The West Branch of the Milwaukee River is located in the rolling glacial topography of Fond du Lac County. The West Branch and its tributaries, which originate in and flow through extensive wetland areas, have been heavily channelized for agricultural purposes. Siltation, nutrient enrichment, elevated bacteria, channelization, and degraded impoundments are the principal factors limiting the quality of the recreational and aquatic life uses in these streams.

The Main Branch of the Milwaukee River arises in an area of wetlands and intensive agriculture. Extensive channelization, siltation, nutrient enrichment, bacteria, degraded impoundments, and impacts of urban runoff are the primary factors which limit the recreational and aquatic life uses in these streams. Planned urbanization in the vicinities of the villages of Campbellsport, Kewaskum, Newburg and the city of West Bend are important concerns due the potential impacts on sediment loading, urban toxins loading, and changes in stream hydrology that can attend urban growth.

Lakes: Lakes also constitute a major surface water feature in the watershed. The majority are of glacial origin formed in depressions of outwash plains or between the ridges of surface and ground moraines. Forty-one named lakes with a combined surface area of about 1,900 acres, are located in the watershed. Fourteen lakes have more that 50 acres of surface area. The largest include Long Lake (427 acres), Kettle Moraine Lake (227 acres), and Auburn Lake (107 acres).

Fourteen named lakes with a combined surface area of 320 acres are classified as impoundments. Historically, these impoundments were created by installation of dams and sills. Most in this watershed are located along the three main branches of the Milwaukee River. The structures were installed to provide either water power to mills, flood control, or aesthetics. Many are no longer serving their original function and offer limited recreational opportunities because of shallow depth, prolific weed and algae growth, degraded water quality conditions, and dominant rough fish populations. The structures also prohibit upstream migration of forage and game fish and restrict navigation.

Wetlands: Wetlands are some of the most valuable natural resource features in the watershed. Their values--wildlife habitat, fish spawning and rearing, recreation, attenuation of runoff and flood flows, removal of pollutants--are well documented. They are particularly important in this watershed because of their prevalence, location, high quality, and diversity.

Wetlands comprise a significant land feature in the watershed. The wetlands in the watershed constitute more than 46 percent of the wetlands in the entire Milwaukee River Basin. The majority are located in the northwestern portion of the watershed.

GROUND WATER RESOURCES

Groundwater is contained in one of four aquifers underlying the watershed. These known as the sand and gravel aquifer, the eastern dolomite (limestone) aquifer, the sandstone and dolomite aquifer, and the crystalline bedrock aquifer. These underground rock formations, which store and transmit water to lakes, streams, and wells in the watershed, are characterized below.

Sand and Gravel Aquifer: The sand and gravel aquifer is comprised of surface material deposited from glacial ice that covered the watershed approximately 10,000 years ago. These deposits, which are generally 100 to 200 feet deep, are unconsolidated soil material with physical and chemical characteristics different from agricultural soils.

Groundwater in these deposits occurs and moves in the void spaces among the grains of sand and gravel. It is locally important as a source of groundwater for both public and private use where there are relatively thick saturated unconsolidated deposits. The potential for contamination is high because of the shallow depth to groundwater and permeability of the bedrock.

Eastern Dolomite Aquifer: The eastern dolomite aquifer occurs beneath the sand and gravel formation. It was deposited approximately 400 million years ago and is 300 to 400 feet thick. It consists of both the Niagara dolomite formation and an underlying shale layer (Maquoketa shale). Dolomite is a brittle rock similar to limestone which contains groundwater in interconnected cracks.

The Maquoketa shale formed from impermeable clays and prevents water from moving between the Niagara dolomite and the deeper aquifers. The demands placed on this resource are high because of the reliability of the quantity and quality of the water. The risk for contamination is moderate.

Sandstone and Dolomite Aquifer: The sandstone and dolomite aquifer occurs beneath the eastern dolomite formation in deposits between 425 and 600 million years old. It consists of sandstone and dolomite bedrock between 400 and 600 feet thick characterized by materials with variable water yielding properties. In eastern Wisconsin, most users of substantial quantities of water tap this deep aquifer to ensure adequate supplies are available. In areas where the Maquoketa shale underlies the dolomite aquifer the potential for contamination is low.

Crystalline Bedrock Aquifer: The crystalline bedrock aquifer is located beneath the sandstone and dolomite aquifer in formations more than 600 million years old. This aquifer is not a primary source of water in the watershed. Most of the deposits are very dense crystalline rock which normally yield small amounts of water. Fractures in the crystalline structured rocks store water but the

natural quality and reliability of this water source and the extreme depth at which it occurs restrict its use.

Environmental Corridors

Areas within southeastern Wisconsin having the highest concentrations of natural, recreational, historic, aesthetic, and scenic resources-- termed environmental corridors--have been identified by SEWRPC. These areas normally include selected elements of the natural resource base (lakes, rivers, and streams; wetlands; woodlands; prairies; wildlife habitat areas; wet, poorly drained soils; rugged terrain and areas of high-relief) as well as existing outdoor recreation sites, historic and archaeological sites, and natural and scientific areas.

Environmental corridors and isolated natural areas--which contain primarily wetlands, woodlands, and surface water--comprise approximately 62,000 acres, or about 37 percent of the watershed. This constitutes more than 47 percent of the total area of environmentally significant lands in the Milwaukee River Basin. Consequently, protection of surface waters resources both in the East-West Watershed and the Milwaukee River Basin as a whole will depend on preservation of these areas.

Natural Area Sites

Natural areas were identified statewide by the Wisconsin Scientific Areas Preservation Council and the Department's Bureau of Endangered Resources. These areas, which are exclusively contained in the above referenced environmental corridors and isolated natural areas, are tracts of land or water which exhibit pristine pre-settlement conditions and/or contain significant native plant and animal communities.

Twenty-seven natural area sites have been identified and classified in the watershed, with a combined area of more than 4,100 acres. Approximately 2,600 acres, or 63 percent of the total area included in these sites, is publicly owned.

Natural areas have been classified into one of three categories: statewide or greater significance, county-wide or greater significance, and local significance. In this watershed, 12 sites are of statewide or greater significance, while 12 additional sites are of county-wide or greater significance. Three sites have natural resource characteristics of local significance.

Endangered Species

The Department has documented the occurrence of 12 animal and plant species in the East-West Watershed, which have been classified as endangered, threatened, or rare in Wisconsin.

CHAPTER III

WATER RESOURCE CONDITIONS, NONPOINT SOURCES, AND WATER RESOURCES OBJECTIVES

INTRODUCTION

This chapter presents the results of the water resources and nonpoint source pollution assessments, and identifies water resources objectives for the Nonpoint Source Control Program in the East-West Watershed.

The first part of this chapter presents an overview of the water resource conditions and pollution sources inventoried in the watershed. Data in this first section are aggregated and presented on a watershed and regional basis. Regions of the East-West Watershed are based on regional delineations developed for the integrated resource management plan developed for this area (WDNR, 1988b).

The second part of this chapter is arranged by subwatershed, presenting for each a summary of the water resource conditions, nonpoint sources, and water resources objectives.

WATERSHED OVERVIEW

SURFACE WATER CONDITIONS

STREAMS

The East Branch of the Milwaukee River, located primarily in the Northern Unit of the Kettle Moraine State Forest, is the most buffered and protected branch of the Milwaukee River. Much of the East Branch remains in a natural, unchannelized condition. Siltation and nutrient enrichment are the primary factors that affect quality of the recreational and aquatic life uses for surface waters in the East Branch and its tributaries.

The West Branch of the Milwaukee River is located in the rolling glacial topography of Fond du Lac County. The West Branch and its tributaries, which

originate in and flow through extensive wetland areas, have been heavily channelized for agricultural purposes. Siltation, nutrient enrichment, elevated bacteria, channelization, and degraded impoundments are the principal factors limiting the quality of the recreational and aquatic life uses in these streams.

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Wetlands are some of the most valuable natural resource features in the watershed. Their values--wildlife habitat, fish spawning and rearing, recreation, attenuation of runoff and flood flows, removal of pollutants--are well documented. They are particularly important in this watershed because of their prevalence, location, high quality, and diversity.

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GROUNDWATER CONDITIONS

Natural groundwater quality varies in the watershed. The problem constituents most common in Wisconsin groundwater are hardness, iron, manganese, total dissolved solids, and sulfate. Many of these natural substances--iron, manganese, and dissolved solids--do not present a risk to human health, but have the potential to stain household plumbing fixtures or emit unpleasant odors. Often, high mineral concentrations in groundwater are the result of prolonged contact of the groundwater with subsurface rock formations.

There are however, some contaminants in groundwater which are a cause for greater concern. Some such as radon are naturally occurring. Others including nitrates, bacteria, volatile organic compounds, pesticides and other toxic compounds may be significantly increased due to human activities.

The Department has completed a statewide evaluation of susceptibility to groundwater contamination. The parameters used were soil characteristics, the types and character of subsurface unconsolidated materials, bedrock characteristics, depth to bedrock, and depth to the water table.

This generalized investigation indicated that southeastern Wisconsin, especially those areas along the shore of Lake Michigan, were shown as being less susceptible to contamination than some other areas of the state. This results from a layer of impermeable bedrock (Maquoketa shale) underlying much of the region which isolates the deeper aquifers from surface contaminants. In addition, glacial deposits which contain thick silts and clays tend to filter out many contaminants before they can percolate to the groundwater.

This is not to say that no groundwater contamination exists in the watershed. Indeed, portions of the watershed are more susceptible than others, and isolated occurrences of contamination may be occurring.

Statewide, the Department has evaluated and ranked the sources of groundwater contamination. The five most important are:

1. Agricultural activities.
2. Municipal landfills.
3. Underground storage tanks.
4. Abandoned hazardous waste disposal sites.
5. Accidental spills of a variety of industrial materials.

Human-induced groundwater contamination occurs as a result of two factors:

1. The occurrence, location, and quantity of materials which can become contaminants.

2. The susceptibility of the regional or local groundwater to contamination.

The rural nature of the watershed suggests that agricultural activities would likely be the most widespread source of contamination. Statewide investigations indicate that all five counties in the watershed project rank in the upper 50 percent of Wisconsin counties in the amount of nitrogen bearing wastes (human and animal wastes and fertilizer) applied per acre. These materials are a source of nitrites and bacteria in groundwater. Further, these counties also rank in the top 50 percent for the amount of the pesticides atrazine and alachlor applied per acre.

NONPOINT SOURCES OF POLLUTION

POLLUTANT LOADING FROM THE WATERSHED

The East-West Watershed is considered to be a major source of pollutants to all sections of the Milwaukee River, including the Milwaukee Harbour Estuary.

The significance of the Milwaukee River system as a source of pollutants to the inner harbour of Milwaukee is summarized in the Water Resources Management Plan For The Milwaukee Harbour Estuary (SEWRPC, 1987). Data collected from 1981-1983 for 23 pollutants show that the Milwaukee River contributes from 57 to 97 percent of the pollutant load to the inner harbour, with the Menomonee River contributing from 3 to 33 percent and the Kinnickinnic River contributing from 1 to 19 percent. The average contributions of the Milwaukee River system for suspended solids and phosphorus during this time period were 72 and 81 percent, respectively.

The East-West Watershed has the potential to be a significant contributor of pollutants within the Milwaukee River system, based on the volume of flow this watershed produces. Long-term flow monitoring data collected from four USGS stations located at Estabrook Park in Milwaukee, at Cedarburg, at Fillmore, and at Waubeka were used to quantify the average annual volume of water coming from each of these four watersheds. The results are shown in Table 1. This data shows that the East-West Watershed produces nearly 50 percent of the flow in this system. If annual pollutant loads measured at the Estabrook Park station from each of the contributing watersheds are proportional to the volume of water each watershed produces, then the estimated pollutant loading from the East-West Watershed would be about 15 million pounds of suspended sediment and 88,000 pounds of phosphorus.

SIGNIFICANCE OF MAJOR SOURCE CATEGORIES IN THE WATERSHED

The relative significance of major pollution source categories in the East-West Watershed was estimated for suspended solids and phosphorus. The suspended solids information includes modelling results for sediment derived from eroding uplands, streambank erosion, and established urban areas. Estimates for sewage treatment plants are based on monitoring data, and

estimates for construction erosion are based on historic development assuming a unit area load of sediment for each acre developed. The phosphorus information includes modelling results for established urban areas, monitoring data for point sources, and unit area load data for agricultural and developing urban land use.

Table 2 shows the results of this analysis. Agricultural nonpoint sources contribute the major portion of the suspended sediment and phosphorus, with eroding uplands a dominant sediment source. Established urban areas are less significant overall as a sediment source, but can be locally significant as in the city of West Bend. Construction site erosion from developing urban areas has posed a significant pollution potential for the watershed, although the actual delivery of sediment eroded from construction sites is unknown. Streambank erosion is insignificant overall, but may be significant locally.

Rural Land Use and Pollution Sources

Land Use: Table 3 shows the agricultural land use distribution for the East-West Watershed.

The eastern region is dominated by non-intensive land uses such as wetland, grassland, and woodland, which make up 67 percent of the regional agricultural land use. Wetlands make up a significant portion of this group of land uses. Cropland, which poses the highest potential for producing pollutant loads, makes up 29 percent of the regional land use.

In the western region of the watershed, these non-intensive land uses make up 35 percent of the agricultural land use. Once again, wetlands make up a significant portion of this total. Cropland in the west region makes up a much larger portion of the land use than in the east region, comprising 62 percent. As in the eastern region, most of the cropland is rotated.

