as isolated instances in some of the bays of Okauchee Lake.

RURAL NONPOINT SOURCE CONTROL STRATEGY

Table III-7 shows that 126 acres of control practices will be needed to bring the sheet and rill erosion rate on these lands down to a range acceptable for purposes of water quality protection. Conservation tillage will be the practice most widely recommended, with an estimated 108 acres needed. In addition, 18 acres of pasture management will be needed. Table III-7 shows that the application of conservation tillage and pasture management practices on upland areas will reduce the soil erosion on lands constituting a high pollution hazard by 46 percent.

The proposed strategy for controlling rural nonpoint pollutant sources is presented below. Changes may be needed in the inventory data as each site in the rural areas is visited by project staff during implementation. When this occurs, changes in the rural pollution control strategy may be made to reflect the new information.

Pollutant Management Categories for each major type of source are as follows:

1. Upland Sheet and Rill Erosion Sources

   - Management Category I. These are the ranked farms which cumulatively contribute the top 50 percent of the portion of the soil erosion that is occurring at a rate greater than three tons/acre/year, or those

Table VI-5. Feasibility of Reducing The Phosphorus Loading To Okauchee Lake

Pollutant Source Category	Portion of the Phosphorus Load Contributed By The Source Category	Portion of Phosphorus Load That Can Reasonably Be Removed From The Source Category	Feasible Phosphorus Load Reduction(1.)
Agricultural Runoff (sediment phosphorus)	3%	46%	1%
Agricultural Runoff (soluable phosphorus)	3%	5%	<1%
Barnyard Runoff	1%	90%	<1%
Manure Stack Runoff	1%	90%	<1%
Urban Runoff	13%	30%	4%
Septic Systems(2.)	13%	99%	13%
Atmospheric Deposition (2.)	12%	0%	0%
Load From North Lake	54%	28%	15%
			Total without septic sys control: 20%(3.)
			Total with septic system control: 33%(3.)

1. This figure = (column B)*(column C).
2. Based on information in the Okauchee Lake Management Plan, prepared by SEWRPC.. Actions needed to reduce phosphorus loading from septic systems are currently being investigated through a feasibility study. This study is limited to septic systems along the lake in the Town of Oconomowoc.
3. The total feasible reduction is valid only for the extreme southwesterly bay of Okauchee Lake, Lower Okauchee Lake, and Upper Oconomowoc Lake. This is because most of the urban pollutant loading and a significant portion of the septic system loadings occur near the outlet of Okauchee Lake.

farms having at least 240 tons/year of soil erosion targeted for control. In addition, any single field in the inventory corridor eroding at a rate exceeding seven t/a/y will be placed in this management category.

- Management Category II. The remaining lands in the Okauchee Lake Subwatershed that have soil erosion exceeding three t/a/y will be placed in this management category.

- Management Category III. Fields that are currently eroding less than three t/a/y are not eligible for cost sharing, and are placed in this management category.

Since the rural upland sheet and rill erosion survey did not assess waterway, gully, or streambank erosion sites, the need for controlling these sources will be assessed during implementation. The five sites of waterway erosion, one site of roadside erosion, and one site of streambank erosion identified by the preliminary inventory of rural nonpoint sources conducted during 1981-82 will be reviewed to determine their significance as sources of sediment. Management categories will be assigned to these sources by project staff at the time they are assessed. In addition, other sites may be identified and assessed.

2. Barnyard Runoff Sources

- Management Category II. The only barnyard contributing phosphorus to surface waters in the Okauchee Lake Subwatershed is placed in this management category.

- Management Category III. Barnyards that are well buffered from the surface channel network, and that produce no loading of phosphorus to the surface waters according to the ARS Model, are not eligible for cost sharing.

3. Runoff of Winterspread Manure

- Management Category III. Farms that currently receive no winterspread manure on critical acres are placed in this management category for manure spreading. This currently is estimated to include all five livestock operations in the subwatershed. The assignment of management categories for manure spreading may be amended to take into consideration the improper storage or spreading of manure during other times of the year.

4. Shoreline Protection

- Management Category II. The Tierney Bay Channel bank erosion and associated upland erosion is placed in this management category.

- Management Category III. In general, other lakeshore erosion sites will be placed in this category, unless a significant impact on public use of the lake can be shown.

URBAN POLLUTION CONTROL STRATEGY

On-site infiltration of rainfall runoff waters is generally good for the types of residential areas found in the Okauchee Lake Subwatershed, and the existing grass swale drainages provide additional infiltration of runoff waters, and some pollutant filtration, where they occur. Information and education programs will be the main tool used to control pollution associated with the urban land uses in the Okauchee Lake Subwatershed. The goal of the information and education program will be to promote good housekeeping practices in the subwatershed, so that the amounts of nutrients, sediment, and hazardous materials available for transport to the lake will be reduced. Details of the information programs for urban areas are presented in Chapter XIV.

A closer assessment of the need and practicality of controlling lead and other toxic materials in the urban runoff to Okauchee Lake will be made by the Department of Natural Resources during plan implementation.

In addition, practices needed to control gully erosion and roadside erosion in urban areas will also be eligible for cost sharing. These sites will be identified by the LCC staff during project implementation. The preliminary urban inventory data collected during 1981-82 will be used as a basis for identifying sites needing erosion controls. The LCC staff will make a determination of management categories for each site at that time. Other sites will be identified and assessed as needed.

A Water Quality Management Plan For Okauchee Lake (SEWRPC, 1981) recommends implementation of construction erosion control ordinances by Waukesha County, the City of Delafield, the villages of Chenequa and Oconomowoc Lake, and the towns of Merton, Oconomowoc, and Summit. As part of the urban pollution control strategy for Okauchee Lake, the Nonpoint Source Control Program will encourage, and provide some support, for the modification or development of construction erosion and stormwater management ordinances where it is felt appropriate for water quality purposes. Chapter XIV of this plan details how this assistance will be made available.

Finally, the Wisconsin Department of Natural Resources, the Wisconsin Department of Transportation (DOT), and Waukesha County will work together to assure that the construction and post-construction runoff from the State Highway 16 reconstruction project will have minimal environmental impacts. This cooperation will be an outgrowth of the agreement between the DNR and DOT to minimize environmental impacts associated with highway projects.