The main stem region is similar to the west region. Here, the non-intensive land uses comprise 45 percent of the agricultural land use. Wetlands are not as prevalent here as in the other two regions. Croplands, most of which are rotated, make up 52 percent of the land use in this region.

Upland Erosion: Sediment delivered to waterways from upland sheet and rill erosion is summarized in Table 4. Only 49 percent of the acreage devoted to grassland, pasture, woodlot, or cropland uses actually delivers eroded sediment to lakes and streams. This proportion varies by region, ranging from 31 percent in the eastern region to 61 percent in the lower mainstem region. The uplands that deliver sediment contribute an estimated 6,262 tons per year to watershed lakes and streams. Most of this comes from lands in the west and lower mainstem regions. The average sediment delivery ratio, which expresses the portion of the gross soil erosion that actually reaches surface waters, is relatively low for this watershed. The average ratio is four percent, ranging from three percent in the west region to five percent in the remainder of the

watershed. This ratio will vary widely for individual land parcels within the watershed.

The abundance of internally-drained lands, and the extensive network of riparian wetlands which buffer the streams from a significant sediment load are the reasons that relatively little of the eroded soil is delivered to lakes and streams. Table 5 shows the extensiveness of this internal drainage in the watershed. Almost 60 percent of the watershed acreage is internally-drained, ranging from about 40 percent in the mainstem region to almost 70 percent in the eastern region. The importance of the riparian wetlands as a sediment buffer is evidenced by the fact that about 1,700 tons of eroded soil are delivered to these areas. If delivered to the streams, this would represent an additional 25 percent in the nonpoint source sediment load to lakes and streams. The impact is greatest in the west region, where the wetlands prevent a 40 percent increase in the sediment load, and prevents about a 20 percent increase in the rest of the watershed.

Streambank Degradation: Table 6 summarizes the extent of streambank degradation in the East-West Watershed. Streambank degradation is defined as areas that are producing sediment, or areas where cattle are causing habitat destruction through trampling of the stream bed and streambank vegetation. In some instances the habitat destruction associated with cattle is due to streambank erosion and sediment deposition. Cattle access also causes other impacts. These include increasing channel width which results directly in a decrease in stream depth, destruction of streamside vegetation which contributes to increased stream temperatures, destruction of streambed habitat for aquatic life needed to support fish populations, and the direct enrichment of the stream with manure. These impacts may not necessarily be accompanied by large increases in streambank erosion.

There are relatively few serious streambank degradation sites in the watershed. Seventy-six sites were identified in the watershed, encompassing about 24,000 feet and producing an estimated 419 tons of sediment per year. The streambank erosion problem is concentrated in the mainstem region, occurring primarily along Quaas Creek and along the Milwaukee River both within and immediately downstream of the city of West Bend.

Cattle access is an important factor in causing general streambank degradation, occurring along 56 percent of the degraded feet. Cattle access is less important as a cause of streambank erosion, however. Cattle access is associated with only 10 percent of the sediment yield from streambanks. Other streambank erosion problems are caused by increases in streamflows that occur as a result of changing land uses. In some areas, woodland shading prevents the establishment of vegetation needed to stabilize the streambanks.

Removal of several dams in the watershed is recommended in the integrated resource management plan as a means to improve habitat and water quality (WDNR, 1988b). After impounding dams are removed, erosion problems in the drained lakebeds can be expected to develop as the soft sediments are subjected to rainfall, runoff, and the erosive action of the stream. As dams

are removed in this watershed, the lakebeds will be evaluated to determine the need for erosion control through this priority watershed project.

Barnyard Runoff: There are 267 barnyards in the East-West Watershed. Table 7 shows the regional distribution and pollution potential of these barnyards.

On a watershed basis, 158 barnyards, or 59 percent of the total, are hydraulically connected to lakes and streams, or their associated riparian wetlands. These barnyards represent 52 percent of the barnyard runoff pollution potential. Most of this surface water pollution potential is caused by a very small percentage of the barnyards. The 15 barnyards having the highest pollution potential account for 50 percent of the pollution potential, and the worst 34 barnyards account for 75 percent of the pollution potential. Fully 98 barnyards, or 62 percent of the total, are responsible for less than 10 percent of the total pollution potential of barnyards draining to surface waters.

Table 7 also shows information concerning barnyard runoff to other potentially sensitive receiving areas, including non-riparian wetlands and shallow soils less than 24 inches deep over bedrock or groundwater. Together, these areas receive runoff from 39 barnyards, or 15 percent of the total. These barnyards represent about 15 percent of the barnyard runoff pollution potential. Most of these 39 barnyards have low to moderate pollution potential, with relatively few posing a severe pollution potential.

Finally, Table 7 shows that 70 barnyards, or 26 percent of the total, have runoff that is internally-drained to deep mineral soils. These barnyards make up 34 percent of the barnyard runoff pollution potential in the watershed. These barnyards do not generally pose a nonpoint source pollution hazard to waters of the state.

Winterspread Manure: The general pollution potential posed by winterspreading manure in the East-West Watershed is summarized in Table 8. Since this analysis was not conducted by sub-watershed or region, the results are displayed by county.

The 233 livestock operations in the East-West Watershed produce an estimated 162,000 tons of manure during the six-month period encompassing late fall through mid spring. This is the period during which manure incorporation may be difficult, and manure runoff from steeply sloping lands or lands near waterways is an elevated hazard. In order to properly landspread this volume of manure, an estimated 6,470 acres are needed. Of the approximately 14,000 acres available for landspreading in the watershed, about 30 percent are critical and not considered environmentally safe for winterspreading. Although there are about 10,000 acres of environmentally safe lands for winterspreading, or nearly 50 percent more than what is needed, there is still a potential for critical lands to be winterspread. This results in part because there are critical lands on most farms that may be spread with manure during the winter. The other factor is that the environmentally safe acres are not distributed throughout the watershed proportional to their need.

In the East-West Watershed, it is estimated that 70 livestock operations, or 30 percent of the total, do not have sufficient environmentally safe acreage to avoid winterspreading critical lands. The result is that an estimated 1,530 acres of environmentally sensitive lands are winterspread each year in the watershed.

The number of critical acres spread by each landowner will vary. It is estimated that 40 livestock operators, or 17 percent of the total, spread 10 or more critical acres per year. Fifty-two operations spread between five and ten critical acres. Over one-half of the livestock operations are estimated to be spreading less than five critical acres per year.

Urban Land Use and Pollution Sources

The urban lands in the watershed are concentrated primarily in and adjacent to the city of West Bend and the villages of Newburg, Kewaskum, and Campbellsport.

The West Bend Study Area includes 75 percent of the urban lands and contributes about 75 percent of the urban pollutant load. Within the West Bend Study Area, the direct drainage area to the Milwaukee River has the highest unit area pollutant loading, producing about 75 percent of the urban pollutants. The urban lands within the Quaas Creek Subwatershed have the lowest unit area pollutant loading, producing only eight percent of the urban pollutant load within the study area. The urban lands within the Silver Creek Subwatershed of the West Bend Study Area have characteristics between these two extremes. Extensive urban development is projected for the West Bend Study Area. The urban area is expected to grow by 87 percent, and the pollution potential of post-development stormwater runoff could increase by 109 percent if not controlled. The largest increase in pollutant loading due to uncontrolled stormwater runoff from new development would occur in the Quaas Creek Subwatershed. Here, pollutant loads could increase by 450 percent. Projected increases for the direct drainage to the Milwaukee River and the area draining to Silver and Engmann Creeks are 75 and 100 percent respectively.

The Campbellsport Study Area includes six percent of the urban area and produces six percent of the urban pollutant load. Projected future growth in this area will increase the urban area by 60 percent and if urban runoff is not controlled, will increase the urban pollutant load by 30 percent.

The Kewaskum Study Area includes 11 percent of the urban area and produces 11 percent of the urban pollutant load. Projected future growth in this area will increase the urban area by 128 percent and if urban runoff is not controlled, will increase the urban pollutant load by 150 percent.

The Newburg Study Area includes seven percent of the urban area and produces four percent of the urban pollutant load. Projected future growth in this

area will increase the urban area by 135 percent and if urban runoff is not controlled, will increase the urban pollutant load nearly 10 times.

In addition to the pollution potential posed by runoff from newly developed areas, there is also a tremendous potential for construction erosion impacts on water quality. This potential occurs not only in the four study areas, but in other unincorporated portions of the watershed.

WATER RESOURCES OBJECTIVES

SURFACE WATER

Surface water objectives involve the watershed's streams, lakes, and wetlands. Stream and lake specific objectives for the priority watershed project focus on the biological and recreational uses discussed in Appendix E and shown on Map 2. Water quality objectives and the measures needed to achieve them are based on subwatershed-specific conditions. However, it should be understood that improvement in downstream water quality both in the East-West Watershed and the Milwaukee River system as a whole are also considered in establishing objectives.

Three basic objectives have been identified and each is summarized below.

Protection: Protection refers to maintaining the present biological and recreation uses supported by a lake or stream. For example, if a stream is supporting a healthy cold water fishery and is used for full body contact recreational activities, the objective would be to maintain those uses through abatement of nonpoint sources.

Enhancement: Enhancement refers to a change in the overall condition of a stream or lake within its given biological and recreational use category. For example, if a stream is supporting a warm water fishery whose diversity and viability could be enhanced, the objective would be to alter the water quality conditions which are keeping the resource form achieving its full biological potential.

Improvement: Improvement refers to upgrading the existing capability of the resource to support a higher category of biological use. An example, would be a stream which historically supported healthy populations of warm water game fish, but no longer does so. The objective would be to change the degraded water quality conditions which support a limited forage fishery and few game fish, to allow viable populations of forage and warm water game fish species to become reestablished.

An underlying water quality objective is the protection of wetlands throughout the watershed. Besides providing some of the best wildlife habitat and

important spawning areas for fish, they serve to buffer streams and lakes from sediment and other materials which would otherwise be carried to surface waters.

GROUNDWATER

The Department is responsible for protecting the quality of groundwater. The priority watershed project has no specific criteria for establishing site-specific objectives to protect existing groundwater quality or improve its conditions. However, existing administrative rules and policies designed to protect groundwater from contamination attributed to nonpoint sources will apply in this project. Indeed, as discussed in Chapter IV, eligibility criteria for cost sharing nonpoint sources impacting groundwater are established and used during project implementation.

SUBWATERSHED CONDITIONS FOR THE EAST REGION

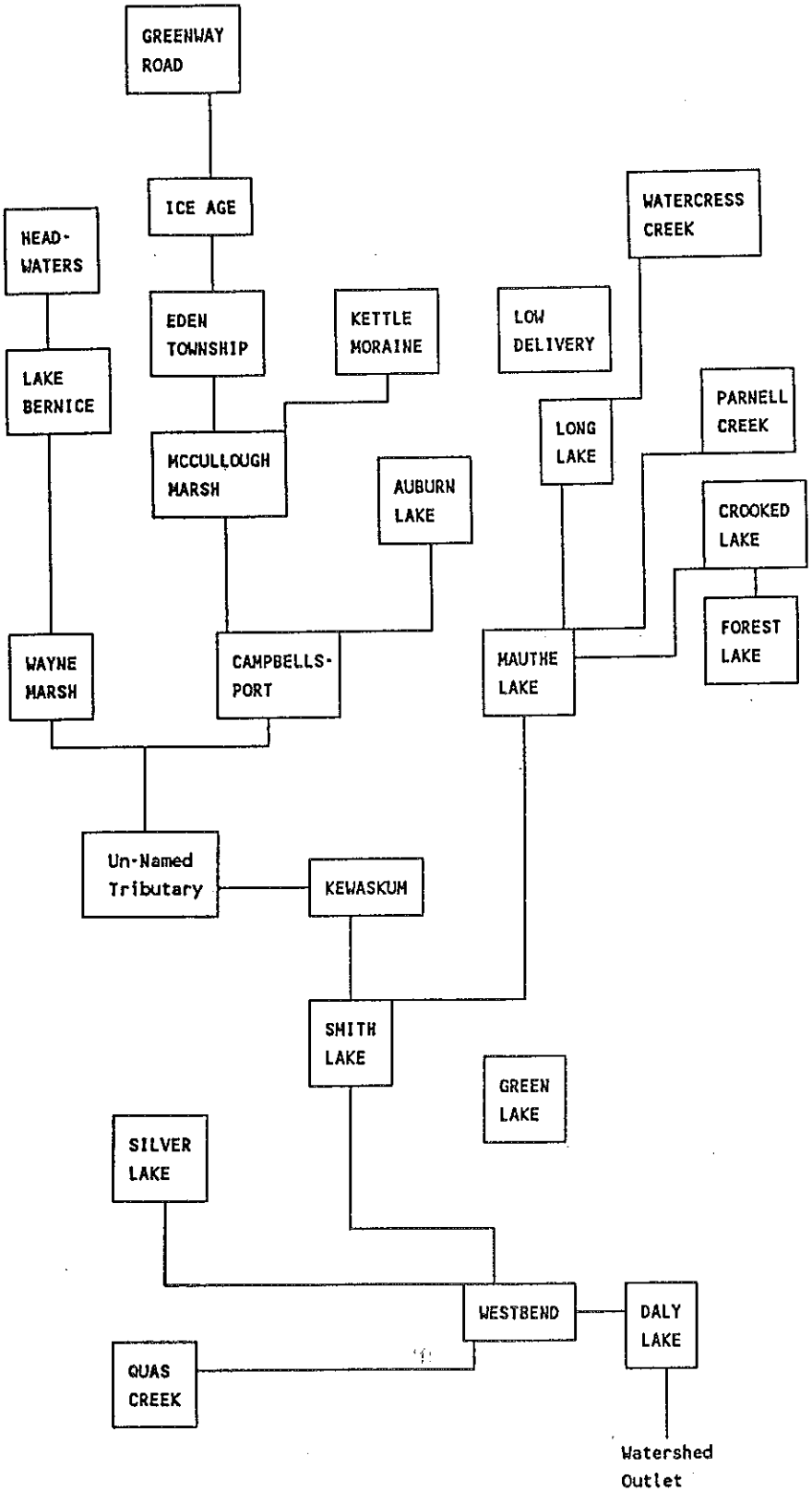
This section presents the water resource conditions and nonpoint sources for each subwatershed in the East Region of the East-West Watershed. Subwatersheds in this region include Crooked Lake (CL), Long Lake (LL), Mauthe Lake (ML), Parnel Creek (PC), Watercress Creek (WC), Forest Lake (FL), and Low Delivery (LD). The locations of these subwatersheds, and the potential uses of the water resources that they contain, are shown on Map 2. The hydrologic flow connection between these subwatersheds is shown in Figure 1.

The agricultural land use distribution for subwatersheds in the region is presented in Table 9.

The description of water resources conditions are based on findings contained in the Water Resources Appraisal and Stream Classification Report (Mace, 1986).

The pollution reductions required to meet the water resources objectives presented in the following text, and the extent of needed nonpoint source practices required, are presented as part of Chapter IV.

Figure 1. Hydrologic flow diagram for the East-West Watershed



WATERCRESS CREEK SUBWATERSHED

WATER RESOURCE CONDITIONS

Watercress Creek: Watercress Creek, originating from a number of springs, is the headwaters of the East Branch of the Milwaukee River. That portion of the stream in Fond du Lac County is bordered by extensive cattail and tag alder wetlands.

That portion of Watercress Creek upstream of the Sheboygan/Fond du Lac County line is considered a Class II brook trout stream (FAL-A). This section lacks enough natural spawning habitat to support significant natural reproduction. Although some trout are present downstream of the county line, northern pike predominate and this lower part of the stream is considered a warmwater sport fishery.

Heavy instream siltation affects both the trout and warmwater sport fish portions of Watercress Creek. In addition, low gradient and mid-summer low flows in downstream reaches limit somewhat the biological uses in Watercress Creek. Parent soils in the downstream portions are partly the cause of this silt.

This stream could benefit from instream habitat structures as well as devices to direct water movement, thereby concentrating flow and reducing silt deposition.

NONPOINT SOURCES OF POLLUTION

General Land Use: Rural lands comprise 5,057 acres or approximately 97 percent of the land use in this subwatershed. The remainder is scattered residential development.

The rural land use distribution is shown in Table 9. This table shows that most of the rural lands are in low intensity uses that are generally associated with low pollution potential. For example, woodlands, grasslands, and wetlands, all of which are low intensity land uses, together make up 61 percent of the rural land use in the watershed. Croplands, which generally have a higher pollution potential, make up only 37 percent of the subwatershed land use. Continuous row cropland, the land use having the highest pollution potential, makes up only 22 percent of the cropland or eight percent of the total rural land cover.

Rural Sources: Table 10 presents a rural nonpoint source summary for this subwatershed.

In general, the barnyard runoff pollution potential to surface waters is low. Of the two barnyards draining to surface waters, only one has a significant

pollution potential. The barnyard draining to the pocket wetland may also be significant, but its impact is unknown.

Upland erosion is the principal source of sediment to the stream system, there being no other important sources. Cropland comprises 36 percent of the land use in this subwatershed, and produces nearly all of the estimated 144 tons of sediment delivered to the stream network. Over 90 percent of the delivered sediment enters Watercress Creek in its headwater section, which is classified as brook trout water. This sediment is produced by only one-third of the agricultural lands. The remaining acres are well buffered from the channel network.

Part of this buffering is due to the riparian wetlands. These natural stream buffers trap a significant amount(54 tons/year) of sediment. Another factor is the extensive internal drainage in this area, which collects runoff from 71 percent of the eroding uplands. Part of the internally-drained areas have wetland vegetation growing in them. These areas trap a significant amount(487 tons/y) of eroded sediment.

The value and sensitivity of these riparian and non-riparian wetland areas vary tremendously, and the impact of this sediment load on them is not known.

Urban Sources: There are no significant urban nonpoint sources in this subwatershed.

Water Resource Objectives

The upper reaches of Watercress Creek are impacted primarily by sediment. The lower reaches are affected not only by sediment but by natural gradient and streamflow characteristics. In both instances the stream is currently supporting recreational, fish, and aquatic life uses for which it is classified. Although nonpoint source controls can be expected to improve the quality of the existing use classification, the use classification will not be changed as a result of successful nonpoint source controls.

The water resources objectives for the Nonpoint Source Control Program are to:

a. Protect and enhance the existing recreational, fish & aquatic life uses of the upstream portion of Watercress Creek.

b. Protect the existing uses of the downstream portion of Watercress Creek.

c. Protect valuable and sensitive wetlands from barnyard runoff and sediment deposition, where subsequent field investigation indicates that the assimilative capacity of the wetlands is being overloaded.

d. Decrease the nonpoint source pollutant loading to Long Lake, the majority of which is generated in the Watercress Creek Subwatershed.

Most of the nonpoint source controls in this subwatershed will be related to the control of upland erosion. The proposed control strategy for the subwatershed is presented in Chapter IV.

Low Delivery Subwatershed

Water Resource Conditions

There are no perennial streams in this subwatershed, which is primarily wetland. Based on aerial maps it appears that what surface water exists is due to extensive channelization of the wetlands. Surface water resources in this subwatershed were not investigated and conditions in the channels are unknown.

Nonpoint Sources of Pollution

General Land Use: Over 97 percent of the land cover is rural. The rural land use distribution is shown in Table 9. About one-half of the rural land use is in cropland. None of the cropland is in continuous row crops, generally the most intensive rural land use with the highest pollution potential. Wetlands make up 27 percent of the rural land use, and other non-intensive rural land uses such as woodland, and grassland make up an additional 23 percent of the land cover.

The urban land use is scattered residential development, which generally has a low pollution potential.

Rural Sources: Table 11 presents a rural nonpoint source summary for this subwatershed. Barnyard runoff was the only source assessed.

In general, the barnyard runoff pollution potential to surface waters is low. Of the seven barnyards, only one has a significant pollution potential. The barnyard internally-drained to deep mineral soils has such a high pollution potential that it may pose a groundwater pollution hazard.

All eroding uplands are internally-drained, there being no surface water connection from this subwatershed to Long Lake.

The degree of sediment delivery was not assessed, and the potential for impacts on wetlands in this area is not known.

Urban Sources: There are no significant urban nonpoint sources in this subwatershed.

Water Resource Objectives

The Nonpoint Source Control Program objective for this subwatershed is to protect valuable and sensitive wetlands from barnyard runoff and sediment deposition, where the assimilative capacity of the wetlands is being overloaded.

LONG LAKE SUBWATERSHED

WATER RESOURCES CONDITIONS

Long Lake: Long Lake is the largest lake in the East-West Watershed, with its water supply coming primarily from Watercress Creek. Tittle Lake is contiguous with Long Lake and is discussed as a part of Long Lake.

The fish community in this lake is diverse, dominated by bass and sunfishes. The forage fishery is also abundant and diverse. Recent fish consumption advisories issued by the Department have included 18-22" walleye from Long Lake. The source of the mercury is unknown.

The calculated annual phosphorus loading to Long Lake approximates that estimated to be an acceptable level. Average summer chlorophyll a concentrations indicate that planktonic algae are not a problem. Based on lake modeling, phosphorus loading to Long Lake should be reduced by four percent to achieve an acceptable level to protect the lake from eutrophication.

Recreational uses on Long Lake include boating, water skiing, and swimming. Bacteriological data from the north and south swimming beaches located at the Long Lake Recreational Area indicate no bacterial contamination in these areas. The lake has an extensive littoral zone that was created when a control dam raised the water level in the lake. The macrophyte growth occurring in this zone is frequently noted as a recreational use impairment. Also, the southern end of the lake is primarily a deep water marsh and may occasionally present use impairments depending on the users' perspective.

Tributaries to Long Lake: Two unnamed tributaries to Long Lake were evaluated. One enters Long Lake in T14N-R19E-SESE12. The entire stream can support partial body contact uses. Habitat and other physical features present in this tributary from the headwaters down to Scenic Drive indicate it is capable of supporting tolerant forms of fish and aquatic life, probably throughout the year. This part of the stream is only partially meeting its potential because of stream channelization. From Scenic Drive downstream to its confluence with Long Lake, the potential of the stream improves making it capable of supporting an intolerant fish and aquatic life community. This portion of the stream is only partially meeting its full potential, primarily due to sedimentation.

The second unnamed tributary enters Long Lake at T14N-R19E-NWSE24. Habitat and other physical features in this tributary from the headwaters down to its confluence with Long Lake indicate the stream is capable of supporting tolerant forms of fish and aquatic life, but only for part of the year. The stream cannot support body contact uses.

Nonpoint Sources of Pollution

General Land Use: Land use in this subwatershed is 94 percent rural and six percent urban. The urban land uses are primarily residential with some associated commercial uses. The urban lands are concentrated along the lakeshore.

The rural land use is shown in Table 9. Croplands in rotation make up 40 percent of the rural land use. The remainder is made up of wetlands, woodlands, and grasslands.

Rural Sources: Table 12 presents a rural nonpoint source summary for this subwatershed.

In general, the barnyard runoff pollution potential to surface waters is low, with no significant barnyards present. Most of the pollution potential to the pocket wetland areas comes from one of the two barnyards, although its impact is unknown.

There are few agricultural sources located within the Long Lake Subwatershed that contribute sediment to the lake. There were no significant sources of streambank erosion inventoried. Although upland erosion occurs, little of it reaches either Long Lake or its associated wetlands. This is because 85 percent of the croplands in the watershed are internally-drained. The remaining areas have very little delivery. Overall, only seven percent of the eroding uplands deliver sediment to the lake, and the combined annual delivery is less than one ton. The dominant source of sediment to the lake remains the agricultural lands within the Watercress Creek Subwatershed, however, which contribute an estimated 85 percent of the annual delivered sediment to the lake.

It has been noted that an intermittent tributary originating in T14N R19E S13 near Lakeview Road and entering Long Lake in the northwest corner of Section 13 carries a noticeable sediment load into Long Lake. The source of this has not been identified through the routine inventories, however, and the sediment load has not been estimated. Similarly, the source of sediment impacting the lower reaches of the un-named tributary located at T14N-R19E-SESE12 is unknown.

The combined acreage of non-riparian wetland vegetation receives a considerable sediment load, but the site-specific impacts are unknown.

Urban Sources: There are segments of the Long Lake shoreline which are developed for cottages. These areas were not inventoried for nonpoint sources. However, these urban lands are estimated to contribute nearly all of the 24 tons of the sediment delivered to Long Lake from the direct drainage area. This represents about 15 percent of the sediment load to Long Lake, the remainder coming from the Watercress Creek Subwatershed. The role of these urban lands in contributing sediment to Long Lake and its tributaries should be further investigated.

WATER RESOURCE OBJECTIVES

Long Lake is threatened by nonpoint sources, primarily those located in the Watercress Creek Subwatershed. Sediment and attached nutrients appears to be the primary pollutant of concern. The role of sediment sources on urban lands surrounding the lake needs further investigation. In addition, the sources of sediment to the streams tributary to Long Lake in T14N R19E S13 northwest quarter and in T14N-R19E-SESE12 needs to be further investigated as part of an effort to protect Long Lake. Although the lake is currently supporting its potential recreation, fish, and aquatic life uses, these uses can be enhanced with nonpoint source controls.

Another potential benefit of nonpoint source controls might be enhancement of the lower portion of the tributary to Long Lake in T14N R19E SESE12, where sedimentation is an important limitation. Other streams noted are also impacted by low flow and previous channelization, making it harder to enhance uses with nonpoint source controls alone.

The Nonpoint Source Control Program objectives for this subwatershed are to:

a. Protect and enhance the existing recreational, fish and aquatic life, and aesthetic uses of Long Lake.

b. Enhance the capability of the lower reaches of the tributary in T14N R19E SESE12 to support its designated use if nonpoint sources can be located.

c. Protect valuable and sensitive wetlands from barnyard runoff and sediment deposition, where the assimilative capacity of the wetlands is being overloaded.

PARNELL ESKER SUBWATERSHED

WATER RESOURCE CONDITIONS

Parnell Creek: Parnell Creek originates in Section 17 of Mitchell Township, Sheboygan County, and flows southwesterly to its confluence with the East Branch of the Milwaukee River, downstream of Long Lake.

The intermittent portions at the headwaters of Parnell Creek were not surveyed. The entire upper headwaters area consists of an extensive wetland area with diffuse, partly diffuse and occasionally well-defined channels. It is unknown how much use is made of the wetlands for fish spawning.

Habitat and other physical stream features from the headwaters down to Butler Lake Road indicate the stream is capable of supporting intolerant forms of fish and aquatic life throughout the year. This portion of the stream can support partial body contact uses. From Butler Lake Road downstream to the confluence with the East Branch of the Milwaukee River, the stream is capable of supporting a diverse warmwater sport and forage fish community (FAL-B). This portion of the stream can support full body contact uses.