INTEGRATION OF PROGRAMS IN ACHIEVING WATER RESOURCES OBJECTIVES

A Water Quality Management Plan For Okauchee Lake, prepared by the Southeastern Wisconsin Regional Planning Commission (1981), includes recommendations in several program areas outside the scope of the Nonpoint Source Control Program. They include:

1. modification of local zoning ordinances,

2. provision of sanitary sewer service to portions of the drainage area directly tributary to the lake,

3. revision of the Waukesha County Community Health Code to address the operation, maintenance, and inspection of privately owned on-site sewage disposal systems that would not be eliminated by the proposed sanitary sewerage system, and

4. continuation of existing lake management activities, such as weed cutting.

CHAPTER VII

THE OCONOMOWOC LAKE SUBWATERSHED

EXISTING WATER RESOURCE CONDITIONS

The Oconomowoc Lake Subwatershed, including the surface area of the lake, encompasses 2,760 acres. Oconomowoc Lake is the principle surface water resource in the subwatershed, which is identified on Map II-1.

Oconomowoc Lake

The following water resource description is summarized from a preliminary draft of A Water Quality Management Plan For Oconomowoc Lake, being prepared by the Southeastern Wisconsin Regional Planning Commission (SEWRPC, 1985).

Oconomowoc Lake is the fourth of six major lakes in the Oconomowoc chain of lakes, and has a surface area of 804 acres. The lake has an average depth of 30 feet and a maximum depth of 62 feet. There is relatively little shallow area, with 41 percent of the lake having a depth of five to 40 feet and 43 percent of the lake having depths exceeding 40 feet. Bottom materials along the entire shoreline consist of gravel, rock, sand, and marl (deposits containing calcium carbonate), with little or no silt or muck present.

A hydrologic budget prepared by SEWRPC for the 1976-1977 period shows the Oconomowoc River dominates the lake hydrology, providing 76 percent of the inflow and 93 percent of the outflow. Groundwater accounts for 16 percent of the inflow, and there are many springs located along the lakeshore. During 1976-77, all groundwater gradients measured were towards the lake. The remaining components of the hydrologic budget include: precipitation, accounting for five percent of the inflow; overland runoff, accounting for three percent of the inflow; and evaporation, accounting for six percent of the outflow.

The lake consists of two basins, which are nearly separated hydrologically by a bedrock sill that comes within three feet of the surface. Although the northern basin is smaller, the water residence time is estimated to be twice that of the larger basin which contains both the inlet and the outlet. The residence time of the entire lake is estimated to be 1.2 years.

Public access to Oconomowoc Lake is adequate, principally due to a public boat access located just below the outlet of Okauchee Lake. This access is owned by the Village of Oconomowoc Lake and leased to a private operator. Provisions will be made by the Wisconsin Department of Transportation to maintain access at this site following the pending reconstruction of State Highway 16. In addition to this access site, there are three walk-in trails and a privately owned boat ramp.

Water resources information available for Oconomowoc Lake indicates it is a mesotrophic, or moderately fertile, lake. A study of aquatic weeds made during August 1976 found sparse to moderate growth. The weed population was relatively diverse, with stonewort being dominant in all areas. This species

Table VII-1. Existing Water Quality Conditions For Oconomowoc Lake(1.)

Water Quality Parameter	Range	Average	Trophic Status Index	Wisconsin Lakes Water Quality Index (2.)
Total Phosphorus(3.) (mg/l)	.01 to .09	0.03	53 (mesotrophic)	good
Chlorophyll-a(4.) (ug/l)	.1 to 8.4	3.9	44 (mesotrophic)	very good
Secchi Disc Depth(4.) (feet)	7.5 to 24.0	12.6	41 (mesotrophic)	very good

1. Water quality data from the Oconomowoc Lake Management Plan prepared by the Southeastern Wisconsin Regional Planning Commission.
2. See Table III-2.
3. Concentration during spring turn-over.
4. Average summer values.

Table VII-2. Expected Algae and Water Clarity Conditions In Oconomowoc Lake Resulting From Total Phosphorus Concentrations Measured In The Lake

Parameter	Measured Value	Calculated Value	Trophic Status Index	Wisconsin Lakes Water Quality Index(1.)
Total Phosphorus (mg/l)	0.03			
Chlorophyll-a (ug/l)		11	54 (meso-eutrophic)	fair
Secchi Disc Depth (feet)		4.6	55 (meso-eutrophic)	poor

1. See Table III-2.

tends to grow in areas where the bottom, in which it is rooted, contains relatively few nutrients. Blue-green algae, which are most commonly associated with nuisance conditions, were the dominant type found during the summer recreation period of 1976-77. However, chlorophyll-a concentrations during the summer were typically below the level associated with visual impairment, and algae growth in general is not likely to inhibit recreational uses. This may be due in part to heavy grazing of the algae by zooplankton, since phosphorus concentrations in the lake are high enough to support more abundant growths of algae.

Chemical applications to control lake weeds and algae have not been used on Oconomowoc Lake since 1974-1975. Swimmer's itch, caused by a microscopic parasite, has been a regular problem in the lake, however, and has required chemical control applications since at least 1965.

Data for Oconomowoc Lake collected during 1976-77 showed adequate dissolved oxygen during the winter. Winterkill of fish due to low dissolved oxygen concentrations has not generally been a problem. During periods of summer stratification, however, there is total oxygen depletion in the bottom waters of the lake.

In 1970, Oconomowoc Lake was reported to have a well-balanced population of game and panfish. Fish collections made during 1975 included two watch species. These are the least darter and the pugnose shiner. Overall, the fish population is large, diverse, and considered to reflect good water quality. Similarly, the community of bottom-dwelling organisms reflects this good water quality, with the dominant species being one indicative of mesotrophic lakes.

Table VII-1 summarizes phosphorus, chlorophyll, and secchi depth measurements made in Oconomowoc Lake during 1976-77. These three parameters are commonly used to assess the trophic status of lakes (see Chapter III). This table shows good water quality with respect to phosphorus, although the concentrations observed are slightly higher than those believed necessary to support nuisance algae blooms. Water quality is very good with respect to chlorophyll-a and water clarity.