The stream is only partially meeting its full potential. In the furthest upstream portions, low flow and past channelization are the primary factors limiting increased biological use of the stream. Rehabilitation would require some form of channel consolidation. Much of the furthest upstream portions of Parnell Creek and its tributaries drain through large wetlands. Through these areas deposition of organic materials contributes to degraded habitat. There are portions of the stream where the streambanks have little or no bank cover, possibly resulting in elevated stream temperatures. High levels of bacterial contamination at times may limit recreational use. State bacterial standards were not met at County Trunk Highway "F" during the summer period. The source of this contamination is not known, although it could be related to animal waste.

Because access and wading are difficult, the river probably receives little fishing pressure.

Flynn's Spring: This is a short, perennial brook flowing into Butler Lake with access via the lake. Stocking of brown trout failed and was discontinued. Fluctuations in water flows have been reported.

Butler Lake Outlet: No data are available for this perennial stream, however, it is tentatively assumed to be able to support warm water sport fish as does Butler Lake.

Butler Lake: Butler Lake is the only lake in this subwatershed. No recent monitoring of the lake has been conducted.

This lake is reported to be fertile, and threatened by bog encroachment from the east and south. Partial winterkill has been reported to occur, however

the fishery is reputedly good for bass and panfish; trout have been stocked in the past.

Nonpoint Sources of Pollution

General Land Use: Most of this subwatershed is in state ownership as part of the Kettle Moraine State Forest.

The rural land use distribution is shown in Table 9. Low intensity land uses including woodland, wetland, and grassland make up 77 percent of the rural land use. Cropland makes up the remainder. Approximately 90 percent of the cropland acreage is farmed in rotation, with the remainder in continuous row crops.
Urban land use is extremely limited, comprising less than one percent of the land use. The urban lands are scattered residential development.

Rural Sources: Table 13 presents a rural nonpoint source summary for this subwatershed.

Based on phosphorus loading potential, there are no significant sources of barnyard runoff to surface waters. However, the bacterial contamination monitored at County Highway F may be related to either barnyard runoff from the barnyard located in Section 30 or from winterspread manure. The barnyard draining to the pocket wetland is probably not significant as a pollution source.

Upland erosion is the principal source of sediment to the stream system. Cropland comprises 20 percent of the land use in this subwatershed, and produces virtually all of the estimated 192 tons of sediment delivered to the stream network. About 92 percent of the agricultural sediment delivered to Parnell Creek enters the stream between Butler Lake Road and the Sheboygan/Fond du Lac County Line. Virtually all of the remainder enters the creek at its headwaters.

The remaining agricultural acres are well buffered from the stream network. In fact, only about 25 percent of the agricultural land use contributes the total delivered sediment load to Parnell Creek.

Part of this buffering is due to the riparian wetlands. These natural stream buffers trap a significant amount (50 tons/year) of sediment. Another factor is the extensive internal drainage in this area, which collects runoff from 80 percent of the eroding uplands. Part of the internally-drained areas have wetland vegetation growing in them. These areas trap a significant amount(131 tons/y) of eroded sediment.

The value and sensitivity of these riparian and non-riparian wetland areas vary tremendously, and the impact of this sediment load on them is not known.

Urban Sources: There are no significant urban nonpoint sources in this subwatershed.

Water Resource Objectives

Sediment appears to be the primary pollutant of concern. This pollutant is the primary limitation on beneficial uses for the section of Parnell Creek downstream of Butler Lake Road. Upstream of Butler Lake Road, the sediment load is far less and other limiting factors, including low flow conditions and past channelization also affect the resource. The source of bacterial contamination is not known, but the role of barnyards draining to surface waters and winterspreading practices should be investigated further. Although nonpoint source controls will not lead to any changes in the beneficial uses which water bodies in this subwatershed can support, nonpoint controls may be successful in enhancing the quality of these uses.

The Nonpoint Source Control Program objectives for this subwatershed are to:

a. Protect the existing recreational, fish and aquatic life uses of Parnell Creek in the reaches above Butler Lake Road.

b. Enhance existing recreational, fish and aquatic life uses of Parnell Creek in the reaches below Butler Lake Road.

c. Protect valuable and sensitive wetlands from sediment deposition, where the assimilative capacity of the wetlands is being overloaded.

d. Decrease the nonpoint source pollutant loading to Mauthe Lake, the majority of which is generated in the Parnell Creek Subwatershed.

MAUTHE LAKE SUBWATERSHED

WATER RESOURCE CONDITIONS

East Branch of the Milwaukee River: The river in this subwatershed provides good sportfish habitat, and is capable of supporting a balanced warmwater sportfish community. There are also abundant numbers of many important intolerant forage fish species. Benthic macroinvertebrates indicate that there is good to very good water quality.

Aquatic macrophytes and algae are generally not a problem in this river. Aquatic plant growth is well-balanced with low to moderate abundance in riverine sections. The mean summer baseflow phosphorus concentration below New Fane is sufficiently low to prevent nuisance growths of macrophytes.

Because of the ecological diversity within this subwatershed there are outstanding opportunities for various water based recreation uses including fishing, swimming, and boating. Obstacles to canoeists include a fence partially crossing the river 0.3 mi upstream of New Prospect, and the dam at New Fane.

Results of bacterial sampling in the subwatershed indicated that overall, the East Branch had low levels of bacterial contamination. High bacterial levels were measured in the East Branch below New Prospect, however. The levels were high enough to indicate a health hazard for full body contact recreation. This hazard is probably not limited to sections of the river immediately downstream of New Prospect, but may limit recreation uses further downstream. The hazard could possibly affect some portions of the Mauthe Lake Recreational Area as well. The bacteria type suggests human waste contamination.

Perennial Tributaries: No data have been gathered on the tributary that joins the East Branch in Section 35 of Osceola Township. It courses through wetlands before joining the East Branch. Access is from the river only. Due to the wetlands nature of this stream and suitability for sportfish spawning, conditions are believed able to support a diverse forage and warmwater sport fish community.

The tributary that joins the East Branch in the southeast corner of Section 36, Osceola Township, originates in springs and may supports a wild brook trout population, although this has not been confirmed. This tributary lies entirely within the project boundaries of the Kettle Moraine State Forest.

The small tributary to Mauthe Lake drains entirely through wetlands. Access is difficult and gained by a hiking trail or small skiff from Mauthe Lake. By default and virtue of its connection with Mauthe Lake, conditions in this tributary are believed able to support a diverse forage and warmwater sport fish community.

Mauthe Lake: Mauthe Lake is relatively shallow (max depth 22 ft) with a surface area of 63 acres. Extensive camping and other recreational facilities have been developed for the recreation area. Except for developed swimming areas, the littoral area supports substantial macrophyte growth. Outboard motors are not allowed to operate on the lake.

Macrophyte growth in littoral areas appears to be fairly diverse but their abundance poses a threat to a healthy environment. Macrophytes in Mauthe Lake grow in such abundance that local diel DO depletions may limit habitat at least in the littoral areas.
Although phosphorus loading is presently greater than that estimated to be acceptable, chlorophyll a levels indicate planktonic algal growth is not a problem. Based on lake modeling phosphorus loading to Mauthe Lake should be reduced by 31 percent to achieve an acceptable loading level to protect the lake from eutrophication.

Dissolved oxygen depletion occurs in the hypolimnion and DO is insufficient to adequately support most aquatic life (<2 mg/l) below the 10-15 foot depth during the summer months. Dissolved oxygen is also depleted, to a lesser degree and greater depth, in the winter under ice cover.

Although northern pike and walleye have been stocked in Mauthe Lake, no appreciable numbers of either of these species have been found in subsequent samplings. Largemouth bass, crappie and sunfish dominate creels.

Nonpoint Sources of Pollution

General Land Use: The land use in this subwatershed is virtually all rural. The only urban land use is scattered residential.

Table 9 shows the rural land use distribution. Of the rural land use, low intensity land uses such as woodland, wetland, and grasslands make up nearly 86 percent of the area. Croplands comprise the remainder, with all of the cropland farmed in rotation.

Rural Sources: This portion of the East Branch Milwaukee River is located primarily in the Northern Unit of the Kettle Moraine State Forest and most of the resource remains in a wilderness state. This is reflected in the low number of nonpoint sources.

Table 14 summarizes the nonpoint sources in this subwatershed. Barnyard runoff poses no threat to any of the water resources. Streambank degradation associated with cattle access is a problem at just one site, located just upstream of New Prospect. The only source of sediment to water resources is upland erosion, with cropland the major source. Almost one-half of the agricultural lands in this subwatershed are internally-drained. As a result, about one-half of the eroding agricultural lands are responsible for delivering all the estimated 32 tons/ year of sediment to surface waters.

The distribution of sediment delivery along the East Branch is as follows: approximately 20 percent enters the stream between the outlet of Long Lake and the northern edge of Osceola Township; approximately 40 percent enters the

stream within Section 1 of Osceola Township, just above New Prospect; approximately the remaining 40 percent enters between the southern boundary of Section 1, Osceola Township and the Smith Lake Subwatershed, with most of this entering the river just above New Fane.

Riparian wetlands filter out an estimated 13 tons of sediment per year. Wetland vegetation in internally-drained areas receives little sediment.

The significance of winterspread manure in this area was not specifically assessed.

Urban Sources: There are no significant urban nonpoint sources in the subwatershed.

WATER RESOURCES OBJECTIVES

Nutrient enrichment and bacterial contamination appear to be the primary nonpoint source impacts. It is estimated that an important portion of the nutrient load to Mauthe Lake is associated with sediment as there are few significant sources of barnyard runoff upstream. Winterspread manure could be another agricultural source, however. Although the potential uses of water bodies in this subwatershed will not change as a result of nonpoint source controls, the quality of these uses should be enhanced.

The water resources objectives for the Nonpoint Source Control Program are to:

a. Protect the existing recreational, fish, and aquatic life uses in the East Branch and its tributaries.

b. Enhance the existing recreational, fish, and aquatic life uses in Mauthe Lake.

c. Protect valuable and sensitive wetlands from sediment deposition, where the assimilative capacity of the wetlands is being overloaded.

Crooked Lake Subwatershed

Water Resource Conditions

Major water resources in this subwatershed include the unnamed creek 14-3, referred to here as Crooked Creek, and six lakes including Crooked Lake, Cedar Lake, Mallardhole Lake, Kelling lakes, Lake Seven, and Little Mud Lake. Lesser resources include five unnamed perennial streams, and two unnamed lakes.

Crooked Creek: Habitat and other physical features in Crooked Creek from the headwaters down to Crooked Lake Road indicate that this part of the stream is capable of supporting intolerant forms of fish and aquatic life throughout the year, and is capable of supporting partial body contact. The portion of Crooked Creek upstream of Tower Drive has been channelized and deepened at some point in the past. Land adjacent to this reach has been purchased by the state as part of the Kettle Moraine State Forest. The channel has not been appreciably widened, the banks are stable and the stream is beginning to reestablish meanders.

Crooked Creek from Crooked Lake Road downstream to the confluence with the East Branch of the Milwaukee River is capable of supporting a diverse warmwater sport and forage fish community and full body contact recreational uses.

Neither of these portions of Crooked Creek are meeting their full potential to support these uses. Shallow water depth is the primary uncontrollable factor limiting increased biological use of the stream in the furthest upstream portions. The lack of depth is primarily a function of flow and channel definition and shape through wetland areas. These impairments are only partially controllable. Rehabilitation would require some form of channel consolidation.

Much of Crooked Creek and its tributaries drain through large wetlands. Deposition of organic materials in these areas contributes to degraded habitat in areas. Seasonal nutrient fluxes from the wetlands to the stream may also occur.
Heavy shading by brush and forest along much of the length of Crooked Creek prevents the establishment of stable bank cover such as deep rooted grasses.

Periodic shallow water, narrow, poorly defined channels and thick bank vegetation limit recreational canoeing, at least during low-flow periods. Portions of the river downstream of Crooked Lake have sufficient depth to provide comfortable recreational canoeing during low flows.

The same obstacles apply to body contact recreation. During most of the warm weather period, water is too shallow to provide much in the way of swimming. Small diameter culverts at road crossings, overhanging brush combined with low flows limits recreational use of many parts of the stream. Because access and wading are difficult, the river probably receives little fishing pressure.

Crooked Lake: Crooked Lake is the largest lake in this subwatershed. Much of the shoreline is in state ownership within the Kettle Moraine State Forest. A small public access is located at the southwest bay. There are no public beaches.

Although phosphorus loading is presently greater than that estimated to be acceptable, chlorophyll a levels indicate planktonic algal growth is not a problem. Based on lake modeling phosphorus loading to Crooked Lake should be reduced by 24 percent to achieve an acceptable loading level to protect the lake from eutrophication.

Dissolved oxygen depletion occurs in the hypolimnion and is insufficient to adequately support most aquatic life (<2 mg/l) below the 15-20 foot depth during both summer and in the winter under ice cover. Dissolved oxygen depletion in the hypolimnion is not controllable in the short term. Reducing the nutrient loading to the lake can contribute to the long term improvement of the dissolved oxygen regime in this lake.

Stunted panfish and northern pike have been reported as a management problem. Seven species of sportfish have been reported as present, the most abundant being black crappie and bluegill sunfish. The forage fishery in Crooked Lake appears somewhat limited in numbers and species richness. Two species of fish on the watch or threatened list exist in this lake: the lake chubsucker (W) and pugnose shiner (T).

The elongated, irregular lake shape and shallow littoral zone with dense stands of macrophytes are conflicting factors to speed boaters. The lake may be more suitable to rowing and canoeing than to fast boat sports.