Table VII-2 includes estimates of the long-term eutrophic potential of Oconomowoc Lake, based on the amount of phosphorus in the lake. This table shows that there is currently less algae and greater water clarity than might be expected, given the moderately high level of nutrient enrichment in the lake. In fact, the observed water clarity in the lake is characteristic of oligotrophic lakes, or those lakes which are very low in nutrients. The low trophic response to nutrient enrichment is typical of lakes in southeastern Wisconsin (Lillie and Mason, 1983). In the case of Oconomowoc Lake, intensive grazing pressure on algae populations by zooplankton may be in part responsible for the low chlorophyll-a concentrations and the good water clarity (SEWRPC, 1985).

LAND USE AND NONPOINT POLLUTION SOURCES

Table III-4 shows the portion of the Oconomowoc Lake Subwatershed inventoried for land use and nonpoint pollution sources. The inventory corridor included

1,317 acres, or about 48 percent of the subwatershed. The lands inventoried were almost equally split between urban and rural land uses. Rural lands in the inventory corridor covered 586 acres and urban lands in the inventory corridor covered 731 acres.

Table III-5 shows the composition of rural lands inventoried in the subwatershed. Row crops cover 178 acres, or 31 percent of the rural inventory corridor. Nearly all of this acreage is in continuous row crops. Little of this cropland has conservation practices, and is a potential source of sediment. The remaining acreage in the rural inventory corridor is made up of land uses having low potential for producing sediment. These lands, including woodlots, pastures, wetlands, farmsteads, and grasslands, cover 410 acres, or 69 percent of the rural inventory area.

Table III-6 summarizes for the Oconomowoc Lake Subwatershed the characteristics of the rural sheet and rill erosion caused by rainfall and runoff. An estimated 1,682 tons of soil are eroded in the Oconomowoc Lake Subwatershed each year as a result of this upland sheet and rill erosion. Eight per cent of the sheet and rill erosion in the subwatershed is coming from lands eroding soil at a rate less than three t/a/y. These lands are not targeted for control practices. The remaining 92 percent of the sheet and rill erosion is coming from lands which are targeted to receive control practices. A large proportion is coming from lands eroding soil at rates between five and 10 t/a/y, and 18 percent, a significant portion, is coming from lands eroding soil at a rate exceeding 10 t/a/y. This distribution of the soil erosion indicates that a fairly high level of erosion control can be achieved by treating the acreage losing soil at rates exceeding three t/a/y.

In addition to water erosion, wind erosion is a concern on some of the croplands in this subwatershed. Although a detailed assessment of the water pollution potential posed by windborne sediment has not been made, plumes of windborne sediment have been observed within the subwatershed during periods when winds are forceful and the ground is without a cover crop. An assessment of the need for additional controls to reduce the potential of sedimentation and nutrient transport caused by wind erosion will be made in the Oconomowoc Lake Subwatershed during implementation.

A determination was made during the initial phases of the inventory that roadside erosion was not widespread enough to warrant a detailed survey. Therefore, detailed assessment of gully erosion in rural portions of the inventory corridor was not made during this nonpoint source inventory. Roadside and gully stabilization needs may be found in some areas by LCC staff during project implementation. These needs will be identified, and management categories assigned during the implementation of this priority watershed plan.

A detailed lakeshore erosion survey was conducted by boat to scan the shoreline of Oconomowoc Lake. Although shoreline erosion is a common concern of many lakeshore property owners who may be losing property, only those areas judged to be having a significant impact on the public use of the lake were considered critical areas for purposes of the Wisconsin Nonpoint Source Water Pollution Abatement Program. No critical sites were identified.

There are no livestock operations in the Oconomowoc Lake Subwatershed, hence livestock waste in the subwatershed is not a source of nutrients or pathogens.

Table III-11 shows the pollutant generation from lands within the urban inventory corridor of the Oconomowoc Lake Subwatershed. This table shows that about 20 tons of suspended solids, 80 pounds of phosphorus, and 56 pounds of lead are generated annually by all lands within the urban inventory corridor. The urban area thus contributes only three percent of the phosphorus load (see Table VI-6), but virtually all of the lead load to Oconomowoc Lake.

Table VII-3 shows the composition and pollution potential of the different urban land uses in the Oconomowoc Lake Subwatershed. This table shows that traditional urban land uses, such as residential, commercial, industrial, and construction areas, encompass about two-thirds of the land uses inventoried in the urban corridor. The remaining one-third of the area is actually rural land uses contained within the urban inventory corridor. These residential, commercial, industrial, and construction areas generated 87 percent of the suspended solids, 88 percent of the phosphorus, and 98 percent of the lead loads coming from within the urban inventory corridor.

Table VII-3 shows that the largest urban land use in the Oconomowoc Lake Subwatershed is low density residential. The 459 acres of residential land use account for 93 percent of the urban land area, but only account for 30 percent of the suspended solids generation, 26 percent of the phosphorus generation, and 10 percent of the lead generation from the urban area. These residential areas do not have curb and gutter drainage, and residences along most of the shoreline have lawns established between the driveways or roads and the lake. This provides additional buffering.

Although these residential areas already have, for the most part, characteristics that limit the generation and transport of pollutants to these lakes, they can pose a water pollution threat where housekeeping practices are poor. Lawn fertilizers and pesticides, leaves, leaf ashes from burning, grass clippings, and improperly disposed waste oil or household chemicals can all contaminate the lakeshore waters.

The commercial land use comprises only 25 acres, or five percent of the urban area in the subwatershed. This commercial area, however, generates 51 percent of the suspended solids, 56 percent of the phosphorus, and 73 percent of the lead from the urban lands. Industrial and construction land uses do not cover much area, and do not contribute substantially to pollutant loadings.

Roadside erosion sites, gully erosion sites, and other sites where erosion requires stabilization were not specifically identified as part of this priority watershed project. However, an inventory of urban nonpoint pollution sources was conducted in the subwatershed during 1984 by staff from SEWRPC and the Waukesha County office of the Soil Conservation Service while preparing A Water Quality Management Plan for Oconomowoc Lake (SEWRPC, 1985). No serious sources were found at that time.

A potential source of construction erosion and stormwater runoff will be the reconstruction of State Highway 16, scheduled for 1987-89. This pending reconstruction is part of a larger project to upgrade State Highway 16 between

Table VII-3. Estimated Pollutant Generation From Urban Land Uses In The Oconomowoc Lake Subwatershed(1.)

		Pollutant Generation(Lbs./Year)		
Land Use	Area(acres)	Suspended Solids	Phosphorus	Lead
Low Density Residential	459	10302	18	5
Medium Density Residential	0	0	0	0
High Density Residential	0	0	0	0
Commercial	25	17664	39	40
Industrial	8	3810	7	10
Construction	2	3140	6	<1
SUBTOTAL	494	34916	70	55
Other(2.)	237	5249	10	1
TOTAL	731	40164	80	56

1. Data compiled by the Southeastern Wisconsin Regional Planning Commission.
2. These lands include rural land uses contained within the urban area. Wetlands, woodlands, recreation lands, and open lands are included.

Pewaukee and Oconomowoc. Most of the construction of the new freeway will be completed along the existing alignment of State Highway 16. Two new bridges will be constructed over the Oconomowoc River south of the Okauchee Lake Dam, and a new bridge will be completed over the river for a frontage road north of the freeway. A frontage road to be located south of State Highway 16 will require realignment of the Oconomowoc River and construction of a new river channel. Approximately 1200 feet of highway east of the Oconomowoc River and 1200 feet located west of the river will drain towards the river.

WATER RESOURCES OBJECTIVES

Oconomowoc Lake

Table VII-4 shows the reduction in the existing phosphorus loading to Oconomowoc Lake that is needed to achieve various long-term concentrations of in-lake phosphorus. Predictions of the associated water quality are especially difficult to make due to in-lake biological processes, as explained above. The secondary criterion for phosphorus is already being met in Oconomowoc Lake, and existing water clarity is excellent. A 33 percent reduction in the phosphorus loading is needed, however, in order to achieve the .02 mg/l phosphorus criterion recommended by the Regional Planning Commission, to protect the existing uses of this lake.

Table VII-5 shows the relative importance of all phosphorus sources in the drainage to Oconomowoc Lake, summarizes the percent reduction of the phosphorus load from each of these sources that can be expected under ideal circumstances, and estimates the phosphorus load reduction that might be achieved for Oconomowoc Lake.

Table VII-5 shows that a 33 percent reduction in phosphorus cannot be brought about by the Nonpoint Source Control Program. The Nonpoint Source Control Program could bring about a 17 percent decrease in the phosphorus load. Little of this, however, will come from urban and rural practices installed in this subwatershed since these practices are anticipated to control only three percent of the existing load. Instead, the control of the trophic status and phosphorus loading from Okauchee, Lower Okauchee, and Upper Oconomowoc Lake will be the greatest determinant in affecting the control achieved in Oconomowoc Lake. Control of septic systems could bring an additional five percent control of the nutrient load.

Given the high level of water quality that exists in Oconomowoc Lake, and the difficulty anticipated in bringing about a significant change in the lake's trophic status, the water resource objective for the Nonpoint Source Control Program will be to maintain the aesthetic, recreational, and aquatic life potential that exists in this lake. This protection will be provided by reducing the loads of phosphorus, sediment, and toxic materials coming from cropland, urban runoff, and potentially from construction sites.

RURAL NONPOINT SOURCE CONTROL STRATEGY

Table III-7 shows that 163 acres of control practices will be needed to bring the sheet and rill erosion rate on these lands down to a range acceptable for purposes of water quality protection. Conservation tillage will be the

Table VII-4. Estimated Water Quality Impacts On Oconomowoc Lake From Different Phosphorus Loading Reduction Levels

		PREDICTED AVERAGE CONDITIONS		
Phosphorus Load (lbs.)	Reduction From Present Load	Total Phosphorus (mg/l)	Trophic Status Index(1.)	Wisconsin Lakes Water Quality Index(2.)
3560(3.)	0	.03(4.)	53	fair
2955	17%	0.025	51	fair
2777	22%	0.023	49	good
2350	33%	0.02	47	good

1. Based on phosphorus concentrations only.
2. See Table III-2.
3. This is the existing phosphorus load estimated by SEWRPC(SEWRPC, 1985). and an in-lake phosphorus concentration of .03 mg/l.
4. This is the secondary criterion proposed for Oconomowoc Lake.
5. This is the primary standard established for Oconomowoc Lake by the Regional Planning Commission.

practice most widely recommended, with an estimated 156 acres needed. In addition, seven acres of pasture management will be needed. Table III-7 also shows that application of conservation tillage and pasture management practices on upland areas will reduce the soil loss on lands constituting a high pollution hazard by 76 percent.

The proposed strategy for controlling rural nonpoint pollution sources in the Oconomowoc Lake Subwatershed is presented below. Changes may be made in the inventory data as each site is visited by project staff during implementation. The strategy outlined below will be modified as necessary to reflect any changes in inventory information.

Pollutant Management Categories are as follows:

1. Upland Sheet and Rill Erosion Sources

   - Management Category I. These are the ranked farms which cumulatively contribute the top 50 percent of the portion of the soil erosion that is occurring at a rate greater than three tons/acre/year, or those farms having at least 141 tons/year soil erosion targeted for control. In addition, any single field in the inventory corridor eroding at a rate exceeding seven t/a/y will be placed in this management category.

   - Management Category II. The remaining lands in the area draining to Oconomowoc Lake that have soil erosion exceeding three t/a/y will be placed in this management category.

   - Management Category III. Fields that are currently eroding less than three t/a/y are not eligible for cost sharing, and are placed in this management category.

Since the upland sheet and rill erosion survey did not assess waterway or gully erosion sites, or areas where wind erosion is contributing to water quality problems, the need for controlling these sources will be assessed during implementation. Management categories will be assigned to any problem areas found by project staff.

URBAN POLLUTION CONTROL STRATEGY

On-site infiltration of rainfall runoff waters is generally good for the types of residential areas found in the Oconomowoc Lake Subwatershed, and the existing grass swale drainages provide additional infiltration of runoff waters generated on streets and driveways. Information and education programs will be used, however, to control pollution associated with residential land management. The goal of the information and education programs will be to promote good housekeeping practices in the subwatershed, so that the amounts of nutrients, sediment, and hazardous materials available for transport to the lake will be reduced. Details of the information programs for urban areas are presented in Chapter XIV.