Extensive upland game and waterfowl hunting takes place here. The lake and its well-preserved wetlands also have a high interest value for outdoor study. Preservation of the lake's wild qualities are necessary for the continuation of this use.

From aerial maps it appears that a channel has been created from Lake Seven to Crooked Creek. This was not investigated and resource conditions are unknown.

Cedar Lake: Cedar Lake is a seepage lake maintained mostly in a wilderness state. Nearly the entire lake has public frontage.

This lake periodically winterkills. This is a function of the shape of the lake basin. Because of periodic winterkill, Cedar Lake has primarily a stunted panfish population. Largemouth bass fishing is reported to be good between winterkills. Monitoring has not been conducted on Cedar Lake and nutrient reduction goals cannot be cited at this time.

The major uses of Cedar Lake are aesthetics and wildlife-related uses. Major wildlife uses include muskrat, puddle duck nesting and use by migrating waterfowl. There is one access road and hunting is permitted.

Kelling Lakes: The Kelling Lakes are comprised of three small seepage lakes, although there are three other lakes immediately adjacent to this group. Most are less than one acre in area with maximum depths of seven feet or less. These are pothole-type lakes in marsh and wilderness surroundings.

The Kelling Lakes commonly experience winterkill and this limits the fishery. Although no data are available for these lakes, panfish and forage species have been reported.

The topography surrounding these lakes features moraines and many hiking trails follow the ridges in this area.

These lakes are considered to have significant furbearer and waterfowl value. Their main assets are wildlife habitat and scenic values. Wildlife use includes duck nesting and muskrats.

Lake Seven: Lake Seven is characterized by periodic, partial winterkills. In spite of this, largemouth bass and panfishing are considered to be good, although stunted panfish have been considered a management problem in the past. Surrounding wetlands serve resident and migrating waterfowl. Dissolved oxygen depletion occurs in the hypolimnion and is insufficient to adequately support most aquatic life (<2 mg/l) below the 10-15 foot depth during ice cover as well as the summer months.

Based on lake modeling phosphorus loading to Lake Seven should be reduced by 48 percent to achieve an acceptable loading level which should protect the lake from eutrophication. Macrophytes in the lake may compete with algae for available nutrients. Although phosphorus loading is presently excessive, chlorophyll a levels indicate planktonic algal growth is not a problem. Macrophyte growth in this lake is, however, abundant.

This lake is suitable for rowing and canoeing; Department regulations prohibit use of motors. Public access and a small park are available at the southeast corner of the lake. There are no public beaches on this lake, although one resort and boat livery are present.

Hunting, trapping and wildlife observation have not been quantitatively assessed, however, the adjoining wetlands provide suitable habitat for nesting puddle ducks and serve as a resting area for migrating waterfowl.

Mallardhole Lake: Mallardhole Lake is a small, shallow seepage lake and is considered a wilderness lake. It is entirely within the Kettle Moraine State Forest with no dwellings.

The fish population is considered healthy. Observations of fish include bullhead, sunfish, largemouth bass, crappie, perch and northern pike.

Monitoring has not been conducted on Mallardhole Lake and nutrient reduction goals cannot be cited at this time.

Mallardhole Lake has no public access or dwellings and is classified as a wilderness lake. As with most of the other small kettle lakes, the surrounding wetlands serve as nesting and resting areas for waterfowl.

Little Mud Lake: Little Mud Lake is a small, shallow seepage lake and, due to winterkill, is not actively managed for a fishery. The total shoreline is in Kettle Moraine State Forest ownership and there is no shoreline development.

Monitoring has not been conducted on Mallardhole Lake and nutrient reduction goals cannot be cited at this time.

Aquatic vegetation is abundant and the lake and adjoining wetlands are extensively used by waterfowl and furbearers. A cranberry bog is located in the adjacent wetlands.

Unnamed Lake 6-6: This lake is connected through wetlands to Crooked Lake. No recent fish data are available. Observations indicate that the fishery is limited to forage fish. There is no public access to this winterkill lake (maximum depth 4.5 ft.). Major uses are nesting and migratory waterfowl.

Unnamed Lake 8-7.8 (T13N-R20E-SWNE Sec8): This lake is reported to have no fishery due to shallow depth (one foot max) and winterkill. There is no public access to this winterkill lake (maximum depth one foot). Its major use is as a unique area for study of bog ecology.

Nonpoint Sources

General Land Use: Approximately 98 percent of the land cover is rural. The distribution of the rural land use is shown in Table 4. About one-third of the rural land use is made up of croplands farmed in rotation. There is a very small amount of croplands farmed in continuous row crops. Woodlands, wetlands, and grasslands make up 60 percent of the rural land use. Approximately one-half of this subwatershed is under state ownership in the Northern Unit of the Kettle Moraine State Forest, much of which remains in a wilderness state.

The remaining two percent of the subwatershed land use is urban, primarily scattered residential areas.

Rural Sources: Table 15 shows the major nonpoint sources inventoried in this subwatershed.

The pollution potential from barnyards is relatively low. One of the barnyards draining to the stream channel system is of moderate concern, as is one of the barnyards draining to an internally-drained wetland area. The remaining six barnyards are of little concern.

Upland erosion is the principal source of sediment. Slightly less than one-half of the eroding uplands are responsible for delivering the estimated 94 tons of sediment per year to the surface water system. About 25 percent of the delivered sediment in this subwatershed enters the headwaters of Crooked Creek above Crooked Lake. The other hot spot is on either side of the Sheboygan/Fond du Lac County Line. This one mile stretch of Crooked Creek receives about 70 percent of the sediment delivered to surface waters in the subwatershed. The principal source of this sediment is rotated cropland.

Riparian wetlands are estimated to filter out about 13 tons of sediment per year that would otherwise make its way to the stream system.

As is typical of other subwatersheds in this portion of the East-West Watershed, the degree of internal drainage is high (61 percent). Wetland vegetation located in areas of internal drainage receive an estimated 661 tons per year of sediment. The ecological value and sensitivity of these areas are unknown, as is the impact of this depositional sediment.

Urban Sources: There are no significant urban sources in this subwatershed.

WATER RESOURCES OBJECTIVES

Most of the nonpoint source controls will be aimed at reducing sediment loads and their associated nutrients. Most of the controls will affect Crooked Lake and sections of Crooked Creek both above Crooked Lake and between Crooked Lake and the East Branch. Although these controls cannot be expected to change the uses of these water bodies, the quality of the existing uses should be protected.

Water resources objectives in this subwatershed for the Nonpoint Source Control Program are to:

a. Protect and enhance the existing recreation, fish, and aquatic life uses currently supported by Crooked Creek.

b. Protect the recreation, fish, and aquatic life uses of Crooked Lake.

c. Protect valuable and sensitive wetlands from barnyard runoff and sediment deposition, where the assimilative capacity of the wetlands is being overloaded.

FOREST LAKE SUBWATERSHED

WATER RESOURCES DESCRIPTION

Forest Lake: Forest Lake is a small, internally-drained lake in southeast Fond du Lac County. Rapid water flow through the soils in this watershed is a major contribution to groundwater recharge in the drainage area. The Forest Lake Subwatershed is entirely within the Kettle Moraine State Forest boundaries.

Based on past analyses, Forest Lake experiences excessive macrophyte growth in localized areas. Most of the abundant macrophyte growth occurs in a band adjacent to the shoreline in the littoral zone.

Phosphorus loading is presently greater than that estimated to be acceptable, but less than that estimated to be excessive. Chlorophyll a levels indicate planktonic algal growth is not a problem. Based on lake modeling phosphorus loading to Forest Lake should be reduced by 18 percent to achieve an acceptable loading level to protect the lake from eutrophication.

Based on recent monitoring dissolved oxygen is insufficient (<2 mg/l) to adequately support most aquatic life below 16 ft. during the summer months. Dissolved oxygen is also depleted, to a lesser degree and greater depth, in the winter under ice cover.

The slow-growing panfish population in Forest Lake may provide plenty of angling, however the quality of the harvest is limited by the small sizes. The unbalanced fish population reflects habitat limitations and constraints. The abundance of macrophytic vegetation may render panfish populations inaccessible to predators.

Hunting, trapping and wildlife observation are limited in the area immediately adjacent to the lake due to cottage and resort development.

Boating on Forest Lake is limited by its small size and poor access. Pleasure boating is deterred by shallow water in the southern portion of the lake, a shallow mid-lake bar and vegetation. Because of vegetation, swimming can probably be rated as fair quality. There are no public swimming beaches.

NONPOINT SOURCES

There are no significant nonpoint sources draining to Forest Lake.

Private sewage disposal systems may, however, be a significant threat to water quality and potentially to public health.

SUBWATERSHED CONDITIONS FOR THE WEST AND UPPER MAINSTEM REGION

This section presents the water resource conditions and nonpoint sources for each subwatershed in the West Region of the East-West Watershed. Subwatersheds in this region include Greenway Road (GW), Ice Age (IA), Eden Township (ED), Kettle Moraine (KM), McCollough Marsh (MM), Campbellsport (CP), Auburn Creek (AC), UnNamed Tributary (UT), Headwaters (HW), Lake Bernice (LB), and Wayne Marsh (WM). The locations of these subwatersheds, and the potential uses of the water resources that they contain, are shown on Map 2. The hydrologic flow connection between these subwatersheds is shown in Figure 1.

The agricultural land use distribution for this region is presented in Table 16.

The description of water resources conditions are based on findings contained in the Water Resources Appraisal and Stream Classification Report (Mace, Bozek, Wakeman, 1986).

The pollution reductions required to meet the water resources objectives presented in the following text, and the extent of needed nonpoint source practices required, are presented as part of Chapter IV.

HEADWATERS SUBWATERSHED

WATER RESOURCES CONDITIONS

Principal water resources include the main stem of the West Branch of the Milwaukee River, one small perennial stream, and one small intermittent stream.

West Branch Milwaukee River: The West Branch in this subwatershed is approximately 4.0 miles long and has a gradient of 5.8 feet per mile.

The main stem of the West Branch in this subwatershed has been extensively channelized. The river flows through wetlands and wet organic soils which partly contribute to a slow moving stream with large amounts or transient silt and organic matter. Both of these factors strongly influence the stream.

The river habitat and adjacent wetlands provide suitable spawning, rearing, and feeding habitat for warmwater game and forage fish species. Based on this, it has been determined that this stream should be designated as capable of supporting both a balanced warmwater fish community. The stream is also considered capable of supporting full body contact recreational activities.

Problems limiting the biological use of the main stem in this subwatershed include: low dissolved oxygen, habitat modification, poor substrate and limited habitat. The recreational potential is limited by low flow, small stream size and overhanging vegetation.

Perennial Tributary: This tributary originates in Section 30 and is tributary to the West Branch in Section 36 of Byron Township, Fond du Lac County. The available spawning habitat along this stream justifies classification as a balanced warmwater fish community, The stream is also considered capable of supporting partial body contact recreational uses.

Factors limiting the biological uses of this stream include low dissolved oxygen, poor bank stability, limited habitat, and poor substrate. Wetland drainage and low flow contribute to the limitations of this stream.

Intermittent Tributary: This intermittent tributary originates in Section 32 of Eden Township and is tributary to the West Branch in Section 6 of Ashford Township, Fond du Lac County.

No formal stream classification has been conducted for this stream by the Department, but it is being considered during the interim as a Full Fish and Aquatic Life Use Class B, to protect for the seasonal spawning value it may provide and the downstream biological uses.

The physical limitations of this intermittent stream are similar to that described in the section of the main stem.

Nonpoint Sources of Pollution

General Land Use: Rural land uses cover 6,657 acres, or 96 percent of the inventoried lands in this subwatershed. The agricultural land use distribution is shown in Table 16. Croplands make up 78 percent of the rural land use. Most of this is rotated row cropland, with few acres in continuous row cropping. Of the remaining rural acreage, wetlands and grasslands are next in importance, comprising nine and six percent of the acreage respectively.

The remaining 258 acres, or four percent of the inventoried lands, is in scattered urban development.

Rural Sources: Table 17 presents the rural nonpoint source summary for this subwatershed.

Only one of the six barnyards draining to surface waters in this subwatershed has a pollution potential of concern. The remaining five barnyards draining to surface waters have very little potential to impact the receiving waters.

Upland erosion is the principal source of sediment delivered to surface waters in this subwatershed. The delivered sediment, estimated to be 291 tons/year, is significant not only for the resources in this subwatershed but for Lake Bernice as well. This is evidenced by the fact that about 40 percent of the sediment delivered to the stream network above Lake Bernice occurs in the Headwaters Subwatershed. This sediment load in the Headwaters Subwatershed is delivered fairly uniformly along the stream, including a substantial input from lands along the perennial tributary mentioned above.

Only about one-half of the uplands are responsible for all of the delivered sediment in the Headwaters Subwatershed, with rotated croplands responsible for nearly all of the delivered sediment. The remaining uplands are well buffered from the surface water network, and even though erosion occurs on these lands the lost soil is not delivered to the surface waters.

Riparian wetlands play a significant role in buffering the stream system from sediment. It is estimated that riparian wetlands trap 172 tons of sediment per year that would otherwise reach the surface water channel network. The extensive internal drainage of lands in this subwatershed are also important in trapping eroded sediment. It is estimated that about 50 percent of the eroding uplands are internally-drained. Some of these internally-drained areas support wetland vegetation. These areas receive an estimated 24 tons of sediment per year.

The value and sensitivity of these wetland areas vary tremendously, and the impact of sediment loading upon them is not known.