Table VII-5. Feasibility of Reducing The Phosphorus Loading To Oconomowoc Lake

Pollutant Source Category	Portion of the Phosphorus Load Contributed By The Source Category(1.)	Portion of Phosphorus Load That Can Reasonably Be Removed From The Source Category	Feasible Phosphorus Load Reduction(2.)
Agricultural Runoff (sediment phosphorus)	2%	76%	2%
Agricultural Runoff (soluable phosphorus)	1%	5%	<1%
Urban Runoff	3%	20%	1%
Septic Systems	6%	90%	5%
Atmospheric Deposition	18%	0%	0%
Load From Okauchee Lake	70%	20%	14%

Total without septic sy control: 17%

Total with septic syste control: 22%

1. Based on information provided by SEWRPC.
2. This figure = (column B)*(column C).

A closer assessment of the need and practicality of controlling lead and other toxic materials in the runoff to Oconomowoc Lake from commercial and industrial areas will be made by the Department of Natural Resources during plan implementation.

In addition, practices needed to control gully erosion and roadside erosion that may be found in urban areas will also be eligible for cost sharing. These sites will be identified during the LCC staff during project implementation.

A Water Quality Management Plan for Oconomowoc Lake, being prepared by SEWRPC (draft, 1985), recommends that Waukesha County, the cities of Delafield and Oconomowoc, the Village of Oconomowoc Lake, and the towns of Oconomowoc and Summit adopt effective construction erosion control programs to protect Oconomowoc Lake from pollutant loads that often accompany development. As part of the urban pollution control strategy for Oconomowoc Lake, the Nonpoint Source Control Program will encourage, and provide some support, for the modification or development of construction erosion and stormwater management ordinances where it is felt appropriate for water quality purposes. Chapter XIV of this plan details how this assistance will be made available.

Finally, the Wisconsin Department of Transportation, the Wisconsin Department of Natural Resources, and Waukesha County will work cooperatively to assure that water quality impacts caused by construction and post-construction runoff from the State Highway 16 project will be minimized. This cooperation will be an outgrowth of the agreement between the DNR and DOT to work together in minimizing the environmental impacts associated with highway projects.

INTEGRATION OF PROGRAMS IN ACHIEVING WATER RESOURCES OBJECTIVES

A Water Quality Management Plan For Oconomowoc Lake, being prepared by SEWRPC, includes recommendations in several program areas outside the scope of the Nonpoint Source Control Program. These recommendations include:

1. modifying local zoning ordinances to bring local planning and zoning into conformance with the adopted regional land use plan as it applies to the Oconomowoc Lake Subwatershed,

2. conducting of an on-site sewage disposal inspection program by the Waukesha County Board of Health,

3. providing sanitary service

4. hypolimnetic aeration of the lake's north basin, and

5. trends monitoring to follow the changing conditions of the lake.

CHAPTER VIII

THE FOWLER LAKE SUBWATERSHED

EXISTING WATER RESOURCE CONDITIONS

The Fowler Lake Subwatershed, including the surface of the lake, totals 425 acres. Principal water resources in this subwatershed include Fowler Lake, and a 1.5 mile long section of the Oconomowoc River stretching between Oconomowoc Lake and Fowler Lake. The subwatershed is located on Map II-1 in Chapter II.

Fowler Lake

Fowler Lake is the fifth lake in a chain connected by the Oconomowoc River, and lies wholly within the City of Oconomowoc. The main basin of the lake covers 78 acres. An expanded inlet to the lake, formed by the Oconomowoc River above Oakwood Avenue in the City of Oconomowoc, covers an additional 21 acres. A public boat access to Fowler Lake is located at St. Paul Street. Based on an evaluation made by the Department of Natural Resources, public boating access to Fowler Lake is adequate (Threinen, 1982). A combination of pedestrian paths and low-traffic city streets provides a promenade centered around the lake. This promenade is heavily used by joggers and walkers.

Physical, biological, and chemical data for Fowler Lake were recently collected as part of a lake study conducted by the United States Geological Survey (USGS), in cooperation with the City of Oconomowoc. Data was collected during the period of January-November, 1984, and a preliminary analysis of the data has been completed (USGS, 1985). The preliminary results of the study are presented below.

Fowler Lake has an average depth of 13 feet and a maximum depth of 50 feet. The lake has an extensive shallow area, reflecting the fact that the natural lake level has been augmented eight feet by a dam located between Fowler Lake and Lac LaBelle. As a result, 33 percent of the lake area is less than five feet deep and 56 percent of the area is less than 10 feet deep. Sixteen percent of the area is from 10 to 15 feet deep, and 28 percent of the area exceeds 15 feet in depth. The Oconomowoc River provides 98 percent of the inflow to Fowler Lake, with 40 percent of the inflow occurring during the months of May, June, and July. The residence time of water in the lake is very short, averaging about seven days (USGS, 1985).

The Oconomowoc River, which is in good condition as it leaves Oconomowoc Lake, has a dominating influence on the water quality of Fowler Lake. Nutrient concentrations and water clarity were measured in Fowler Lake during 1984, and the measurements indicate that the lake is very clean. Table VIII-1 summarizes these phosphorus and water clarity measurements. The phosphorus concentrations at spring turn-over were consistently low. In fact, phosphorus concentrations in the upper waters of the lake were low throughout the sampling period, indicating that the water quality in Fowler lake directly reflects the water quality in the Oconomowoc River. The secchi depth

Table VIII-1 . Existing Water Quality Conditions For Fowler Lake

Water Quality Parameter	Range	Average	Trophic Status Index	Wisconsin Lakes Water Quality Index (1.)
Total Phosphorus(2,3.) (mg/l)	<.01 to .01	0.01	40 (mesotrophic)	very good
Chlorophyll(4.)			(oligo-mesotrophic)(4.)	excellent
Secchi Disc Depth(5.) (feet)	10 to 12	11	43 (mesotrophic)	very good

1. See Table III-2.
2. Water quality data from "The Hydrology and Water Quality of Fowler Lake, Wisconsin(DRAFT)", U.S.G.S., 1985.
3. Concentration during spring turn-over.
4. From Martin, et al. 1983 . A Trophic Assessment of Wisconsin Lakes Using Satellite Imagery, USEPA Report. 123 p.
5. Average summer values.

measurements during the summer months were consistently high. These measurements indicate very good water quality which is characteristic of a mesotrophic, or moderately fertile lake.

A trophic index was also developed for Fowler Lake using satellite imagery collected between 1979-1981 by LANDSAT (Martin et al., 1983). The amount of algal chlorophyll estimated to be in the lake on seven separate dates over the summer months was very low, indicating a meso-oligotrophic condition. The extensive growth of lake weeds may be in part responsible for the low level of algae growth as the weeds will strip phosphorus from the water column, leaving less phosphorus available for the algae.

A bottom substrate survey of Fowler Lake for bottom depths less than 25 feet was conducted in 1984 by a private consultant, and the results tabulated in the USGS draft report. The survey recorded the type and depth of soft sediments. Forty-three percent of the surveyed bottom is covered by a muck and clay mixture, including nearly the entire bottom of the expanded inlet to Fowler Lake and the bottom of the southern one-fourth of the lake, including the southwest bay. Muck covers 15 percent of the surveyed lake bottom, and is most prevalent in the central basin of Fowler Lake. Muck depths up to seven feet were measured in this area. Muck mixed with sand, rubble, or gravel covered about 30 percent of the surveyed area, and is most prevalent along parts of the shoreline and in the upper part of the expanded inlet. The dominance of muck as a substrate material reflects the fact that when the level of the lake was increased by the dam, the expanded lake covered shoreline swamp and marshland.

The soft substrate, extensive shallow water area, and excellent water clarity all contribute to the abundance of lake weeds found growing throughout Fowler Lake. During a 1984 DNR survey, these weeds were found growing over the entire bed of the lake to a depth of 15 feet. The maximum depth at which weeds were found growing was 22 feet. The most abundant weed growths occurred in the southwest bay of the lake, and in the southeast bay, or expanded inlet, above the bridge. These are the areas where muck and clay dominate the bottom substrate. These sediments probably contain adequate phosphorus to support these weeds, and provide a good substrate for the plants to grow in. Combined with the excellent water clarity, the weeds have an ideal habitat in which to flourish. The city currently conducts an extensive weed cutting and chemical control program on Fowler Lake.

Fowler Lake stratifies during both the winter and summer months, with the water column completely mixing during spring and fall. Dissolved oxygen concentrations are sufficient at all depths during the winter to support fish life, but during the summer months the bottom waters become completely devoid of oxygen at depths exceeding 25 feet. This condition, caused in part by the decay of plant and animal materials, is common in the other lakes in the Oconomowoc chain and throughout southeastern Wisconsin. This reduced dissolved oxygen concentration in the lake during the summer months has not led to any noticeable fish mortality. The water quality studies conducted on Fowler Lake did not include monitoring for toxic substances in urban runoff, or evaluations of the environmental impacts commonly associated with many urban pollutants. The runoff from urban areas in the subwatershed is of concern, however, because the presence of toxic materials in urban runoff has

Table VIII-2. Estimated Annual Loading Budgets To Fowler Lake For Phosphorus and Sediment

Source	Phosphorus Pounds	Phosphorus % of Total	Sediment Pounds	Sediment % of Total
Oconomowoc River(1.)	2040	81%	1888700	87%
Agriculture(2.)	180	7%	133000	6%
Urban(3.)	260	10%	130000	6%
Atmospheric Deposition(4.)	30	1%	19000	1%
TOTAL	2510	100%	2170700	100%

1. As measured between January and November, 1984 at the outlet to Oconomowoc Lake. Values as reported in "The Hydrology and Water Quality of Fowler Lake, Wisconsin" (Draft USGS WRI Report 86, 1985).
2. Based on inventory data collected through the Nonpoint Source Program. USGS Draft Report 86 estimates inputs from agriculture to be 10% of the values stated in this table.
3. Based on inventory data collected through the Nonpoint Source Program.
4. Based on information presented in USGS Draft Report 86.

been well documented and the body of evidence linking this pollution source with water quality impacts is growing (Bannerman, et al, 1983; Pitt, 1985). These toxic substances include heavy metals, such as lead, copper, and zinc, pathogens and fecal bacteria, pesticides, and a wide range of hazardous organic compounds. Environmental impacts caused by stormwater runoff of these materials have been documented in waterbodies near fairly large urban areas, including Milwaukee. Impacts include elevated concentrations of heavy metals in bottom sediments, dissolved oxygen depressions, severe flow fluctuations, and degraded fish and aquatic insect populations. In addition, extremely high bacteria counts have been measured in urban stormwater discharges and receiving waters.

LAND USE AND NONPOINT POLLUTANT SOURCES

Table VIII-2 shows the estimated loading of phosphorus and suspended sediment to Fowler Lake, and the relative importance of pollutant sources within the subwatershed. The main source of phosphorus to Fowler Lake is flow from Oconomowoc Lake, which provides 81 percent of the load. The urban areas in the subwatershed provide an estimated 10 percent of the loading, and agricultural land an estimated seven percent. The flow from Oconomowoc Lake is also the dominant source of suspended sediment, providing 87 percent of the loading. The urban and agricultural areas each provide approximately six percent of the suspended sediment load.

The urban areas in the subwatershed are the major source of pollutants such as lead, copper, and zinc, and some of the hazardous organic compounds. Rural areas are also sources of some organic compounds, such as those found in pesticides.

Rural Land Use and Pollutant Sources

Table III-4 shows the portion of the Fowler Lake Subwatershed inventoried for rural nonpoint pollutant sources. The inventory corridor included 1,306 acres, or 92 percent of the subwatershed. Rural land uses covered 512 acres, or 39 percent of the inventory corridor.

Table III-5 shows the composition of rural lands inventoried in the subwatershed. Wetlands and grasslands cover 61 percent of the agricultural inventory corridor, with woodlot and farmstead land uses adding another two percent. Therefore, the majority of the agricultural land use in this subwatershed has a low potential for generating sediment and associated pollutants. Although row crops cover only 192 acres, or 37 percent of the corridor, most of these acres are planted in grain year after year, giving them a higher potential for generating pollutants. Little of this cropland has conservation practices in place.