Urban Sources: There are no significant urban nonpoint sources in the subwatershed.

WATER RESOURCES OBJECTIVES

There are many factors affecting the use potential of the streams in this subwatershed that will not be affected by the Nonpoint Source Control Program. These include past channelization, low flow characteristics of the streams, and the effects of wetland drainage on dissolved oxygen and substrate. Although the existing uses of these streams will not be changed with nonpoint source controls, these uses should be enhanced with the resulting reduction in sediment loading and to a lesser extent from the reduction in animal waste loading.

The water resources objectives for the Nonpoint Source Control Program in this subwatershed are to:

a. Protect and enhance the existing recreation, fish and aquatic life uses on the west branch and its tributaries.

b. Protect valuable and sensitive wetlands from sediment deposition, where the assimilative capacity of the wetlands is being overloaded.

c. Reduce the loading of nonpoint pollutants to downstream resources.

LAKE BERNICE SUBWATERSHED

WATER RESOURCES CONDITIONS

The water resources within this subwatershed include the West Branch of the Milwaukee River, Lake Bernice, and several small, unnamed perennial and intermittent tributaries.

Milwaukee River West Branch: The portion of the West Branch within this subwatershed is a second order stream with a total length of 10.3 miles and a gradient of 2.0 feet per mile. The habitat and other physical characteristics of the West Branch Mainstem in this subwatershed are suitable for supporting a diverse and abundant warmwater sport fishery and full body contact recreational activities.

The factors that reduce the usability of the mainstem include: bacterial contamination, excessive aquatic plants and algae, and sedimentation. Control or elimination of these problems will improve the existing quality of the biological and recreational uses.

Unnamed Perennial Tributaries: The perennial tributaries join the West Branch in Sections 7 and 26 of Ashford Township, Fond du Lac County.

The habitat of the stream tributary in Section 7 is sufficient to support a warmwater sport and forage fishery and is capable of supporting partial body contact recreational activities.

The perennial stream tributary in Section 26 is capable of supporting a good forage fishery and partial body contact recreational uses.

The problems associated with these perennial tributaries include bacterial contamination and sedimentation.

Unnamed Intermittent Tributaries: These four streams are tributary to the West Branch in the following sections of Ashford Township, Fond du Lac County: 1) Section 8, 2) Section 16, SENE, 3) Section 16, SWNW, and Section 23.

The intermittent tributaries within this subwatershed were not officially classified during the 1986 inventory process. However, until they are given an official biological use classification they should be considered to be capable of supporting a balanced warmwater sportfish community. This interim classification protects for the downstream biological uses. In addition all of these tributaries are capable of supporting partial body contact recreational activities.

The existing problems associated with these tributaries include bacterial contamination, excess nutrients, sedimentation and channelization.

Lake Bernice: Lake Bernice is an impoundment at the downstream border of this subwatershed. This impoundment has a surface area of 33 acres and is 12 feet deep. Lake Bernice supports a warmwater sport fishery, and full body contact

recreational activities. Current problems with this resource include excessive aquatic plants and algae due to high nutrient loadings.

Nonpoint Sources of Pollution

General Land Use: Rural land uses cover 11,814 acres of the inventoried lands in this subwatershed. The agricultural land use distribution is shown in Table 16. Croplands make up 70 percent of the rural land use. Most of this is rotated row cropland, with few acres in continuous row cropping. Wetlands also comprise a significant part of the land use, encompassing 2,144 acres or 18 percent of the rural land use.

The urban acreage is in partly scattered urban development and partly concentrated in a small portion of the village of Campbellsport.

Rural Sources: Table 18 presents the rural nonpoint source summary for this subwatershed.

Only one of the six barnyards draining to surface waters in this subwatershed has a pollution potential of concern. The remaining five barnyards draining to surface waters have very little potential to impact the receiving waters.

Upland erosion is the principal source of sediment delivered to surface waters in this subwatershed. The delivered sediment is estimated to be 376 tons/year. The sediment is delivered in significant quantities all along the river, including significant inputs to the perennial and intermittent tributaries mentioned above.

Only about one-half of the uplands are responsible for all of the delivered sediment in the Lake Bernice Subwatershed, with rotated croplands the most important source. The remaining uplands are well buffered from the surface water network, and even though erosion occurs on these lands the lost soil is not delivered to the surface waters.

Riparian wetlands play a significant role in buffering the stream system from sediment. It is estimated that riparian wetlands trap 202 tons of sediment per year that would otherwise reach the surface water channel network. The extensive internal drainage of lands in this subwatershed are also important in trapping eroded sediment. It is estimated that about 50 percent of the eroding uplands are internally-drained. Some of these internally-drained areas support wetland vegetation. These areas receive an estimated 414 tons of sediment per year.

The value and sensitivity of these wetland areas vary tremendously, and the impact of sediment loading upon them is not known.

Urban Sources: A portion of the village of Campbellsport lies within the Lake Bernice Subwatershed. Based on topographic maps, a portion of the surface drainage would flow to the unnamed intermittent tributary entering the West Branch in Section 23 of Ashford Township. Existing land use in this portion of the village includes single family residential, commercial, and industrial.

Increased development is projected for this portion of the Campbellsport Study Area.

Water Resources Objectives

In general, both nonpoint sources and factors such as channelization and wetland drainage affect the use potential of the water bodies in this subwatershed. Most of the nonpoint source controls will be aimed at the reduction of sediment and its associated nutrients from urban and rural sources.

The water resources objectives for the Nonpoint Source Control Program in this subwatershed are to:

a. Enhance the existing recreation, fish, and aquatic life uses of Lake Bernice by improving the existing trophic status of the lake.

b. Enhance the existing recreation, fish, and aquatic life uses of the Milwaukee River and its tributaries.

c. Protect valuable and sensitive wetlands from sediment deposition, where the assimilative capacity of the wetlands is being overloaded.

d. Reduce the nonpoint source pollutant loading to downstream water resources.

WAYNE MARSH SUBWATERSHED

WATER RESOURCE CONDITIONS

The water resources within the Wayne Marsh Subwatershed include the West Branch of the Milwaukee River, unnamed perennial tributaries, one unnamed intermittent tributary and Wayne Marsh.

Milwaukee River West Branch: The West Branch of the Milwaukee River within this subwatershed is 6.3 miles long, stretching from the Lake Bernice Dam to its confluence with the Milwaukee River mainstem.

The West Branch within this subwatershed is limited by low flow, bacterial contamination, aquatic plants and large amounts of transient bed material. The habitat was considered to be good for forage fish and fair for game fish species. As a result the West Branch is classified as capable of supporting a warmwater sport fishery. The recreational potential may be improved by reducing the bacteria levels which have been found to be above the recommended level for full body contact activities and reducing nutrient levels to reduce aquatic plants.

Perennial Tributaries: The small perennial tributary to the West Branch in Section 32 of Auburn Township, Fond du Lac County, originates in Wayne Marsh. Wayne Marsh is located in Sections 13-14 of Wayne Township and Sections 18 and 19 of Kewaskum Township, Washington County. This tributary is classified as capable of supporting an intolerant forage fish population. The stream is capable of supporting partial body contact activities. The factors which limit its biological or recreational potential include bacterial contamination, sedimentation and aquatic plants and algae which are a result of excessive nutrients.

The unnamed tributary to the West Branch in Section 31 of Auburn Township is also classified as capable of supporting an intolerant forage fish community and partial body contact activities. The factors limiting the biological and recreational potential of this stream include bacterial contamination, excessive aquatic plants and algae, sediment and channelization.

Intermittent Tributaries: One of these streams is tributary to the West Branch in the sw quarter of Section 31, Auburn Township. The other joins the perennial tributary originating in Wayne Marsh. It originates in Section 2 of Wayne Township and joins the perennial tributary in Section 6 of Kewaskum Township.These unnamed intermittent tributary were not formally classified during the 1986 inventory process. However in the interim they should be considered to be capable of supporting warmwater sportfish in order to protect for the downstream biological uses and for the possible seasonal spawning value to sport fish. The factors which are impacting this tributary include channelization, bacterial contamination and sedimentation.

Nonpoint Sources of Pollution

General Land Use: Rural land uses cover 12,684 acres, or nearly the entire subwatershed. The agricultural land use distribution is shown in Table 16. Croplands, all of which are rotated, make up 66 percent of the rural land use. Ungrazed woodlots, and wetlands are also significant land uses, making up 16 and 9 percent of the lands inventoried, respectively.

Rural Sources: Table 19 shows the results of the nonpoint source inventory for this subwatershed.

The 30 barnyards draining to surface waters form a substantial pollution potential to surface waters and wetlands in this subwatershed. Twelve of these are of concern due to their pollution potential. These drain primarily to the Wayne Marsh, the West Branch, and the perennial tributary originating in Wayne Marsh. Most of the remaining barnyards are of less concern, either because of the low sensitivity of the area receiving the drainage or because of the low pollution potential of the barnyards. However, the potential impact of the two barnyards draining to shallow soils is unknown.

It is estimated that 853 tons of sediment are delivered per year to surface waters. Most of this (96 percent) comes from upland erosion. The remainder comes from five eroding streambank sites.

This sediment loading is the highest in the west region of the watershed, and amongst the highest in the East-West Watershed. The West Branch as well as the perennial and intermittent tributaries mentioned above all receive significant loads of delivered sediment. The most intensive sediment delivery occurs along the perennial tributary that joins the West Branch in Section 32 of Auburn Township and the intermittent tributary that joins this perennial tributary in Section 6 of Kewaskum Township. This system of perennial and intermittent streams accounts for 50 percent of the delivered sediment in the entire subwatershed.

Slightly less than one-half of the uplands are responsible for all of the delivered sediment in the subwatershed. The remaining uplands are well buffered from the surface water network, and even though erosion occurs on these lands the lost soil is not delivered to the surface waters.

Riparian wetlands play a role in buffering the stream system from sediment. It is estimated that riparian wetlands trap 142 tons of sediment per year that would otherwise reach the surface water channel network. The extensive internal drainage of lands in this subwatershed are also important in trapping eroded sediment. It is estimated that about 61 percent of the eroding uplands are internally-drained. Some of these internally-drained areas support wetland vegetation. These areas receive an estimated 339 tons of sediment per year.

The value and sensitivity of these wetland areas vary tremendously, and the impact of sediment loading upon them is not known.

Streambank degradation is not extensive, occurring at nine sites. The four sites on the West Branch include 2,145 feet which produce 8.5 tons of sediment per year. One site is important primarily because of trampled streambanks and streambed, not because of sediment production. Five sites are located on the perennial stream tributary to the West Branch in Section 32 of Auburn Township, and its intermittent tributary. These sites include 1,900 feet which produce an estimated 24 tons of sediment. Three of these sites are important primarily because of trampled streambed and banks.

Urban Sources: There are no significant urban nonpoint sources.

Water Resources Objectives

Most of the surface waters suffer both from limitations not dealt with through the Nonpoint Source Control Program, such as low flow and channelization, as well as traditional nonpoint source impacts such as sedimentation, nutrient enrichment, and bacterial contamination. The perennial tributary originating in Wayne Marsh appears to be affected entirely by nonpoint sources. The pollutant loading to this perennial stream system is dramatic. Although improvements in the existing use are possible, changes in the use class will not result from nonpoint source controls alone. The objectives for the Nonpoint Source Control Program are to:

a. Enhance the quality of existing recreational and aquatic life uses in the Milwaukee River and its intermittent and perennial tributaries, particularly the perennial tributaries supporting intolerant forage fish communities.

b. Protect valuable and sensitive wetlands from sediment deposition, where the assimilative capacity of the wetlands is being overloaded.

c. Reduce the nonpoint source pollutant loading to downstream water resources.

GREENWAY ROAD SUBWATERSHED

WATER RESOURCES CONDITIONS

The water resources within this subwatershed are limited to the headwater reaches of an unnamed, partially intermittent tributary to the Main Branch (Upper) of the Milwaukee River. The headwaters of this stream is located in a wetland located in Section 17 of Eden Township, Fond du Lac County. Two intermittent streams join this stream within the subwatershed.

Perennial and Intermittent Tributaries: Nearly the entire length of these streams in this subwatershed has been channelized for agricultural purposes. Because of the physical alterations and the naturally limiting low flow and stream size, the habitat was considered to be poor and is only capable of supporting a tolerant forage fish community, and partial body contact recreational uses. Other factors impacting these water resources include sedimentation and macrophytes. Elimination or reduction of these pollutants will improve the existing quality within the Greenway Road Subwatershed and downstream, but a change in use classification cannot be achieved through nonpoint source controls.

NONPOINT SOURCES OF POLLUTION

General Land Use: The rural land use for this subwatershed is summarized in Table 16. All land use in this subwatershed is rural. Croplands make up 72 percent of the land use, with nearly all of this cropland in rotation. Wetlands, which make up 634 acres or 23 percent, is the other major land use.

Rural Sources: Table 20 shows the results of the nonpoint source inventory for this subwatershed.

The nonpoint source potential in this subwatershed is very low. There are no barnyards and no streambank erosion sites. The only source of sediment is eroding uplands, which contribute an estimated 51 tons of sediment per year to surface waters. Nearly all of this is from the cropland. Nearly all of this delivered sediment enters the stream network in Section 21 of Eden Township; little enters above this point.

Less than one-third of the eroding uplands deliver sediment to the streams. The remaining uplands are well buffered from the stream network. This buffering is due in part to riparian wetlands, which filter an estimated 23 tons of sediment per year. It is also due to the extensive amount of internal drainage, which claims the runoff from 77 percent of the uplands.