Table III-6 summarizes the characteristics of the rural sheet and rill erosion. An estimated 1,661 tons of soil are eroded in the subwatershed each year as a result of this upland sheet and rill erosion. About 84 percent of the erosion is coming from lands losing soil at a rate exceeding three tons per acre per year (t/a/y). The majority of the erosion is occurring at fairly high rates, with 18 percent of the eroded soil coming from lands losing soil at a rate exceeding 10 t/a/y, and 81 percent of the erosion occurring on lands

losing soil at a rate exceeding five t/a/y. Only 16 percent of the soil loss occurs on lands losing soil at a very low level (less than three t/a/y). The distribution of the soil loss in the different erosion categories reflects the large proportion of acres planted in row crops with few conservation practices applied. This distribution of the soil loss indicates that a fairly high level of erosion control can be achieved through conservation practices.

A detailed lakeshore erosion survey was conducted using a boat to scan the shoreline of Fowler Lake. Although shoreline erosion is a common concern of many lakeshore property owners who may be losing property, only those areas judged to be having a significant impact on the public use of the lake were considered critical areas for purposes of the Wisconsin Nonpoint Source Water Pollution Abatement Program. Only one site having the potential to significantly affect public use was identified along the Fowler Lake shoreline. This site is located in Fowler Lake Park.

A determination was made during the initial phases of the inventory that roadside erosion was not widespread enough to warrant a detailed survey. A detailed assessment of gully erosion in rural portions of the inventory corridor was not made during this nonpoint source inventory, either. Roadside and gully stabilization needs may be found in some areas by LCC staff during project implementation. These needs will be identified by project staff during implementation of this priority watershed plan.

There are no livestock operations in the Fowler Lake Subwatershed.

Urban Land Use and Nonpoint Pollution Sources

This discussion is divided into two parts. The first part concerns the role of developing areas as nonpoint pollutant sources. Developing areas are considered to include a wide array of situations including urban renewal projects, individual site development within the existing urban area, or new subdivision development. The second part concerns existing urban areas as pollution sources. These areas include established residential, commercial, industrial, highway, and open space land uses.

Developing Areas

Development was occurring on three acres of land in the Fowler Lake urban inventory corridor at the time land use was surveyed for this project. However, land development patterns are dynamic and often unpredictable. Therefore, accurate predictions of the extent, timing, and location of lands that will be undergoing development in this subwatershed are difficult to make.

The reconstruction of portions of State Highways 16 and 67, scheduled to occur between 1986 and 1989, will involve work within the Fowler Lake Subwatershed. The new highway will pass through an area of open land north of the existing road alignment, as it enters the subwatershed from the east. The highway will swing south and follow the existing alignment as it crosses the Oconomowoc River just downstream of Oconomowoc Lake. Two new bridges will be constructed over the river at this point as part of the reconstruction project. The State Highway 67 portion of this project will use the existing right-of-way south of State Highway 16.

Previous experience in Wisconsin and throughout the country has underscored the importance of developing lands as pollutant sources. Table III-10 shows that construction sites in the Oconomowoc River Watershed can be expected to produce suspended solids and phosphorus at rates several times higher than established commercial or industrial land uses. These estimates may be conservative. Other studies estimate that construction sites can generate sediment at a rate of 30 to 200 tons/acre/year, or at a rate 10 to 25 times higher than cropland, and eight times higher than industrial sites. Phosphorus generation rates for construction sites can exceed generation from industrial areas by as much as 18 times (U.S. EPA, 1977; Chesters et al., 1979). Analysis of construction site erosion from several developing watersheds in the Village of Germantown in Washington County showed that the amount of sediment leaving each acre of developing land is independent of the type of development. Single family home development is just as important as a pollutant source as multi-family developments.

These figures indicate that even a small amount of construction can result in tremendous pollutant loadings to waterways. The impacts on water quality resulting from construction site runoff are well documented, and include loss of recreation areas and fish habitat through siltation, and nutrient enrichment of waterbodies (Pitt, 1985). If water quality is to be protected or improved, there is a need to control pollutant generation and transport from areas undergoing development, even if they cover areas less than one acre.

Pollutant generation from these areas continues even after construction has been completed and the areas are considered established. This pollutant generation and transport can be a problem if post-development stormwater management is not taken into account during site design. Pollutant generation from established urban areas in the Fowler Lake Subwatershed is described in the following section.

Existing Urban Areas

Urban lands comprised 794 acres, or 61 percent of the inventory corridor. Most of the land within the urban inventory corridor lies within the City of Oconomowoc. Table III-11 shows the pollutant generation from lands within the urban inventory corridor of the Fowler Lake Subwatershed. This table shows that about 65 tons of suspended solids, 260 pounds of phosphorus, and almost 200 pounds of lead are delivered to Fowler Lake by all lands within the urban inventory corridor. Although lead is the only toxic material listed in Table III-11, it indicates the presence of the other toxic materials previously mentioned.

Primary sources of the urban toxic pollutants include automobiles (heavy metals and hydrocarbons), fertilizer and pesticide application, pet wastes (bacteria), metal corrosion, and leachate from preserved wood (arsenic, copper, pentachlorophenol). Primary sources can be controlled, such as through pet waste control ordinances, judicious use of lawn and garden chemicals, or the use of nonleaded gasoline. Secondary sources of these pollutants are areas where the pollutants accumulate before being washed off by rains or snowmelt. These secondary sources include such areas as streets, parking lots, rooftops, and landscaped areas. Secondary sources can be controlled, by either cleaning up the pollutants that accumulate on them, or

Table VIII-3. Estimated Pollutant Loading From Urban Land Uses In The Fowler Lake Subwatershed(1.)

Land Use	Area(acres)	Estimated Pollutant Loading(Lbs./Year) Suspended Solids	Phosphorus	Lead
Low Density Residential	149	3175	5	1
Medium Density Residential	208	31065	73	29
High Density Residential	9	2532	6	3
Commercial	98	65058	129	118
Industrial	39	18251	28	38
Construction	3	4460	8	
Recreation/ Open Land	288	5459	10	7
TOTAL	794	130000 0	259 0	196

1.Based on data compiled by the Southeastern Wisconsin Regional Planning Commission.

by reducing the volume of stormwater runoff that washes these pollutants away to surface waters. Finally, the points at which storm sewers enter a waterbody can be considered pollutant sources. These sources can be partially controlled through the use of stormwater detention basins and other pollution control devices.

The relative importance of these three pollution source types varies greatly for different land uses, rain conditions, and development patterns. Shopping centers, for example, have large roofs and parking areas which generate large amounts of flow and pollutants. Residential areas have extensive areas that can soak up precipitation. In residential areas, small rains are most important in washing pollutants from the streets, sidewalks, and driveways. During large rains, lawns become saturated with water and start to produce pollutants as well. Many site specific factors must therefore be assessed in evaluating urban runoff source areas (Pitt, 1985). In assessing the source and controllability of pollutants generated from the urban areas within the Fowler Lake Subwatershed, two approaches were taken.

One approach was to identify the importance of different land uses as pollutant sources, and to estimate the effect that management practices applied to these land uses would have on reducing pollutant loads. Major land use categories used in analyzing the urban areas included: low, medium, and high density residential; commercial; industrial; construction; and recreation/open land. The areas covered by each of these land uses in the Fowler Lake Subwatershed, and the estimated pollutant loadings to Fowler Lake attributed to each land use are shown in Table VIII-3. Construction areas were not included in this table since the acreage fluctuates so much from year to year. These developing areas are very important, however, as discussed in the previous section.

The pollutant loading from each type of urban land use was determined by both the rate at which the land use produces pollutants and by its total acreage. The rates at which the different land uses deliver pollutants to surface waters are shown in Table III-10. Although commercial and industrial land uses combined cover only 17 percent of the urban land area, they contribute 80 percent of the lead loading, 61 percent of the urban phosphorus loading, and 64 percent of the suspended sediment loading. These two land uses are important contributors because they produce high unit area pollutant loadings. Medium density residential land use is also an important contributor of these pollutants to Fowler Lake, mainly because this land uses covers an extensive portion (26 percent) of the urban area.

The second approach used to assess the source and controllability of urban pollutants in the subwatershed was to divide the urban area up into small sub-basins based on drainage patterns, and then to calculate the importance of each sub-basin based on the pollutant load it delivers to the lake. This approach was used to determine what effect end-of-pipe controls, such as detention basins, would have on reducing pollutant loadings to Fowler Lake. The most cost effective arrangement of detention basins was then identified.

In the Fowler Lake Subwatershed, 25 separate urban sub-basins were delineated and analyzed for pollutant loadings. Table VIII-4 identifies the nine important urban sub-basins in the Fowler Lake Subwatershed, which encompass

Table VIII-4. Important Urban Sub-basins in the Fowler Lake Subwatershed.

Urban Sub-basin	Storm Sewers	Area (acres)	Portion of Subwatershed's Urban Area Located In This Sub-basin	Sub-basin Contributes Significantly to the Subwatershed's Lead Loading	Sub-basin Contains A Significant Portion of the Subwatershed's Critical Land Uses(1.)
R	Yes	221	27%	X	X
P	Yes	12	2%	X	X
M	Yes	12	2%	X	X
N	Yes	9	1%	X	X
A	Yes	44	6%	X	X
B	Yes	31	4%	X	X
J	No	9	1%		X
Q	No	24	3%		X
L	Yes	6	1%		X
TOTAL		368	47%		

1. Includes sub-basins that contain at least 5% of the subwatershed's sewered commercial or industrial land uses. Unsewered sub-basins J and Q are included because they are located directly on the shoreline.

368 acres or almost one-half of the urban area in the subwatershed. These sub-basins and the locations of their storm sewer discharges are located on Map VIII-1. Sub-basins R, P, M, N, J, L, and Q are located entirely within the city of Oconomowoc. Most of sub-basins A and B are located in the city, with small portions located in the Town of Oconomowoc.

Sub-basins R, P and N discharge via storm sewers into the expanded inlet to Fowler Lake. Sub-basin Q also discharges to this area, but via overland flow, since the sub-basin is not served by storm sewers. Sub-basins M, J, and L all discharge along the southern shore of the lake. Sub-basins L and M discharge via storm sewer pipes, while J discharges via overland flow. Sub-basins A and B are both served by storm sewers, and discharge close to one another at a point adjacent to the north boundary of Fowler Park.

Each of these nine sub-basins is important because it contains at least five percent of the industrial or commercial land use in the subwatershed, although source area controls targeted at these land uses will not be limited to specific sub-basins. Sub-basins R,P,M,N,A, and B have additional importance because they cumulatively account for a large portion of the urban pollutant loading, as indicated for lead. Five of these sub-basins (R,P,M,N,A) represent areas where detention basins can effectively capture significant portions of the the urban pollutant load. Table VIII-5 provides more detailed characteristics of these 9 urban sub-basins.

WATER RESOURCES OBJECTIVES

Fowler Lake

Based on the water quality data and nonpoint pollution source assessment presented above, the following water resource objectives were developed for Fowler Lake. These include protecting the aesthetic, recreational, and fish and aquatic life uses currently being supported by the lake. This will be done by protecting the high level of water quality that exists in both the lake and the inflowing Oconomowoc River.

Water quality will be maintained by reducing the nutrient and sediment loads to the river and lake currently coming from rural and urban lands in the subwatershed and from Oconomowoc Lake. Table VIII-6 presents the nutrient loading reductions feasible through the Nonpoint Source Control Program.

Water quality will also be maintained by reducing the flow of toxic urban stormwater pollutants into Fowler Lake, both from existing urban areas and from areas that will be developed in the future.

Finally, preventing sedimentation from future construction sites will be instrumental in meeting these objectives.

RURAL NONPOINT SOURCE CONTROL STRATEGY

Table III-7 shows that 180 acres of control practices will be needed to bring the sheet and rill erosion rate on these lands down to a range acceptable for purposes of water quality protection. Conservation tillage will be the practice most widely recommended, with an estimated 174 acres needed. In

Table VIII-5 .Land Use and Estimated Pollutant Loading Characteristics of Important Urban Sub-basins in the Fowler Lake Subwatershed.

	% of Urban Pollutant Load From Sub-Basin			% Land Use In Sub-Basin	
Urban Sub-basin	Lead	Phosphorus	Sediment	Industrial	Commercial
R	26%	26%	30%	84%	42%
P	12%	7%	8%	1.	10%
M	10%	7%	7%		7%
N	7%	5%	5%	1.	5%
A	5%	8%	6%		1.
B	5%	6%	5%		5%
J	1.	1.	1.		7%
Q	1.	1.	1.	12%	8%
L	1.	1.	1.		6%
TOTAL	73%	65%	68%	100%	93%

1. Values represent less than 5% of the total for the subwatershed.