Some of these internally-drained areas support wetland vegetation, which receives an estimated 72 tons of sediment per year. The impact of this

sediment on the riparian and non-riparian wetland vegetation is unknown, although it is expected to be site-specific and highly variable.

Urban Sources: There are no urban lands in the subwatershed.

Water Resource Objectives

Due to the multitude of factors affecting these streams, the most the nonpoint source program can attempt to achieve is limited enhancement of the existing recreation, fish, and aquatic life uses of these water bodies, principally through sediment control. This enhancement will likely be limited to the perennial and intermittent stream segments located in Section 21 of Eden Township.

Water resources objectives for the Nonpoint Source Control Program in this subwatershed are to:

a. Improve the quality of existing recreational and aquatic life uses in the perennial and intermittent tributaries, particularly in Section 21 of Eden Township.

b. Protect valuable and sensitive wetlands from sediment deposition, where the assimilative capacity of the wetlands is being overloaded.

c. Reduce the nonpoint source pollutant loading to downstream water resources.

Ice Age Subwatershed

Water Resource Conditions

The water resources within this subwatershed include the lower reaches of an unnamed perennial tributary to the Main Branch of the Milwaukee River, and one intermittent tributary.

The unnamed perennial stream originates in the Greenway Road Subwatershed and ultimately joins the Milwaukee River in Section 28 of Eden Township, Fond du Lac County. The total length of this tributary is 2.1 miles. The intermittent tributary flows approximately 3.6 miles before it joins the perennial tributary in Section 28 of Eden Township.

Perennial Tributary: Based on the 1986 inventory data, this unnamed perennial tributary is classified as capable of supporting tolerant or very tolerant fish or tolerant macroinvertebrates. It is also capable of supporting partial body contact recreational activities.

The perennial tributary within this subwatershed is impacted by several factors which limit its biological and recreational potential. These factors include sedimentation, aquatic plants and algae, and channelization.

Intermittent Tributary: The complex of intermittent tributaries within this subwatershed are not officially classified, but are considered to be capable of supporting partial body contact recreational activities. By default it is recommended that these streams be classified as capable of supporting warmwater sportfish, in order to protect the biological potential until these streams can be formally classified.

They are impacted by the same factors which limit the biological and recreational potential of the perennial tributary.

Nonpoint Sources of Pollution

General Land Use: The Ice Age Subwatershed is found in the Ice Age National Scientific Reserve (Campbellsport Drumlins Area). The entire area is in rural land use. The rural land use distribution is shown in Table 16. The predominant land uses are cropland, which comprises 59 percent of the land use, wetland, which makes up 21 percent of the land use, and ungrazed woodlot, which makes up 15 percent of the land use.

Rural Sources: Table 21 shows the results of the nonpoint source inventory for this subwatershed.

Eroding uplands are the only significant nonpoint source in the subwatershed. It is estimated that 128 tons of sediment are delivered annually to the stream

network. Sediment delivery is relatively uniform along the stream network. This sediment load is derived almost entirely from rotated cropland. A fairly high proportion (62 percent) of the uplands deliver sediment to the stream network. Riparian wetlands capture an estimated 64 tons of sediment per year that would otherwise reach the surface water network.

About one-half of all lands in the subwatershed are internally-drained. Some of these areas support wetland vegetation and receive an estimated 60 tons of sediment per year from eroding uplands. The impact of this sediment loading on riparian and non-riparian wetlands is not known, but can be expected to vary widely.

Urban Sources: There are no urban lands in the subwatershed.

Water Resources Objectives

The effectiveness of nonpoint source controls will be limited due to the many other factors impacting these streams, such as channelization, low flow, and wetland drainage. Nonpoint source controls will emphasize sediment load reduction.

The water resources objectives for the Nonpoint Source Control Program are to:

a. Protect the existing recreation, fish, and aquatic life uses tributaries from further degradation.

b. Reduce the pollutant loading to downstream water bodies.

c. Protect valuable and sensitive wetlands from sediment deposition, where the assimilative capacity of the wetlands is being overloaded.

EDEN SUBWATERSHED

WATER RESOURCE CONDITIONS

The water resources located within this subwatershed include the headwaters to the Main Branch of the Milwaukee River. There are also four perennial tributaries with drainage entirely within the subwatershed boundaries, one perennial tributary entering from the Ice Age Subwatershed, numerous intermittent tributaries, and extensive wetland areas.

Milwaukee River Main Branch: The headwaters of the Milwaukee River Main Branch originate in wetlands located in Section 13 of Eden Township, Fond du Lac County.

Based upon the 1986 inventory results, the Main Branch in this subwatershed is classified as capable of supporting a warmwater sport fishery and is also considered to be capable of supporting full body contact recreational activities.

The biological and recreational potential of the Main Branch in the Eden Township is limited by several factors, including bacterial contamination, plants and algae, low dissolved oxygen, habitat modification, sedimentation, poor substrate, and turbidity.

Perennial Tributaries: Perennial tributaries to the Main Branch in this subwatershed are unnamed. Their respective confluences with the Main Branch are located as follows: 1) Section 36 SESE, Eden Township; 2) Section 36 SENW, Eden Township; 3) Section 14 SWSW, Eden Township.

All three of the perennial tributaries in the Eden Subwatershed are classified as capable of supporting a warmwater sport fishery. In addition they are classified as partial body contact recreational streams.

The biological and recreational potential of these streams is limited by several factors, including bacterial contamination, aquatic plants and algae, low dissolved oxygen, channelization, sedimentation, low flow and parent soils.

Intermittent Tributaries: The major intermittent tributaries to the Main Branch in this subwatershed are unnamed. Their respective confluences with the Main Branch are located as follows: 1) Section 35 NENW, Eden Township; 2) Section 26 SESW, Eden Township; 3) Section 15 SESE, Eden Township, and Section 22 SESE, Eden Township.

The most important limiting factor to these streams is channelization which has resulted in poor habitat quality. Based on the 1986 inventory results, these streams are considered to be capable of supporting partial body contact

recreational activities. No stream classification was determined for these intermittent tributaries.

Smaller streams are likely to have the same limiting factors.

Nonpoint Sources of Pollution

General Land Use: The general land use in this subwatershed is virtually all rural, with less than one percent in scattered urban development. The rural land use distribution is shown in Table 16. Croplands and wetlands dominate the landscape, comprising 65 and 24 percent of the land use respectively. Most of the cropland is in rotation.

Rural Sources: Table 22 shows the results of the nonpoint source inventory for this subwatershed.

There are twelve barnyards having runoff going to surface waters and their associated wetlands. Of these, there are only two that are a concern due to their pollution potential. The remaining barnyards, including the internally-drained ones, are not a concern.

Eroding uplands are the primary source of sediment delivered to the surface water network. These uplands deliver an estimated 218 tons of sediment per year. Sediment delivery is significant to most parts of the Milwaukee River as well as to most of the perennial and intermittent tributaries listed above. Exceptions include the streams tributary to the Milwaukee River in T14N R18E Section 26 SESW and Section 22 SESE. This sediment comes almost entirely from croplands. About 50 percent of the eroding uplands are responsible for delivering this sediment to surface waters. The remaining uplands are well buffered from the stream network. Part of this buffering is due to riparian wetlands, which filter an estimated 100 tons of sediment before it reaches surface waters. About one-third of all lands are internally-drained, also contributing to the low proportion of eroding parcels which contribute sediment to surface waters. Internally-drained areas that support wetland vegetation receive 476 tons of sediment per year, but the effects of this deposited sediment are unknown.

There is only one streambank erosion site in the subwatershed, located on the mainstem near the mouth of the subwatershed. The site may have localized impacts, but contributes only one percent of the subwatershed sediment load.

Urban Sources: There are no significant urban nonpoint sources in the subwatershed.

Water Resources Objectives

Wetland drainage, stream channelization, and low flow all have significant impacts on the streams in this subwatershed. Although nonpoint source impacts

such as sedimentation, nutrient enrichment, and bacterial contamination can be alleviated, changes in these streams will be limited. Most of the nonpoint source controls will be aimed at reduction of sediment and its associated nutrients. Water resources objectives for the Nonpoint Source Control Program are to:

a. Enhance the existing biological and recreational uses of the Milwaukee River and its tributaries.

b. Reduce the nonpoint source pollutant loading to downstream water bodies.

c. Protect valuable and sensitive wetlands from sediment deposition, where the assimilative capacity of the wetland is being overloaded.

KETTLE MORAINE SUBWATERSHED

WATER RESOURCE CONDITIONS

The water resources within this subwatershed include the Waucousta River, one unnamed perennial tributary, and two intermittent tributaries. In addition there are three lakes, Kettle Moraine Lake, Mud Lake and Spruce Lake. This subwatershed also contains extensive wetland areas.

Waucousta River: The major stream in this subwatershed is the Waucousta River which is 10 miles long and joins the Milwaukee River Main Stem in Section 6 of Auburn Township, Fond du Lac County. The headwaters is located in a drainage ditch in wetlands located in Section 4 of Osceola Township.

The Waucousta River is a low gradient stream that is greatly influenced by the adjacent wetlands. Based upon the available habitat data, fish and macroinvertebrate collections, it is recommended that the stream be classified as capable of supporting a warmwater sport fishery and full body contact recreational activities. The factors which are limiting the biological or recreational potential of this stream includes; bacteria contamination, severe sedimentation, Purple Loosestrife, channelization and aquatic plants and algae.

Mitchell Creek: The unnamed perennial tributary in this subwatershed is sometimes referred to as Mitchell Creek. This tributary to the Waucousta River originates in Section 18 of Osceola Township and joins the Waucousta River eight miles downstream in Section 20.

Mitchell Creek has been recently and illegally channelized and moved for agricultural practices. In addition to channelization, several other factors limit the biological and recreational potential of Mitchell Creek. These include bacterial contamination, aquatic plants and algae and sedimentation.

Based upon the 1986 inventory results, Mitchell Creek is being classified as capable of supporting an intolerant forage fish community. It is also considered capable of supporting partial body contact recreational activities.

Intermittent Tributaries: Two unnamed intermittent tributaries also enter the Waucousta River in the Kettle Moraine Subwatershed. Their confluences are located in Sections 10 and 15 of Osceola Township.

Both of these tributaries are classified as capable of supporting a warmwater sport fishery or providing valuable sport fish spawning habitat. They are also considered to be capable of supporting partial body contact recreational activities.

The factors which limit the biological and recreational potential of these intermittent tributaries include channelization, low dissolved oxygen, available cover and sedimentation.

Lakes: Three lakes - Kettle Moraine, Mud, and Spruce Lake - occur in the Kettle Moraine Subwatershed. Mud Lake is located in line with the Waucousta River. Both Kettle Moraine Lake and Spruce Lake have no inlet or outlet. Kettle Moraine Lake is well developed, while Mud and Spruce Lake are not. Spruce Lake is located entirely within the Spruce Lake National Natural Landmark boundaries.

The lakes within the Kettle Moraine Subwatershed are impacted by factors which reduce their recreational attractiveness. These factors include aquatic plants and algae, size and depth. The source of the aquatic vegetation problem is excessive nutrients.

Nonpoint Sources of Pollution

General Land Use: The general land use in this subwatershed is virtually all rural, with only two percent in scattered urban development. The rural land use distribution is shown in Table 16. Croplands and wetlands dominate the landscape, comprising 51 percent and 35 percent of the rural land use respectively. Nearly all of the cropland is in rotation. Grassland and ungrazed woodlots together make up 12 percent of the rural land use.

Rural Sources: Table 23 shows the results of the rural nonpoint source inventory for this subwatershed.

Two of the five barnyards draining to surface waters have high enough pollution potential to be of concern. Both drain to Mud Lake, one directly and one via the lower reaches of Mitchell Creek. The remaining barnyards draining to surface waters have a relatively low pollution potential. Generally, the internally-drained barnyards are not a concern. However, two of the barnyards draining to pocket wetlands have relatively high pollution potential, and the effects are not known.

Sediment delivered from rural land uses is estimated to be 136 tons per year. This accounts for 90 percent of the sediment load to lakes and streams in the subwatershed. The remaining load is associated with scattered urban development. The largest portion of the delivered sediment enters the surface water system along the lower reaches of the Waucousta River, between County Highway F and its confluence with the Milwaukee River. This portion of the Waucousta River receives over 50 percent of the delivered sediment load. Mud Lake, via the upper reaches of the Waucousta River, receives about 15 percent of the delivered sediment load, while Kettle Moraine Lake receives about 15 percent from its direct drainage area. The remaining stream segments receive more moderate amounts of delivered sediment.

Over 90 percent of the sediment delivered from rural land use comes from croplands. Farmsteads account for four percent and wetlands for two percent of the total respectively.

It is estimated that only 20 percent of the rural land use delivers eroded soil to the surface water network. This is in part because of the riparian wetlands that act to buffer the stream network. It is estimated that riparian wetlands filter 60 tons of sediment per year that would otherwise reach surface waters.Perhaps an even more important factor is the extensive internal drainage in the subwatershed. Nearly 90 percent of all lands are internally-drained. Some of these areas support wetland vegetation, which together receive an estimated 672 tons of sediment per year.

The effects of sediment loading on riparian and non-riparian wetlands is not known, although they are expected to vary widely.

Urban Sources: The urban development in this subwatershed makes up about two percent of the inventoried lands, and consists primarily of residential land with a small amount of associated commercial development. The development is concentrated around the shores of Kettle Moraine and Birchwood lakes. It is estimated that approximately 10 percent of the sediment loading within the watershed comes from these land uses.

WATER RESOURCE OBJECTIVES

Wetland drainage, stream channelization, and low flow all have significant impacts on the streams in this subwatershed. Although nonpoint source impacts such as sedimentation, nutrient enrichment, and bacterial contamination can be alleviated, changes in these streams will be limited. Most nonpoint source controls will be aimed at reducing sediment and its associated nutrients, with limited effort put into controlling animal waste sources.

The water resources objectives for the Nonpoint Source Control Program are to:

a. Protect and enhance the existing aquatic and recreation uses of Mud Lake, Kettle Moraine Lake, and the lower reaches of the Waucousta River.

b. Protect the existing uses in the remaining portions of the Waucousta River and its tributaries.

c. Reduce the nonpoint source loading to downstream water bodies.

d. Protect valuable and sensitive wetlands from sediment deposition and barnyard runoff, where the assimilative capacity of the wetland is being overloaded.

McCullough Marsh Subwatershed

Water Resource Conditions

The McCullough Marsh Subwatershed contains the Main Branch of the Milwaukee River and two intermittent streams.

Milwaukee River Main Branch: One-third of the 3.0 miles of the Main Branch in this subwatershed is impounded by the 23 acre Campbellsport millpond.

The Main Branch of the Milwaukee River upstream of the Campbellsport Millpond flows through McCullough Marsh and is very diffuse with no discernible stream channel. Very little is known concerning the exact habitat characteristics of the river in McCullough Marsh. However, it can be assumed to have characteristics that are similar to streams that flow through extensive wetlands. The characteristics include low gradient, organic substrate, and low dissolved oxygen. In addition, bacterial contamination from fecal material is also present and is limiting the recreational potential of the Main Branch is this subwatershed.

Intermittent Tributaries: The confluences of the two intermittent tributaries with the main branch are located in Sections 6 and 7 of Auburn Township, Fond du Lac County.

No habitat data is available on these two streams. It can be assumed that they have characteristics which are similar to intermittent streams which are greatly influenced by wetlands. Generally these characteristics include low gradients, organic substrates, low dissolved oxygen problems and limited available cover due to low flow. In addition these two tributaries have been channelized.

The intermittent tributaries within this subwatershed have not been officially classified. However, it is recommended that in the interim they be classified as capable of supporting warmwater sport fish, to protect for the downstream use and any potential spawning value they may have. They are also considered to be capable of supporting partial body contact recreational uses.

Campbellsport Millpond: The Campbellsport Millpond is very shallow, silty and weed choked. Summer fish kills due to oxygen depletion by aquatic macrophytes have been reported in the past.

Nonpoint Sources of Pollution

General Land Use: The general land use in this subwatershed is virtually all rural, with only one percent in urban land use. The rural land use distribution is shown in Table 16. Croplands make up 71 percent of the rural land use. All of the cropland is in rotation. Wetlands and grasslands are

the next most prevalent land uses, making up 16 and 8 percent of the rural lands respectively.

Rural Sources: Table 24 shows the results of the rural nonpoint source inventory for this subwatershed.

Only one of the four barnyards draining to surface waters has a pollution potential of any concern, and the concern for that barnyard is only marginal. The other barnyards draining to surface waters are of no concern.

Sediment delivered from rural land uses is estimated to be 67 tons per year. This accounts for 97 percent of the sediment load to lakes and streams in the subwatershed. The remaining load is associated with the urban development. Approximately 75 percent of the sediment is delivered to the river below the line dividing Sections 6 and 7 of Auburn Township. The intermittent tributary entering the river in Section 7, just above the Campbellsport Millpond, is a major contributor of sediment.

Virtually all of the sediment delivered from rural land use comes from croplands.

It is estimated that only 42 percent of the rural land use delivers eroded soil to the surface water network. This is in part because of the riparian wetlands that act to buffer the stream network. It is estimated that riparian wetlands filter 18 tons of sediment per year that would otherwise reach surface waters. Perhaps an even more important factor is the extensive internal drainage in the subwatershed. Nearly 60 percent of all lands are internally-drained. Some of these areas support wetland vegetation, which together receive an estimated 73 tons of sediment per year.

The effects of sediment loading on riparian and non-riparian wetlands is not known, although they are expected to vary widely.

Urban Sources: The urban development in this subwatershed makes up about one percent of the inventoried lands, consisting of residential development. It is estimated that approximately three percent of the sediment loading within the watershed comes from this land use.

Future residential development is anticipated for the northwest corner of Campbellsport, which drains to the millpond.

Water Resources Objectives

Wetland drainage, and to a more limited extent stream channelization, have significant impacts on the streams in this subwatershed. Sedimentation and its associated nutrient load is the primary nonpoint source impact that can be alleviated. Reduction of nutrients through barnyard runoff controls and controls on manure spreading will be more limited.

The water resources objectives for the Nonpoint Source Control Program are to:

a. Protect the existing biological and recreational uses in the Milwaukee River and its tributaries, and in the Campbellsport Millpond.

b. Reduce the nonpoint source loading to downstream water bodies.

c. Protect valuable and sensitive wetlands from sediment deposition and barnyard runoff, where the assimilative capacity of the wetland is being overloaded.

AUBURN CREEK SUBWATERSHED

WATER RESOURCE CONDITIONS

Major water resources include Auburn Lake Creek, Virgin Creek, Auburn Lake and several small lakes.

Auburn Lake Creek, Virgin Creek: Auburn Lake Creek is 8.2 miles long and has a gradient of 8.1 feet per mile. Auburn Lake Creek is joined by four tributaries including Virgin Creek. The other three tributaries are first order unnamed streams and have relatively small drainage areas.

Virgin Creek is approximately 3.4 miles long and has a gradient of 7.0 feet per mile.

Auburn Lake Creek and Virgin Creek have sufficient habitat and water quality to support a good forage fish and sport fish population. The extensive wetlands provide valuable Northern Pike spawning habitat as well as wildlife habitat. Based on the biological, and physical characteristics of these streams they can be classified as capable of supporting a warmwater sport fish use. The headwaters of Auburn Lake Creek should be considered capable of supporting a cold water sport fishery. Auburn Lake Creek is capable of supporting both full and partial body contact recreational uses, while Virgin Creek is capable of supporting partial body contact recreational uses.

Both streams are considered to be close to their biological and recreational potential. High bacteria levels and channel modification are the most important problems limiting the use of these streams. Abatement of the controllable factors will improve the existing quality of the biological and recreational uses within this subwatershed and downstream.

Unnamed Perennial Tributaries: These streams are tributary to Auburn Lake Creek and Virgin Creek in Sections 10 and 16 of Auburn Township. Little is known about the unnamed perennial streams within this subwatershed. They are likely to exhibit the same characteristics that Auburn Lake Creek and Virgin Creek have as the general topography and soils are similar. They are classified as capable of supporting a warmwater sport fishery and partial body contact recreational activities.

Auburn Lake: The single most important lake in this subwatershed is Auburn Lake, which is a 107 acre, 29 foot mesotrophic headwater drainage lake.

Auburn Lake supports a wide variety of recreational uses and does not appear to have any severe limiting factors.

Nonpoint Sources of Pollution

General Land Use: The general land use in this subwatershed is virtually all rural, with only four percent in urban land use. The rural land use distribution is shown in Table 16. Wetland make up 35 percent of the rural land use. Croplands, all of which are rotated, make up 28 percent of the rural land use, and ungrazed woodlots and grasslands comprise 36 percent.

Rural Sources: Table 25 shows the results of the rural nonpoint source inventory for this subwatershed.

The pollution potential from barnyards is very low. Only one barnyard, which drains into the lower reaches of Virgin Creek, is a concern.

Sediment delivered to surface waters from rural land uses is estimated to be 101 tons per year. This accounts for 90 percent of the sediment load to lakes and streams in the subwatershed. The remaining load is associated with the urban development. About 70 percent of the sediment delivered from upland erosion enters the Virgin Creek drainage, while the other 30 percent enters the Auburn Creek drainage above Auburn Lake. Relative hot spots for sediment delivery to the Virgin Creek drainage include the mile of Virgin Creek below Highway 67, and the perennial tributary located in Section 16 of Auburn Township.

Ninety percent of the sediment delivered from rural land use comes from croplands. The remaining 10 percent comes from woodlands, wetlands, and grasslands.

It is estimated that 62 percent of the rural land use delivers eroded soil to the surface water network. The remainder is buffered from the surface water network. Part of the buffering is due to riparian wetlands, which trap an estimated 70 tons of sediment per year. Another important factor is the extensive internal drainage in the subwatershed. About 55 percent of all lands are internally-drained. Some of these areas support wetland vegetation, which together receive an estimated 126 tons of sediment per year.

The effects of sediment loading on riparian and non-riparian wetlands is not known, although they are expected to vary widely.

Urban Sources: The urban development in this subwatershed makes up about four percent of the inventoried lands, consisting primarily of residential development and its associated commercial areas. It is estimated that approximately 10 percent of the sediment loading within the watershed comes from this land use.

WATER RESOURCES OBJECTIVES

Nonpoint source controls, mainly to reduce sediment and its associated nutrients, may enhance somewhat the resource in Virgin Creek and protect, or possibly enhance the other resources. Other limitations, including channelization and low flow characteristics will continue to pose problems, however, for some of these resources.

The water resources objectives for the nonpoint source program are to:

a. Protect and enhance the existing recreation and aquatic life uses in the perennial and intermittent streams and in Auburn Lake.

b. Reduce the pollutant loading to downstream water bodies.

c. Protect valuable and sensitive wetlands from sediment deposition, where the assimilative capacity of the wetland is being overloaded.

CAMPBELLSPORT SUBWATERSHED

WATER RESOURCES CONDITIONS

Water resources located within the subwatershed boundaries include the Main Branch Milwaukee river, two small perennial streams, one small lake and wetlands.

Milwaukee River: The major perennial stream in this subwatershed is the Main Branch of the Milwaukee River. The Main Branch in this subwatershed is 8.3 miles long, from the outlet if the Campbellsport Millpond dam to its confluence with the West Branch of the Milwaukee River.

The Main Branch of the Milwaukee River is classified as capable of supporting a warmwater sport fishery and is considered to be capable of supporting full body contact recreational activities. The factors which are limiting the biological and recreational potential of the Main Branch include bacterial contamination, aquatic plants and algae, low dissolved oxygen, sedimentation, and low flow.

Perennial Tributaries: The confluences of the two small perennial streams with the Main Branch are located in Section 17, NWNE and Section 33, NWSE of Auburn Township, Fond du Lac County. Each of these streams is less than one mile long.

Neither of these tributaries were classified during the 1986 inventory process. However, they are considered capable of supporting partial body contact recreational activities.

The perennial tributaries are being impacted by factors which are preventing them from reaching their maximum biological and recreational potential. These factors include low dissolved oxygen, channelization, low flow and parent soils.

NONPOINT SOURCES OF POLLUTION

General Land Use: This subwatershed is predominantly rural. Rural lands comprise 86 percent of the area, while urban lands make up 14 percent. The urban lands within the subwatershed are concentrated in the Campbellsport Study Area.

Table 16 shows the distribution of rural lands in the subwatershed. Croplands make up 73 percent of the rural lands, with all of this land in crop rotation. Woodlands and wetlands are also important land uses, each making up 11 percent of the rural land use.

Urban land use in the Campbellsport Study Area covers 455 acres. The urban land use distribution for the study area is shown in Map 3. Low intensity land uses such as recreational and transportation lands make up 21 percent of the area. Single family residential areas, a relatively low intensity land use, make up 54 percent of the area. Higher intensity land uses, including commercial, industrial, and institutional lands, make up 25 percent of the area. A large portion of the industrial land use actually occurs in the Lake Bernice Subwatershed, and drains via a tributary to the West Branch of the Milwaukee River.

Nearly all of the high intensity urban lands are within the incorporated limits of the village. This ranges from 85 percent for commercial and institutional, to almost 100 percent for industrial. A larger portion (26 percent) of the residential land within the study area occurs outside the village limits.

Rural Sources: Table 26 shows the results of the rural nonpoint source inventory for this subwatershed.

Barnyards are a relatively insignificant source of pollution. Of the five barnyards draining to surface waters, four pose little hazard and one is of marginal concern.

Eroding uplands are estimated to deliver 159 tons of sediment per year to surface waters. Sediment delivery from these uplands is distributed fairly evenly along the Milwaukee River and its perennial tributaries. About 92 percent of this comes from croplands, all of which are in rotation.

This sediment load from eroding uplands is estimated to make up 78 percent of the total sediment load in the subwatershed.

About three-fourths of the uplands are estimated to be contributors of this sediment load to surface waters. The remaining acres do not deliver eroded sediment to surface waters partly because of internal drainage that affects about one-third of the subwatershed, and partly because of the buffering effects of all lands, including riparian wetlands. It is estimated that riparian wetlands trap an estimated 99 tons of sediment per year that would otherwise have entered surface waters. Wetland vegetation within internally-drained areas receives an estimated 26 tons of sediment per year. The effects of this sediment deposition on these wetlands is unknown, but expected to vary widely, as does the sensitivity and value of the wetlands themselves.

Urban Sources: Diffuse urban runoff contains a wide array of pollutants that can lead to the degradation of surface waters. Each urban pollutant is associated to varying degrees with specific types of urban land uses. The pollutants, therefore are generated wherever these land uses occur, regardless of the size of the community. The nature of the stormwater conveyance system, however, can have a dramatic effect on the transport and delivery to surface waters of these pollutants generated in urban areas.